Agricultural Value Added and Economic Growth in the European Union Accession Process

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Abstract

The aim of this paper is to analyse the impact of agricultural income within the framework of the European Union integration process using an extended Solow growth model and panel data analysis tools. The effects of per capita agricultural value added on per capita income were examined using two samples of 25 and 30 EU member and candidate states respectively for the periods 1995-2007 and 2002-2007. A dummy variable representing EU membership status and a composite risk variable computed by the PRS Group, which provided information on structural properties of the economies of relevant countries, were used as independent variables. According to the two-way random effects estimation results, the agricultural value added elasticity of per capita income was 0.025 for the 1995-2007 period, and 0.22 for the 2002-2007 period. It was estimated that average per capita income is 5.6 % higher among EU members. With a change representing a 1 point rise in composite risk, which means a reduction of the risk faced by the country concerned, it was demonstrated that per capita income rose 1% during both periods. The results also showed that agriculture retains its economic importance, and that average per capita income among EU members is higher than among non-members due to exogenous factors.

Keywords: *European Union, integration, Solow growth, agricultural value added, risk.*

Résumé

L'objectif de cet article est d'analyser l'impact du revenu agricole dans le cadre du processus d'intégration dans l'Union européenne, en utilisant une extension du modèle de Solow et des outils d'analyse des données de panel. Les effets de la valeur ajoutée agricole par habitant sur le revenu par habitant ont été examinés en s'appuyant sur deux échantillons de 25 et 30 États membres et Pays candidats, respectivement pour les périodes 1995-2007 et 2002-2007. Une variable nominale représentant le statut de membre de l'UE et une variable de risque composite, calculée par PRS Group, fournissant des informations sur les propriétés structurelles des économies des pays concernés, ont été utilisées comme variables indépendantes. Selon les résultats du modèle à effets aléatoires bidirectionnel, l'élasticité de la valeur ajoutée agricole du revenu par habitant est égale à 0,025 pour la période 1995-2007 et à 0,22 pour la période 2002-2007. Il a été estimé que le revenu moyen par habitant est 5,6% plus élevé dans les pays membres de l'UE. Avec un changement représentant 1 point de hausse de la valeur du risque composite, ce qui signifie une réduction du risque auquel le pays fait face, il a été démontré que le revenu par habitant a augmenté de 1% dans les deux périodes. Les résultats indiquent également que l'agriculture garde son importance économique et que le revenu moyen par habitant dans les pays de l'UE est plus élevé par rapport aux pays non-membres en raison de certains facteurs exogènes.

Mots-clés: Union européenne, intégration, modèle de Solow, valeur ajoutée, risque.

1. Introduction

Development has been an important concept since the definition of 'economy' was provided for the first time. Yet, methodological evaluation of development and its relationship with growth has acquired greater emphasis since the World War II. In addition, four periods of development have been observed which display significant features (Dutt and Ros 2008).

– 1945-1950: Low savings, high population growth, less willingness to invest, intensive production in agriculture and limited industry orientation.
– 1950 - Late 1960s: mass protectionism and import substitution, as no focus on export was needed.
– Late 1960s-1980s: Rebirth of the neo-classical approach. Extended focus on integration of countries, emphasis on the overdependence school.
– 1980 - Present: Measurement of economic development by mathematical economics. Interpretation of the effects of economic development on distribution, income and preferences started with integration of micro-theory with macro-theory.

As a result, the factors underlying economic development and the effects of development on welfare have been broadly investigated, specifically since the 1990s. In addition to growth models stemming from production function and capital stock, index studies measuring total and marginal productivity and growth accounting models were brought into use in the international literature (Oyeranti 2000, Knowles and McCombie 2002).

Factor productivity studies focusing on the Cobb-Douglas production function developed by Solow (1957) and Kendrick (1961), which takes employment as a reference production factor, were widely observed in the literature. These studies were also referenced as growth accounting studies, and included output growth against input growth. Generally, growth refers to technical change when it depends on all production factors, while it is called partial factor productivity when it depends on the efficiency of a single factor. The main convergence studies focussed on the welfare effect of increased commercial activities (Balassa 1971, Chenery 1962, Chenery and Eckstein 1970, Wilhelm 2008) and on changes in total and partial factor productivity levels (Balassa and Bertrand 1970, Hayami and Ruttan 1970, Komlos 1988, Dowrick and Nyguen 1989).

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However, the convergence of countries has been tested based on the utilization of production functions. By way of example, Pittau and Zelli (2006) measured regional convergence within the EU between 1977 and 1996 and found that convergence from poor regions to rich regions was relatively low. Mayawala (2007) analysed the effects of agriculture on economic growth for 71 countries in three groups (developed – developing – less developed) between 1984 and 2004, with the inclusion of economic and social structural variables. The study revealed that both the capital structure and the rise in exports affected growth positively in all countries, while investment risk affected inversely medium income level countries. Government instability affected growth positively in the top two groups.

Indeed, structural convergence has been an important research topic in recent years. In their push studies focusing on commercial gains across the EU member states, Lejour *et al*., (2009) found that EU membership increased commercial relationships by 33 % when considered alone and by 55 % when changes in the structure of economic institutions were also taken into consideration. Moreover, income levels of candidate countries were expected to rise between 31% and 43 % in the long run after they had became EU members.

Another study investigating the single sector neo-classical growth model also incorporated an exogenous agriculture sector, and aimed to clarify the reasons behind the late industrial development of some countries regardless of resource abundance (Gollin *et al.,* 2002). Research on 62 developing countries in the period 1960-1990 demonstrated a significant rise in agricultural efficiency when interpreting the uprising trend of GDP per capita. Later, the same study found that agriculture cannot be substituted for the relevant economies.

