Long Term Structural Changes in the EU Countries (1970-2000): Convergence or Divergence in the Agri-Food System?

Cristina Brasili
e-mail: brasili@stat.unibo.it

Roberto Fanfani
e-mail: fanfani@stat.unibo.it

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Department of Statistics "Paolo Fortunati"
University of Bologna
Italy

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by
Cristina Brasili, Roberto Fanfani[1]

Roberto Fanfani
Department of Statistics
University of Bologna
Belle Arti, 41
40126 Bologna
Ph +39 051 2098212
Fax +39 051 232153
e-mail: fanfani@stat.unibo.it

Cristina Brasili
Department of Statistics
University of Bologna
Belle Arti, 41
40126 Bologna
Ph +39 051 2098260
Fax +39 051 232153
e-mail: brasili@stat.unibo.it

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Abstract

The main objective of this paper is to analyse the structural changes in European Agri-food systems in the last 30 years in order to verify the presence of a convergence process towards a more homogeneous structure among EU countries. This analysis considers the relative importance of the main components of Agri-food systems (agriculture, food industry and food consumption) and how they change over time. The analysis of convergence utilise the European National Accounting Data (from the SEC2 Data Base of Eurostat) from 1970 to 2000 for twelve EU countries. We use tests of convergence on cross section data by countries, but also stochastic kernel methodologies to verify the dynamic evolution of groups of countries inside the EU. The results show there are important process of convergence among countries for the variables of the Agri-food system that are more linked to the economic development, such as the importance of agriculture and food consumption in GDP. On the other hand there are divergences on the variables more linked to the openness degree and to the competitiveness of the Agri-food system. The presence of polarisation process among groups of countries contribute to the permanence of long run structural changes among Northern and Southern countries in the EU.

1. Introduction

The comparative analysis among the economies of countries and regions has received a growing attention in the last decade. A great contribution to these studies has been given by the renewed interest in growth theory and in particular to the convergence analysis. The convergence analysis has been utilised to verify the neoclassical assumption of catch-up between poor and rich countries. Baumol (1986), Dowrick and Nguyen (1989), Barro and Sala-i-Martin (1992, 1995). In these and more recent works the main variable to measure and to test the existence of economic convergence among countries has been the GDP per capita. Barro and Sala-i-Martin utilized data by countries or regions to measure **ß**-convergence (over cross section growth rate) and **σ**-convergence (dispersion over time of the per capita income). A new approach to the analysis of convergence has been developed by Quah (1993, 1966, 1997) to verify not only the existence of the catch-up phenomena, but also the role of polarization process among countries (convergence clubs).

The recent development of convergence analysis has been focused more and more on regional disparities mainly inside the largest countries. In fact, many studies has been done on the USA and China regional development to measure convergences or growing disparities, same examples are reported in Zhang , Liu and Yao (2000), Yao and Zhang (2001), Dèmurger (2001) and Kocenda (2001). In the European Union the analysis of economic convergence at regional level (NUTS 2 geographical definition of EUROSTAT) assumed a great political relevance since the 1986 structural policy reform, which has been allocated increasing financial support for regional and cohesion policies, Leonardi (1998), Button and Pentecost (1999), European Commission (1999, 2001).