Another important question addressed has been whether agriculture, having inelastic production factors, affects economic growth and per capita income. Therefore, a survey on the effects that agriculture has on economic growth can be important to assess the productivity of the sector and the supportive financial transfers to the sector. The European Union (EU) integration process involves specific tools and produces certain outcomes for economies, and one of the main impacts of the integration process has been recorded in agriculture. The aim of this paper is to analyse the effects of agriculture on economic growth within a sample of EU member and candidate countries.

By analysing the impact of agriculture on the national economies, it seems possible to provide information on the productivity of the sector and on efficiency change according to the time considered and the countries involved. Therefore the impact of agricultural value added on per capita income has been estimated using a version of the Solow growth model extended with structural coherence variables to cover the European Union member and candidate countries in two reference periods, 1995-2007 and 2002-2007, taking into account the accession process. Samples were constructed according to data availability and the number of member states. The analysis was based onto two samples to include more candidate and new member states specifically for the 2002–2007 sampling period. Therefore, the main objective of the study was to understand the effect of the relationship between agriculture and growth levels through differences in per capita GDP according to the membership status of the countries with respect to the European Union.

2. Materials

Description of the model and variables

The Extended Solow Growth Model was applied using panel data analysis for two periods between 1995 and 2007. By the year 2013 there will be 28 EU members and 4 candidates. While it was possible to acquire data for Iceland, Turkey, no data was available for Macedonia and Montenegro. Therefore, 30 countries were included in the study.

Within the scope of the study, an analysis was made to measure the impacts of agricultural value added, specific macroeconomic variables and indices representing social and institutional structure over per capita income as growth indicator. Most of the fundamental economic indicators used were retrieved from World Development Indicators and Global Development Finance (Anonymous, 2011a). In addition, structural coherence indices retrieved from the International Country Risk Guide (ICRG) were used in the analyses in order to represent the institutional and social structures of the countries.

Political, economic and financial risk

The composite risk score is the arithmetic mean of political (100 points), economic (50 points) and financial (50 points) risk scores. The composite risk score is divided into the following rating categories: too low (80-100) and too high (0-49.9) according to ICRG methodology (Hoti, 2003).

A new basket composed of *government stability, socio-economic conditions, investment profile, openness for democratic control and bureaucratic quality* was established, and the scores were indexed to 100 points for political risk. The components of economic risk are *per capita GDP risk* (ratio of the Dollar-based national income to the average income of all countries)*, real GDP growth risk* (growth rate calculated relating to 1990 prices)*, annual inflation risk* (non-weighted Consumer Price Index)*, budget balance risk* (budget balance of the country with domestic currency to the overall GDP) *and current account risk* (balance of payments in Dollars to the GDP of the country).

Financial risk components are *external debt risk* (debt to GDP ratio), *external debt service risk* (current account total to Dollar value of exported goods and services) *net international liquidity risk* (Dollar value of official annual reserves to monthly Dollar value of import cost of goods) and *exchange rate stability risk* (depreciation or appreciation of the national currency). For this study, the economic and financial risk components indexed for 50 points were adjusted to a 100 points scale. The average of the three risk scores is treated as the composite risk variable in the growth model implemented.

3. Method

Measurement of economic development using panel data

For the empirical analysis of economic development, time series analysis can be preferred as a methodology, with the utilization of measures retrieved from a unique data source for different time periods. However, panel data studies are preferred when measuring time and place variations of growth, and when comparing the growth performances of different countries (Ederveen *et al.*, 2006, Islam 2003, Chenery and Taylor 1968). Panel data analyses are also preferred in cross-country macro-economic studies due to the short time series (Olofin *et al.*, 2009, Lloyd *et al.*, 2001).

Panel data may be estimated with the Least Squares (OLS) or Maximum Likelihood (ML) methods. Yet, what is more important in panel data analysis is whether the estimation could be bound to time series and/or cross sectional points. Due to the decision made on this extended model, panel estimation, fixed effects or random effects estimation methodology is selected (Arellano, 2003). In order to select the proper estimation method, it is important to test the stationarity of a series using the specification tests. After determining whether the series analysed are stationary initially or after being differentiated, it is also important to determine whether the series could be estimated with a co-integration procedure or not. After co-integration was defined as a specific field of study in 1995, many different tests were developed. In our study, Pedroni's (1999) four-statistic test is used. This test was developed by investigation of P and t statistics in the panel and in the group of series.

Panel estimation incorporates OLS estimation which disregards cross-sectional and time effects for the valuation of the model. In case of models for which panel estimation is not suitable, the one-way error components model, which refers to the inclusion of unobserved cross-sectional effects, or the two-way error components model involving unobserved time effects as well, are considered to be the appropriate estimation model. In order to understand whether the set could be estimated in the form of a panel, it is important to first implement a cross-sectional dependency test. If we reach a concrete result according to which cross-sectional variables are independent of neglected fixed effects and random effects, then utilization of unified panel regression produces more accurate estimation results.

The first testing methodology proposed for a panel series was the *Breusch-Pagan Lagrange Multiplier (LM)* test (Korkmaz *et al.*, 2010; Berke, 2009). The LM test gives accurate results when the number of time related data points (T) is larger than the number of cross-section related data points (N). By contrast, when there are more cross-sectional observation points, other proposed tests should also be considered (Hoyos and Sarafidis, 2006). The *Pesaran CD* test, which also depends on the Lagrange Multiplier methodology, is appropriate for situations where T is smaller than N, and when there is a balanced panel (Hoyos and Sarafidis, 2006; Pesaran, 2004). In addition, the non-parametric statistic of Friedman (1937), which relies on the *S-pearman rank correlation coefficient* and Frees statistic (1995, 2004) depending on the square of the correlation coefficient, can be used for the measurement of cross-sectional dependence (Hoyos and Sarafidis, 2006).

All three tests assume cross-sectional independence. When independence is inapplicable, it is clear that the model fits best the random effects estimation. In this situation, it is necessary to implement the Hausman specification test to determine whether to use random effects or fixed effects estimation methodology (Baltagi, 2005). In this test, the h coefficient retrieved after taking differences of the regressors with respect to cross-sections and time series can be used to test whether the random effects model is preferred to fixed effects or not (Arellano, 2003). This test focuses on correlations of independent variables with random group effect variables. If this correlation is equal to 0, the random effects model is preferred. At the opposite end of the scale, the fixed effects model is preferred (Lloyd *et al.*, 2001, Washington et *al*., 2003; Kunst, 2009).

Panel data analysis methods - Two-way error component regression model

When the objective is to measure the impact of an unobserved time series variable, as well as the unobserved cross-sectional variable in panel data analysis, it is necessary to implement a two-way error components regression model. Accordingly, the error term takes the following form (Baltagi 2005).

$$u_{it} = \mu_i + \lambda_t + v_{it} \qquad i=1,\ldots\ldots,N;\ t=1,\ldots..,T \qquad [1]$$

Here, while μ_i is the unobserved cross-sectional effect, λ_τ is the unobserved time series effect. In addition, λ_τ is independent of the cross-section and provides information on all time-related data excluded from the regression.

In a two-way fixed effects analysis, when μ_ι and λ_τ are interpreted as constant parameters to be estimated, v_{it} is the two-way error term [1]. Statistical inference depends on the values that N observation points take during definite time periods (Baltagi, 2005). Then the function takes the following form in this situation [2].

$$y_{it} = \alpha + \beta x_{it} + \mu_i + \lambda_t + v_{it} \qquad [2]$$

The main assumption for random effects estimation is that μ_i, λ_τ and v_{it} components have independent distributions with 0 mean and constant variance (Wooldridge, 2002). Inference with random effects analysis gives general information on the population from which the sample is constructed (Baltagi, 2005). In this analysis, it is assumed that the error terms have constant variance for all i and t as $var\ (u_{it}) = \sigma_{\mu}^2 + \sigma_{\lambda}^2 + \sigma_{v}^2$. By contrast, covariance of error terms is σ_{μ}^2 for the same cross-sections (i=j) and for different time periods (t≠s) and is σ_{λ}^2 for the same time period (t=s) and different observation periods (i≠j) and 0 otherwise.

In addition, random effects estimation allows inference on three different error components for the population from which that sample is collected. Accordingly, random effects estimation is referred as the error components analysis in the literature as well.

The two-way error components model is preferred when the data set and degrees of freedom are available. Yet, when no cross-sectional dependence is detected, it is more appropriate to estimate the data set in a simplified way.

Model Structure – The effect of agriculture and European Union Membership on economic growth

This study implies a specifically modified Solow Growth Model. The model is extended with sector productivity variables and social and economic indicators.

The Solow Growth Model stemming from the production function is turned into the following general form [3] after including agriculture, exports and inflation (Hwa, 1988).

$$\dot{Y} = a + \alpha\dot{K} + \beta\dot{L} + \gamma\dot{A} + \theta\dot{X} + \delta\dot{P} + \varepsilon \qquad [3]$$

where: $\dot{Y}$ = average annual GDP growth rate; $\dot{K}$ = average annual capital stock growth rate; $\dot{L}$ = average annual labour growth rate; $\dot{A}$ = average annual agricultural growth rate; $\dot{X}$ = average annual export growth rate; $\dot{P}$ = average annual inflation growth rate.

Humphries and Knowles (1998) included *non-farm labour, education and health expenditures* variables in this system, while Barro (1991) extended the model with *economic and structural coherence variables*. Since the aim of this study was to measure the impacts of integration to the Union's social and economic structures on economic growth in the EU member and candidate countries, the following extended form [5] of the Solow Growth Model was applied.

i= 1,2,……., N; t = 1,2,……., K;

$$lnY_{it} = \beta_0 + \beta_1 lnAVA_{it} + \beta_2 lnCS_{it} + ln\beta_4 E_{it} + \beta_5 EU_{it} + \beta_6 CR_{it} + \varepsilon_{it} \qquad [4]$$

The main variables for the model were the following:

- $\mathbf{Y_{it}}$: Per capita income in country i and time t
- $\mathbf{AVA_{it}}$: Per capita agricultural value added in country i and time t
- $\mathbf{CS_{it}}$: Per capita capital stock in country i and time t
- $\mathbf{E_{it}}$ Per capita education expenditure amount in country i and time t
- $\mathbf{EU_{it}}$: EU membership condition in country i and time t (member=1; non-member=0)
- $\mathbf{CR_{it}}$: Per capita composite institutional quality index value

GDP (Gross Domestic Product) is used as the explained variable of the model as a proxy for growth measurement. All quantitative variables in the model were logarithmically transformed.