The studies done on regional development inside the EU are numerous and they have utilized different methodologies to measure convergence, Sala-i-Martin (1996), Martin P. (1997), Leonardi R. (1998), Button K. and Pentecost E. (1999), European Commission (1999), Brasili C. and Oppi M. (2001). The main empirical results show the presence of both process of convergence and polarization among the EU regions. In recent years other numerous works are going on considering regional disparities at a more desegregated geographical level inside each EU countries.
Nerveless the growing interest in convergence among countries and regions the main variable utilized in the analysis is still the aggregate GDP per capita, also if these data have been improved considering, for example, the power purchase parity. These aggregate analysis of economic convergence often are the result of a really different contribution of the main economic sectors or industries, as pointed out by Bernard and Jones (1996).
A deeper knowledge of the relative contribution of the different sectors or industries to the economic convergence of countries and regions is relevant, not only to better measure and explain the process development, but also to better define regional policies. This is particularly true for the role of agriculture and Agri-food system to the convergence of national and regional economy. In the past, many studies analyzed the productivities growth of agriculture (labor or total factor productivity) but only recently some works are done to measure if the agriculture productivity converges among countries and regions (Bernini and Sassi, 1999; Gutierrez, 2000).
In this work we will further disaggregate the analysis of convergence considering the long run structural changes of the agriculture and the Agri-food system of the main 12 EU countries in the last thirty years (1970-2000). In particular we will show how the different components of the Agri-food system in Europe (agriculture, food industry, food consumption, export and import) behave differently in term of convergence among countries in the long run. The work finds strong evidence of convergence on the variable more directly related to economic growth such as the decreasing importance of agricultural value added and food consumption on total GDP of the EU-12 countries. At the same time there are clear evidences of divergence in the degree of openness of the Agri-food systems (exports and imports). The convergence analysis will further show the existence of polarization process with groups of countries which behave differently characterizing the permanence of long run structural differences in the Agri-food system between Northern and Southern countries of the EU.

In this paper we will first describe the long run structural changes in the Agri-food system in the EU countries considering the main variables that could better explain the complexity and the dynamic evolution of the modern Agri-food systems. Starting from the suggestions of Malassis (1992) we will enlarge the analysis, other than agriculture and food consumption, to other important variables, such as the trade of food products (imports and exports) and considering explicitly the role of food industry. Than we will analyse the evolution of the main variables that describe the Agri-food systems to verify if there is convergence or not in the structural changes of the Agri-food systems of the EU countries. In this part of the paper we will utilise convergence test on cross section data for the all period 1970-2000 and sub periods. In the following paragraph we will try to demonstrate the presence of polarization process among groups of countries that influence the permanence of structural

differences in the EU Agri-food system at country level. In the last paragraph we will drown some concluding remarks.

2. Data and variables to describe the EU Agri-food system.

The Agri-food system in Europe is important not only from an economic and social point of view but also because it has been at the core of the process of integration of the EU countries[2]. The integration process and the realisation of the agricultural policy largely influenced the structural changes in the Agri-food system in Europe and have determined some common patterns of development among the different EU countries.

In particular, in the last decades the European Agri-food system has been largely influenced by the general changes in food consumption, characterised by a decrease both in its annual growth rate and in its importance in families' total expenditure. Total food consumption has reached 711 billion ECU in 1995, representing about 18% of total expenditure of EU households. The food consumption models have became more homogeneous among the different countries. In the last decades, food industry has grown more rapidly than agriculture and its added value has nearly reached that of agriculture. The value of final agricultural production reached over 220 billion ECU in 1995 (EU-15) with an added value of more than 117 billion ECU.

The process concentration and specialisation of the EU agricultural production at national and regional level led to a greater exchange of Agri-food goods, determining a greater openness of the Agri-food systems of each EU country, both intra than extra UE. The trade of agricultural products intra–EU countries has largely exceeded the value of imports from the rest of the world. The EU became the largest trade area of the world (imports plus exports) for Agri-food products. Agricultural imports and exports from and to the rest of the world reached the value of 66 and 48 billion ECU, respectively and nowadays they represent about 50% of the value of total agricultural production..

The analyse of the important and complex Agri-food system of the EU countries require that we considering explicitly the main variables that could represent all its components and describe in appropriate way the structural changes that are going on in the long run. We will first individuate these variables and than we will conduct the analysis of convergence on structural changes of Agri-food system of EU' countries over the period 1970-2000.

The starting point to describe the Agri-food system are Malassis' suggestions to analyse agricultural and food development in the more general way because their dynamic evolution and the changing role of the different components of the system strictly depends on general economic development (Malassis 1992). He suggests an analytical model composed by three principal variables, which are directly and

[2] In fact, the common agricultural policy (CAP) has been the most important policy of the EU, receiving founds for an amount of about 75% of the EU budget during the 70's and absorbing about 50% the total EU expenditure in the last few years. The Agenda 2000 agreement will maintain this importance of agricultural expenditure until 2006.