As the composite risk variable includes information on the openness of the economy, the debt situation of the country, and the payment schedule of internal and external debts and inflation, direct variables were not used to prevent potential multi-collinearity problems. Accordingly, the financial performance of the relevant country is assessed using the value and significance of the composite risk coefficient. Model [4] is estimated for two different time periods and the cross-section structure while taking the data set limitations into consideration. The relevant countries and time periods are demonstrated in Table 1.

Table 1 - *Time series and cross section definition for modeling function.*

1995-2007			2002-2007		
N = 25		K = 13	N = 30		K = 6
Germany	Italy	1995	Germany	Italy	2002
Austria	Iceland	1996	Austria	Iceland	2003
Belgium	Cyprus	1997	Belgium	Cyprus	2004
Bulgaria	Luxemburg	1998	Bulgaria	Latvia	2005
Czech Rep.	Hungary	1999	Czech Rep.	Lithuania	2006
Denmark	Malta	2000	Denmark	Luxemburg	2007
Finland	Poland	2001	Estonia	Hungary	
France	Portugal	2002	Finland	Malta	
Netherlands	Romania	2003	France	Poland	
U.K.	Slovakia	2004	Croatia	Portugal	
Ireland	Turkey	2005	Netherlands	Romania	
Spain	Greece	2006	U.K.	Slovakia	
Sweden		2007	Ireland	Slovenia	
			Spain	Turkey	
			Sweden	Greece	

The cross-section set is longer than the time series set in both periods. Accordingly, for the use and interpretation of descriptive and diagnostic statistics in analytical processes, the N > T situation is considered. Models are estimated by the SAS 9.2 Enterprise 4.3 statistical program. Moreover, E-VIEWS 7.1 is used for unit root tests and co-integration tests, and STATA 11.0 is used for model specification tests.

4. Description and Results

Data generation process for 1995-2007

Prior to the estimation of the econometric model, the stationarity of the variables was tested. The results for per capita income, agricultural value added and composite risk variables are provided in Table 2.

According to the test results, lny was stationary on level. All tests rejected the existence of a unit root specifically when a time trend was included to the level measure, and agricultural value added series were stationary. The composite risk variable also produced an outcome similar to agricultural value added. The composite risk was clearly stationary on level according to all individual statistics (IPS, ADF and HT) and common unit root statistic (LL). Besides, as the series did not have common unit root, there was no need to test for co-integration across these series.

Table 2 - *Stationarity test results for 1995-2007 period.*

lnY_{it}	N: 25	K: 13			
Test statistic	**Hypothesis**	**Level + Drift**	**ρ**[1]	**Time trend**	**ρ**
IPS	H_0: All panels have unit roots	5,65	1,00	0,73	0,77
LL	H_0: Panel has a unit root	-2,242	0,01**	-9,90	0,00**
Fisher – ADF[2]	H_0: All panels have unit roots	3,2948	< 0,01**	3,29	< 0,01*
HT	H_0: All panels have unit roots	1,01	1,00	0,7510	1,00
$lnAVA_{it}$	**N: 25**	**K: 13**			
Test statistic	**Hypothesis**	**Level + Drift**	**ρ**	**Time trend**	**ρ**
IPS	H_0: All panels have unit roots	1,75	0,96	-4,44	0,00**
LL	H_0: Panel has a unit root	-0,79	0,21	-7,06	0,00**
Fisher – ADF	H_0: All panels have unit roots	6,57	0,00**	2,51	< 0,01*
HT	H_0: All panels have unit roots	0,81	0,68	0,28	< 0,01*
CR_{it}	**N: 25**	**K: 13**			
Test statistic	**Hypothesis**	**Level + Drift**	**ρ**	**Time trend**	**ρ**
IPS	H_0: All panels have unit roots	-2,66	< 0,01**	-1,18	0,12
LL	H_0: Panel has a unit root	-10,71	0,00**	-9,97	0,00**
Fisher – ADF	H_0: All panels have unit roots	12,16	0,00**	2,31	0,00**
HT	H_0: All panels have unit roots	0,67	< 0,01**	0,51	0,56

[1] Null hypothesis is rejected on* 0,05 and on** 0,01 significance level.
[2] Statistic computation for Fisher ADF with time trend does not involve drift.

Estimation results for 1995-2007

Due to one-way error components estimation outputs shown in Table 3, Frees, Peseran CD and Friedman R_{AVE} tests indicated that the model had cross-sectional dependence, and that the data could not be estimated in panel form. However, the Hausman specification test results showed that one-way random effects estimation would produce biased results. However, as the parameter estimate of per capita agricultural value added did not comply with economic expectations, and as the length of the series was long enough, it was decided to execute comparative estimation for two-way error components. The outputs of the two-way error components estimation are provided in Table 4.

Initially, considering the FRE and B-P statistics it was clear that the model had cross-sectional dependence. As the Frees test was developed by evaluation of Friedman and Peseran statistics, the test result was used to reject cross-sectional independence. In any case, the difference between in group (0.86) and total (0.37) goodness of fit (R^2) values retrieved from the two way random effects estimation also indicated that the data could not be estimated using joint panel (Kunst, 2009). What is more, the Hausman statistic, which compares the fixed effects model with the random effects model, was not significant with a 0.98 p-value. Accordingly, it was found that the random effects model would lead to more significant and unbiased results when compared with the fixed effects model.

Table 3 - *One-way error component estimation results (1995-2007).*

Independent Variable	OLS	One Way Random Effect	One Way Fixed Effect
$lnAVA_{it}$	0,5493 (0,00)	-0,2857 (0,00)	-0,3418 (0,00)
CR_{it}	0,0658 (0,00)	0,0139 (0,00)	0,0122 (0,00)
EU_{it}	0,5285 (0,00)	0,1720 (0,00)	0,1647 (0,00)
Constant	0,8140 (0,02)	10,013 (0,00)	10,48 (0,00)
N	25	25	25
K*N	325	325	325
R^2	0,77	In-group: 0,65 Between groups: 0,04 Total: 0,05	In-group: 0,66 Between groups: 0,003 Total: 0,0099
F Test	**F (3,321):** 362,45 (0,00)		**F (3,297):** 188,06 (0,00)
Wald Parameter Test($\chi^2(3)$)		409,63 (0,00)	
B-P CSD[3] Test ($\chi^2(1)$)		80,21 (0,00)	
FRE CSD Test [4]		5,471 (0,00)	
R_{AVE} CSD Test		108,253 (0,00)	
Peseran CD Test		18,227 (0,00)	
Hausman S. T. ($\chi^2(3)$)			16,53 (< 0,01)
Wooldridge Test (F(1,24))			271,63 (0,00)
Wald Test ($\chi^2(3)$)			2.045,24 (0,00)

[3] CSD = Cross Sectional Dependence.
[4] Q values 0,10: 0,1984; 0,05: 0,2620; 0,01: 0,3901.

Table 4 - *Two-way error component estimation results (1995-2007).*

Independent Variable	OLS	Two-Way Random Effect	Two-Way Fixed Effect
$lnAVA_{it}$	0,5493 (0,00)	0,0245 (0,41)	-0,0019 (0,94)
CR_{it}	0,0658 (0,00)	0,0081 (0,00)	0,0075 (0,00)
EU_{it}	0,5285 (0,00)	0,0561 (0,00)	0,0549 (0,00)
Constant	0,8140 (0,02)	8,5247 (0,00)	8,7348 (0,00)
N	25	25	25
K*N	325	325	325
R^2	0,77	In group: 0,86 Between groups: 0,83 Total: 0,37	In group: 0,86 Between groups: 0,73 Total: 0,29
F Test	**F (3,321):** 362,45 (0,00)		**F (15,285):** 112,57 (0,00)
Wald Parameter Test ($\chi^2(15)$)		1279,94 (0,00)	
B-P CSD Test($\chi^2(1)$)		831,25 (0,00)	
FRE CSD Test[5]		7,056 (0,00)	
R_{AVE} CSD Test		1,899 (1,00)	
Peseran CD		-1,966 (1,95)	
Hausman S. T. ($\chi^2(15)$)			6,06 (0,9788)
Wooldridge Test (F(1,24))			271,63 (0,00)
Wald Test ($\chi^2(12)$)			$5{,}42*e^{16}$ (0,00)

[5] Q values 0,10: 0,1984; 0,05: 0,2620; 0,01: 0,3901.

While all parameter estimates were significant in the panel solution, the per capita agricultural value added parameter estimate was not significant in the random and fixed effects solutions. Even so, the Wald parameter significance test[1] indicated that the parameter estimates of random effects had common significance. The parameters were jointly significant due to the 0 p-value of the Wald statistic. Furthermore, the 37% total goodness of fit (R^2) indicated that explanatory variables could explain the 37% variation in the dependent variable.

Prior to interpretation of the findings, diagnostic tests were implemented to understand whether there was some autocorrelation in error terms, and whether the error variance was homoscedastic. As a result of the Wooldridge autocorrelation test results, the null hypothesis of 'no autocorrelation' was rejected. In any case, the likelihood ratio based Wald heteroscedasticity test rejected 'no heteroscedasticity' hypothesis. Accordingly, the model was re-estimated using the White error correction methodology. The test findings and consistent parameter estimates are provided in Table 5.

[1] Degrees of freedom for the statistic (k-1): 13 years + 3 explanatory variables - 1.

Table 5. *Two-way random effects estimates with consistent standard errors for 1995-2007 period.*

Independent Variable	Two-Way Random Effects
$lnAVA_{it}$	0,0245 (0,79)
CR_{it}	0,0081 (0,00)
EU_{it}	0,0561 (0,07)
Constant	8,5247 (0,00)
1996	0,01 (0,16)
1997	0,02 (0,10)
1998	0,05 (0,00)
1999	0,09 (0,00)
2001	0,13 (0,00)
2001	0,15 (0,00)
2002	0,15 (0,00)
2003	0,17 (0,00)
2004	0,18 (0,00)
2005	0,21 (0,00)
2006	0,25 (0,00)
2007	0,29 (0,00)
N	25
K*N	325
R^2	In group: 0,86 Between groups: 0,83 Total: 0,37
Wald Parameter Test ($\chi^2(15)$)	807,47 (0,00)

Consequently, the agricultural value added elasticity of per capita national income proves to be 0.0245. Per capita income rises by almost 1% (0.08 %) due to a 1 point increase in the composite risk variable, which means an appreciation of the risk position of the country. Consequently, the composite risk semi-elasticity of per capita income is 1% as semi-elasticity refers to the parameter estimates directly in variables taking numerical values (Gujarati, 2003).