indirectly involved in the economic growth processes. The first one is the ratio of food consumption to the gross domestic product (FC/GDP), which gives an immediate linkage to the global economy. This variable generally decreases because of the smaller elasticity of food consumption with respect to other goods. The second variable is the relative weight of agricultural final production in food consumption (AFP/FC). It considers the decreasing role of agriculture and the greater importance of food industries and food distribution (retail and logistics) in determining the final value of food consumption[3]. The last variable considers the ratio of agricultural net added value to agricultural final production (ANVA/AFP) which describes technical inputs that are more and more utilised in agriculture.
We can summarise Malassis's suggestions in the following identity:

ANVA/GDP = FC/GDP * AFP/FC * ANVA/AFP (1)

We can extend this model by including in an explicit way food industry because its added value tends to became greater than that of the agricultural. In fact food industry is becoming more and more important within the Agri-food system. We can modify and extend the previous identity by including the ratio of the food industry added value to food consumption (FIVA/FC).

The new identity can be specified as following:

ANVA/GDP = FC/GDP * FIVA/FC * AFP/FIVA * ANVA/AFP (2)

The two previous description of Agri-food system are closed models. They do not directly consider the importance of the import-export variables which are particularly important in the structural transformations. The growing degree of openness of the Agri-food system is due both to the integration process of the European Union, and to the globalisation of Agri-food world market. The new identity can be specified as following:

ANVA/FC=(Imp+Exp)/FC*(ANVA+FIVA)/(Imp+Exp)*ANVA/(ANVA+FIVA) (3)

In this identity, there are three new components which represent (a) the index of openness (import–export) of the Agri-food system: (Imp+Exp)/FC, (b) the index of openness of agriculture and of food industry (ANVA+FIVA)/(Imp+Exp), (c) the index of structure of agriculture on food industry ANVA/(ANVA+FIVA). This third identity is very important because it let us to know the influence and the importance of trade among European countries and with the rest of the world.
In the following paragraphs we will utilise these main variables considered in the three models specified above to point out if there are similarities or differences in the structural changes of the Agri-food system for each of the 12 countries of European Union from 1970 to 2000.

[3] In the original Malassis's definition agricultural final production has been corrected to consider non-food production and external trade, but we will not use this correction.

The source of data to build the variables of the Agri-food system come from the Database of the System of National Accounts of Eurostat SEC2 from 1970 to 1997[4]. The data for this period are homogeneous, whereas thereafter, from the 1998, the national accounting system has changed. Since the new time series for the previous years is not yet available, to have a longer time series, we have projected all the variables from 1997 to 2000. We utilised different ARIMA model to the times series analysis of each Agri-food variables for each EU countries for the period 1970-97. The ARIMA model that give the best results to forecast variables (1997-2000), is the AR(1): $\mathbf{X_t = c + \alpha X_{t-1} + \mu_t}$ where c is a constant and $\mu_t \sim WNn(0,\sigma_\mu)$. [5]

3. Some Structural changes in the Agri-food system in the EU countries

The analysis of the trends of the main variables shows that the Agri-food systems of each EU countries over the period 1970 to 2000 is characterised not only by structural differences but also by differences in the changes over time. The Agri-food system in the EU countries is and remains different, even if, as we will see, some convergence phenomena are taking place in structural variables during the last 30 years.[6]

A brief description of the main trends show some relevant structural changes in the EU Agri-food system. For reason of space we will consider only the changes of few variables of the EU Agri-food system.

The importance of *agricultural added value in GDP* (AAV/GDP)decreases over time quite remarkably in each European country. This decrease is more evident for some of the less developed and most rural countries, such as Portugal (from 10% to 3.4%), Ireland (from 14% to 2.8%) and Spain (from 11% to 2.7%). Also in Greece the pattern is clearly decreasing too, but it is still much higher respect to that of other countries: the Greek values are about 15%, whereas most of the other countries have values below 5%.The value of this variable convergence toward a values similar to that of a group of countries such as United Kingdom, Germany, Belgium and Luxembourg, which have a smaller values and a constant decrease over time.

The value of *food consumption expenditure on GDP (FC/GDP)* have experienced a general reduction in the European countries, from 1970 to 2000 (Fig. 1). Each country is clearly going toward a similar value despite they were in different starting situations. Major reductions have been registered in Ireland (from 30% to 11.2%), Italy (from 23% to 11.2%), Spain (from 21% to 11.5%) and the United Kingdom (from 20% to 12.4%). In any case, also in Ireland and Portugal the importance of food consumption in GDP is still remarkably higher compared to the other European countries.