Table 6 - *Stationarity test results for 2002-2007 period.*

lnY_{it}	**N: 25**	**K: 6**			
Test statistic	**Hypothesis**	**Level + Drift**	**ρ[6]**	**Time trend**	**ρ**
IPS	H_0: All panels have unit roots	13,82	1,00		
LL	H_0: Panel has a unit root	3,57	0,99		
Fisher – ADF[7]	H_0: All panels have unit roots	-2,63	0,99	21,08	0,00**
HT	H_0: All panels have unit roots	1,05	1,00	0,24	0,98
$lnAVA_{it}$	**N: 25**	**K: 6**			
Test statistic	**Hypothesis**	**Level + Drift**	**ρ[8]**	**Time trend**	**ρ**
IPS	H_0: All panels have unit roots	0,84	0,79		
LL	H_0: Panel has a unit root	-4,09	0,00**		
Fisher – ADF	H_0: All panels have unit roots	6,02	0,00**	14,94	0,00**
HT	H_0: All panels have unit roots	0,47	0,09	-0,31	0,01**
CR_{it}	**N: 25**	**K: 6**			
Test statistic	**Hypothesis**	**Level + Drift**	**ρ[9]**	**Time trend**	**ρ**
IPS	H_0: All panels have unit roots	1,12	0,87		
LL	H_0: Panel has a unit root	-24,26	0,00**		
Fisher – ADF	H_0: All panels have unit roots	5,27	0,00**	-1,42	0,92
HT	H_0: All panels have unit roots	0,51	0,22	0,30	0,99

[6] * Null hypothesis is rejected on 95 %, ** null hypothesis is rejected on 99%.
[7] Fisher ADF statistic with time trend does not include drift.
[8] * Null hypothesis is rejected on 95 %, ** null hypothesis is rejected on 99%.
[9] * Null hypothesis is rejected on 95 %, ** null hypothesis is rejected on 99%.

The EU dummy variable parameter estimate of 0.0561 indicates, after taking the anti-log, that average per capita income is around 1 Dollar higher in EU member countries. Like the composite risk interpretation, the EU membership semi-elasticity of per capita income is 0.057. The semi-elasticity for categorical variables is calculated by taking the anti-log of the parameter estimate and deducting 1 in semi-logarithmic models as demonstrated by Halvorsen and Palmquist (1980) (Gujarati, 2003).

Following this calculation, almost the same value is reached using the parameter estimate. Accordingly, being a member of the European Union leads to a 0.057 % rise in per capita income. Also, time has a significant effect on per capita income rise. Average per capita income rises with time.

Data generation process for 2002-2007

The same unit root tests were applied as in the previous period in order to test whether the variables were stationary or not. Stationary test results are indicated in Table 6 for per capita national income, agricultural value added and composite risk variables.

According to results with time trend, the Fisher ADF test indicated that per capita income variable in logarithmic form was stationary. Accordingly, lny was stationary with trend on level. The per capita agricultural value added series was stationary for LL and Fisher ADF statistics. However, the same series was not stationary according to the IPS and HT statistics. Even so, when interpreted with trend on level, the per capita agricultural value added series was found to be stationary using the Fisher ADF and HT statistics. In contrast, the composite risk variable was stationary on level due to the LL and Fisher ADF statistics and it was found to be non-stationary with trend. Accordingly, the series were found to be stationary on level, and investigating co-integrating relationship among the series was considered to be unnecessary.

Estimation results for 2002-2007

As for the 1995-2007 period, an initial comparative analysis was made between the one-way error component and the panel LS estimation outputs.

Table 7 - *One way error component estimation findings (2002-2007).*

Independent Variable	OLS	One Way Random Effect	One Way Fixed Effect
$lnAVA_{it}$	0,6068 (0,00)	0,0102 (0,88)	-0,1524 (<0,01)
CR_{it-1}	0,0856 (0,00)	0,0116 (< 0,01)	0,0029 (0,32)
EU_{it}	0,3908 (0,00)	0,1868 (0,00)	0,1691 (0,00)
Constant	-1,0854 (0,00)	8,3212 (0,00)	9,9651 (0,00)
N	30	30	30
K*N	180	180	180
R^2	0,83	In-group: 0,28 Between groups: 0,70 Total: 0,62	In-group: 0,65 Between groups: 0,04 Total: 0,05
F Test	**F (3,176):** 290,10 (0,00)		**F (3,147):** 27,46 (0,00)
Wald Parameter Test ($\chi^2(3)$)		56,48 (0,00)	
B-P CSD Test ($\chi^2(1)$)		169,80 (0,00)	
FRE CSD Test [10]		7,025 (0,00)	
R_{AVE} CSD Test		90,819 (0,00)	
Peseran CD Test		26,215 (0,00)	
Hausman S.T. ($\chi^2(3)$)			34,30 (0,00)
Wooldridge Test (F(1,29))			1783,356 (0,00)
Wald Test ($\chi^2(3)$)			2669,03 (0,00)

[10] Q values 0,10: 0,4127; 0,05: 0,5676; 0,01: 0,9027.

Table 8 - *Two-way error component estimation results (2002-2007).*

Independent Variable	OLS	Two-Way Random Effect	Two-Way Fixed Effect
lnAVA$_{it}$	0,6068 (0,00)	0,2178 (0,00)	0,1671 (0,00)
CR$_{it}$	0,0856 (0,00)	0,0067 (< 0,01)	0,0033 (<0,07)
EU$_{it}$	0,3908 (0,00)	0,0558 (< 0,01)	0,0507 (< 0,01)
Constant	-1,0854 (0,00)	7,4859 (0,00)	8,0572 (0,00)
N	30	30	30
K*N	180	180	180
R^2	0,83	In-group: 0,78 Between groups: 0,65 Total: 0,56	In-group: 0,79 Between groups: 0,59 Total: 0,46
F Test	**F (3,176):** 290,10 (0,00)		**F (29,142):** 422,86 (0,00)
Wald Parameter Test ($\chi^2(8)$)		303,96 (0,00)	
B-P C-D ($\chi^2(1)$)		200,36 (0,00)	
FRE CSD Test[11]		8,395 (0,00)	
R_{AVE} CSD Test		-0,950 (1,66)	
Peseran CD Test		2,533 (1,00)	
Hausman S. T. ($\chi^2(15)$)			9,44 (0,31)
Wooldridge Test (F(1,29))			1783,356 (0,00)
Wald Test ($\chi^2(8)$)			156,11 (0,00)

[11] Q values 0,10: 0,1984; 0,05: 0,2620; 0,01: 0,3901.

As a result of the findings demonstrated in Table 7, the initial cross-sectional dependency was confirmed for each variable with B-P, FRE, R_{AVE}, and CD values. In addition, it is understood that the model could be estimated at least by using the random effects model when the difference between the in-group and total R^2 is considered. In addition, the Hausman m statistic indicated that the fixed effects methodology was the most appropriate methodology in one-way error components estimation. Yet, as the concerned variables reached level stationarity only with trend, and due to the availability of the data, the findings were interpreted with two-way error components analysis. Comparison of the two-way error components analysis results and the panel estimation outputs are provided in Table 8.

Initially, cross-sectional independence was rejected as a result of the FRE and B-P statistics. However, the CD and R_{AVE} statistics seemed not to reject cross-sectional independence, but the difference between the in-group (0.78) and total (0.56) goodness of fit values (R^2) indicated that the series could not be estimated with joint Panel (Kunst, 2009).

In addition, the Hausman m-statistic, which compares the fixed effects and random effects estimation finding of two-way estimation, was not significant with a 0.31 p-value. As a result, as it was the case for the 1995-2007 period, the random effects estimation was preferred to the fixed effects estimation.

Table 9 - *Two-way random error estimation outputs for 2002-2007 with consistent standard errors.*

Independent Variable	Two--Way Random Effects
lnAVA$_{it}$	0,2178 (< 0,01)
CR$_{it}$	0,0067 (<0,06)
EU$_{it}$	0,0558 (0,02)
Sabit	7.4859 (0,00)
2003	0,03 (0,00)
2004	0,05 (0,00)
2005	0,11 (0,00)
2006	0,16 (0,00)
2007	0,20 (0,00)
N	30
K*N	180
R^2	In-group 0,78 Between groups: 0,65 Total: 0,56
Wald Parameter Test ($\chi^2(15)$)	156,11 (0,00)

Table 10 - *Two-way fixed effects estimation results for 2002-2007.*

Independent Variable		Two-Way Random Effects	
lnAVA$_{it}$	0,1671 (0,00)		
CR$_{it}$	0,0033 (<0,07)		
EU$_{it}$	0,0507 (< 0,01)		
Constant	8,0572 (0,00)	**2005**	0,11 (0,00)
2003	0,03 (0,00)	**2006**	0,16 (0,00)
2004	0,05 (0,00)	**2007**	0,20 (0,00)
BE	0,05 (0,14)	**LUX**	-1,46 (0,00)
BL	-2,25 (0,00)	**LET**	-1,51 (0,00)
CRT	-1,30 (0,00)	**LİT**	0,79 (0,00)
CZ	-1,68 (0,00)	**MAL**	-0,78 (0,00)
CY	-0,52 (0,00)	**NL**	-0,04 (0,16)
DEN	0,18 (0,00)	**PL**	-1,43 (0,00)
ES	-1,27 (0,00)	**POR**	-0,69 (0,00)
Fİ	-0,05 (0,09)	**ROM**	-2,24 (0,00)
FR	-0,12 (0,00)	**SLV**	-1,19 (0,00)
GE	0,06 (0,06)	**SLK**	-0,67 (0,00)
GR	-0,64 (0,00)	**SP**	-0,49 (0,00)
HUN	-1,34 (0,00)	**SW**	0,17 (0,00)
IC	0,11 (0,15)	**UK**	0,21 (0,00)
IR	0,13 (0,00)	**TR**	-1,62 (0,00)
IT	-0,23 (0,00)		

While the composite risk parameter estimate had lower significance than the fixed effects estimation, all parameter estimates were found to be significant in all models. The Wald test[2] mentioned earlier, which combined the parameter significance and 56 % of variation of the dependent variable is explained by independent variables.

Finally, autocorrelation and heteroscedasticity were tested in order to assess the consistency of estimation. The Wooldridge autocorrelation test findings rejected existence of an autocorrelation in the model and the Wald statistic findings retrieved by Generalized Least Squares rejected constant variance hypotheses. Therefore, the model was re-estimated according to the White error correction mechanism, and the outputs are reported in Table 9. Estimation with consistent errors did not lead to loss of significance except for the composite risk variable. However, joint significance was secured as indicated using the Wald statistic.

Based on the 2002-2007 estimation outputs, the agricultural value added elasticity of per capita income was 0.22. Per capita income rose by around 1% (0.7 %) with a 1 point rise in the composite risk indicating an appreciation in the risk condition of the country. In accordance with this finding, the composite risk semi-elasticity of per capita income was 1%. Any reduction in the composite risk or appreciation of the countries' economic, political and financial risk condition affects countries in a similar way to that observed in the previous period.

[2] Degrees of freedom for the statistic (k-1): 6 years + 3 independent variables - 1.

As for the 1995-2007 sampling period, the average per capita income was around 1 Dollar (1.0574) higher in EU member countries, and at the same time the EU membership elasticity of per capita income was 0.057.