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[4] In the analysis, we will use agricultural added value at factor cost (AAV) instead of net agricultural added value (ANVA).

[5] The trends that results on this time series analysis on the main Agri-food variables for the 12 EU countries are not reported for reason of space but they are available from the authors. These results are generally very good with an high level of significance. This will ulterior justify the utilization of data up to 2000.

[6] For a description of these structural differences among EU countries you can see a previous work of Brasili, Fanfani (1999).

The *Agricultural Final Production to Food Consumption (AFP/FC)* shows really large differences among EU countries. The highest value is in Netherlands (about 80%) is mainly due to the strong development of greenhouse production. The United Kingdom situation is noteworthy for the lowest values in the whole period -about 25% in the most recent years- showing a food consumption value determined by a bigger share of processing and distribution services expenditure.

The *Ratio of Food Industry Added Value to Food Consumption (FIVA/FC)* has been increasing over time in the European Agri-food system. The value of food industry in food consumption has mainly increased in the most dynamic countries, such as the Netherlands (from 28% to 44%), Ireland (from 28% to 36%), Denmark (from 23% to 31%) and Portugal (from 19% to 33%). On the other hand, Italy, Greece and Luxembourg show a slower trend and very low values, about 15% .

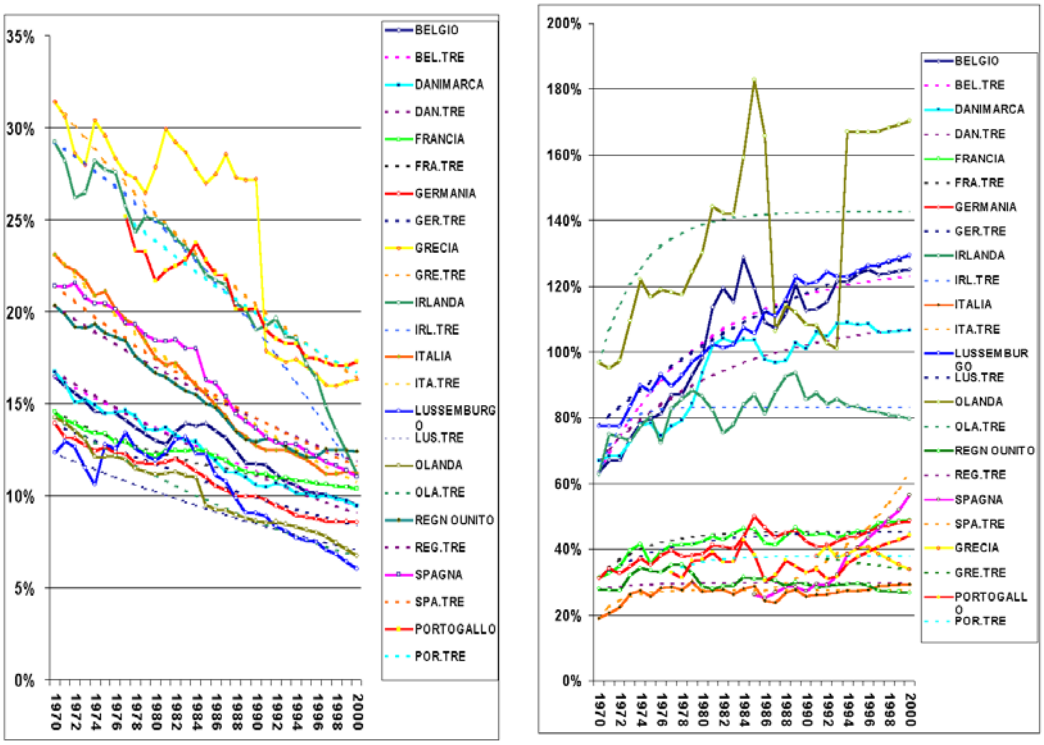
The *ratio of agricultural final production to food industry added value (AFP/FIVA)* has been involved in a clear convergence process from 1970 to 2000 in the European countries. In 1970 this ratio was above five in some countries as Italy weather in the some period in the Netherlands the same value was a little over 1. In 2000 the range of this ratio had reduced significantly with values from 1 to 3. The countries with the most significant reductions, during the period considered are Italy (from 3.4 to 1.9), Portugal, Ireland (from 3.4 to 1.1), Spain (from 3.0 to 1.7), and France (from 3.5 to 1.7), while there has been a slower decreasing trend for Germany, Belgium, Denmark and the Netherlands.