After assessing the estimation results, the objective was to interpret the two-way fixed effects estimation results for 2002-2007 to conform to the economic expectations and quantitative proximity to random effects estimates. The main reason was to evaluate the country parameter estimates. The estimates, in accordance with this aim, are reported in Table 10.

Considering the estimation outputs from which the Austrian data for 2002 is taken as a base, the average per capita GDP shows changes according to the countries concerned. In 22 countries from the sample of 29 countries (excluding Belgium, Denmark, Iceland, Ireland, Latvia, Sweden and the United Kingdom), the semi-elasticity of per capita income with reference to Austria and year 2002 is negative. Alternatively said, the average per capita income in these 22 countries is lower than the 2002 average per capita income level of Austria. The reduction rate for Turkey was 0.81 % when the antilog of the parameter estimate (-1.62) was taken. As with Turkey, the average per capita income reduction was higher in Poland, Bulgaria, Romania and the Czech Republic. This finding is compatible with the economic expectations of recent new member countries from Central and Eastern Europe.

The analysis of the impacts of agricultural value added, composite risk and EU membership on per capita income in two different samples considering different time dimensions were completed accordingly. The fundamental findings indicated that contribution of agricultural value added to per capita income has increased over the 2002-2007 analysis period when the 5th enlargement has been completed. In addition, EU membership and appreciation in the risk position has affected per capita income positively.

5. Discussion

The objective of this study was to investigate the impact of agriculture on national economies within a sample constructed from member and candidate countries of the European Union. The study focused on panel data estimation of the effect of agricultural value added on per capita income by applying empirical methods to two sub-samples. An extended form of the Solow Growth Model was applied to 25 countries in the period ranging from 1995 to 2007, and to 30 countries between 2002 and 2007.

The model used was an extension of the Solow Growth Model, and per capita income was used as a growth indicator. The impacts of per capita agricultural value added, and the composite risk variable determined through economic and social risk indicators pre-calculated by the PRS group were used as explanatory variables. In addition, the effect of EU membership was measured by a dummy variable used as an explanatory variable.

As regards the two-way random effects estimation results for 25 countries between 1995 and 2007, the agricultural value added elasticity of per capita income was found to be 0.025, and it was clear that 1 point appreciation of composite risk leads to a 1% rise in per capita income. Also, average per capita income proved to be 5.6 % higher in EU member countries.

Following the two-way random effects estimation results for 30 countries between 2002 and 2007, the agricultural value added elasticity of per capita income was found to be 0.22, and it was again clear that a 1 point appreciation of composite risk leads to a 1% rise in per capita income. However, the average per capita rise due to EU membership was the same as in the previous period i.e. 5.6%.

Hence, the agricultural value added and the rise in agricultural value added contributed to the average per capita income in the two sub-periods. The reason why the quantitative effect of agricultural value added was higher in the second period seems to be related with the accession of Central and Eastern European countries, which proceeded from low equilibrium to equilibrium during the 2002-2007 period. This explains why the above countries display a higher population density compared to former members and their range of economic activity is less diversified. Finally, EU membership, which is measured categorically, also contributed to the rise in average per capita income. Therefore, EU membership affects per capita income externally as an independent factor for the period. In other words, it is estimated that if different countries have the same factor endowments, if they have institutional structures in conformity with each other, and if they are likely to have more open economic structures, they will have comparatively higher per capita income levels. Consequently, EU membership contributed to average per capita income by 5.6% in both the reviewed periods.

Appreciation of economic, financial and political risk conditions also leads to positive improvements in average per capita income. The composite risk score is taken as the average of political risk, meaning the institutional quality and administrative capacity of a country, economic risk, meaning the economic stability of an economy, and financial risk, meaning the economic openness and commercial capacity of an economy. A one point rise in this average score, or a one point appreciation of the economic, financial and political situation of a country resulted in an almost 1% rise in per capita income in both periods.

The findings of the relevant reviewed periods and samples indicate that EU membership and appreciation of the composite risk score leads to positive improvements in per capita income. Moreover, in order to measure inter-country differences, a two-way fixed effects model was also estimated for the 2002-2007 period. Based on these findings, an average per capita income reduction was observed in 22 countries with reference to the 2002 Austrian data. The reduction measured for Turkey was 0.81 %.

The following inferences are reached regarding the EU accession process, and the impacts of this process on agriculture and economic growth due to the analytical findings.

The findings demonstrate that per capita income is higher in EU member countries compared to non-member countries. One of the main factors explaining this condition is the effect of the free movement of goods, services, persons and capital, and the specific implementation provisions developed in accordance with these principles.

Specifically, the free movement of persons allowed more opportunities to gain access to income generating activities in the 12 countries which had completed the accession process, without considering Bulgaria, Romania and Cyprus. In addition, the procedures used for cross-border movement of goods provided specific commercial advantages to recently developing new member countries, as well as to developed member countries. From this perspective, the external contribution of European Union membership to per capita income level as an indicator of economic growth can be inferred.

Agriculture secures its importance in terms of contribution to the economy of both member and candidate countries of the European Union. Specifically, when new member countries that have a significant rural population rate despite being over-populated and Mediterranean member countries, where agricultural trade continues to be a fundamental economic activity, are considered, agriculture cannot be evaluated as a sector that should be kept out of the integration process. Basically, the positive impact of agricultural value added on per capita income in the two periods under investigation confirms the evidence-based perspective of the European Union, according to which agriculture has to be considered an important sector.

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