The importance of *agricultural added value in food consumption (AAV/FC)*has shown a general decreasing trend in the European countries though not as pronounced as the ratio of agricultural added value to GDP. There are two main groups of countries to be considered: the first one includes Italy, France, Spain, Denmark, the Netherlands and Ireland -with higher values from 32% to 47% in 1970, but with slightly different values (from 27% to 38%) in 2000; the second group of countries is represented by Luxembourg, Belgium, United Kingdom and Germany with values ranging from 12% to 26% in 1970 and with much similar values ,-around 14%,- in 2000. The Greek pattern, with the highest value in 2000 (44%), seems to be still quite different from most of the other European countries, but with a clear decreasing trend in the period considered.

The *ratio of agriculture and food industry trade to food consumption (IMP+EXP/FC)*, measures, as we sad the degree of openness of the countries (Fig. 2). There is strong empirical evidence that this variable is increasing over time, but there are groups of countries with different development models. The Netherlands show a large increase in the importance of trade in food consumption: in 2000 this ratio reached the value of 1.8. Some northern countries (Belgium and Denmark) made the most of the new opportunity for trade created in Europe. Other countries (Germany, France, Portugal, United Kingdom and Italy) have slowly increased this ratio over time, showing more closed Agri-food economies than the former ones. At the end of the period (2000), the ratio's values exceeded 1 for the Netherlands, Belgium and Denmark, while the values were below 0.5 for the other group of countries.

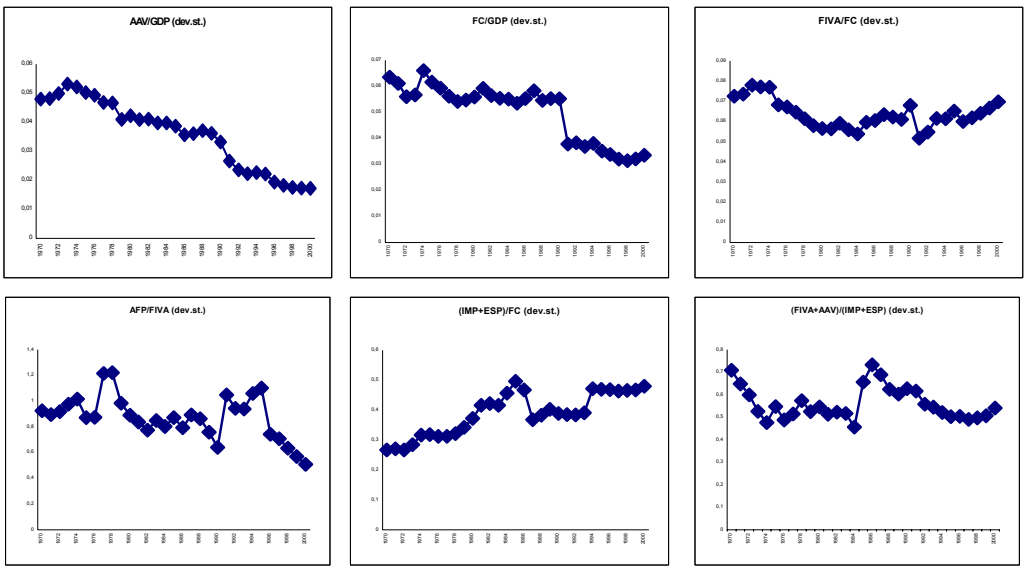
Fig. 1
Food consumption on GDP

Fig.2
Ratio of agriculture and food industry trade to food consumption



Source: Eurostat: CRONOS -Sec2, our processing

Fig.3 - *Standard Deviation of Agri-food variables (1970-2000)*



Source: Eurostat: CRONOS -Sec2, our processing

4. Convergence analysis

4.1 Testing the convergence hypothesis: cross-section evidence

In the previous paragraphs, we analysed the evolution of the different variables which describe the European Agri-food system. As we could see, among the EU countries there are different trends and patterns for the main variables considered. In this section, we attempt to test the hypothesis that the various countries are converging towards the same structure of Agri-food system. We will do this using three different statistical tests based on the variance of the structural variables of the previous three models described.

These three statistics were proposed by Lichtemberg (1991) and Carree-Klomp (1997) to test for convergence in productivity in the 22 OECD countries for the 1960-1985 period. Carree and Klomp proposed two tests (T2 and T3), alternative to the T1 test proposed by Lichtemberg to test the hypothesis that the variances in the first and the last period were equal. The test T2 is obtained by using the likelihood-ratio test statistic, while the T3 is obtained by deriving the correct distribution of Lichtemberg's statistic T1, defined more precisely by Carree and Klomp. The formulas and the details relative to the tests utilised can be found other than in authors works also in Brasili, Fanfani, Montini (1999).

The three tests to measure convergence have been estimated for all the variables considered, in order to underline the structural changes have affected the Agri-food systems in the EU countries in the period 1970-2000. We consider three sub-periods (1970-1980,1980-1990 and 1990-2000), in order to investigate if the convergence processes were different in the 70s the 80s and in the 90s. The results of the test T_1, T_2, and T_3 for the twelve EU countries and for the period considered are reported in table 1and 2.

4.1.1Convergence by Countries and by Time Periods

The analysis of the tests for the ratio of agricultural added value to GDP, in the whole period and in the two sub-periods, show convergence in this important variables among the EU countries. In particular, the T_1-statistic suggests that there has not been convergence of the variable, whereas the other two statistics report convergence. However, as pointed out by Carree and Klomp (1997) the use of the T_1-statistic for short time periods has a large probability of committing a type II error. We can conclude, with T_2 and T_3-statistics significant, that there has been convergence of the share of agricultural added value in GDP within the 1970-2000 period (Table 1). We did some more computations excluding the Greek values which have a clearly different development model from those of the other European countries (outlier problem). In this case, the significance of the convergence tests is much higher.

We found a stronger convergence about the trend of food consumption in GDP. Excluding Greece. The tests showed a significant convergence process, not only with regards to the whole period, but also considering the three sub-periods 1970-1980 and 1980-1990 and 1990-2000. This is anyway an evident sign of a continuous process of integration of food consumption in the general structure of families' consumption, and more in general in the EU economic development.

Despite a clear process of convergence there are still differences among the countries. In fact, the food consumption share in GDP of some Mediterranean countries still have an high values today: about 14% in Spain and 17% in Portugal and Ireland, whereas Greece has the highest value (32%) and is not converging with the other countries. For all the other countries there is a strong convergence towards an average value of roughly 10-12%.

One even more important convergence pattern has to be pointed out for the ratio of agricultural final production to food industry added value. All three *T*-statistics are significant for the periods 1980-1990 and 1990-2000. For the sub-period 1970-1980, only the T_3-statistics is significant, showing that the convergence process has been stronger and more significant in the Eighties and Nineties than in the Seventies.

The range of this variable among the EU counties countries was very large in 1970 (from a maximum of 5.8 to a minimum of 1.2) but it has converged to a more uniform value from less than 3 to 1 in 2000. The lowest values of the ratio of final agricultural production to food industry added value are now in Germany and United Kingdom, with values very close to one. So, we can see a more homogeneous structure among the countries, for what regards changing relations between agricultural production and industrial transformation.

The process of convergence of this variables allows to distinguish two main groups of countries. The first and more numerous group includes Netherlands, France, Italy, Spain and Denmark with a share of agricultural added value in GDP around 3.3 to 4.2%. The other group, with very low values of this variable, about 1.3 to 1.8%, includes Germany, United Kingdom and Luxembourg. The only two countries showing a high value of agricultural added value in GDP are Greece (14%) and Ireland (8%).

For what regards the other variables we have considered and analysed in the previous section, such as AFP/FC, AAV/FC, AAV+FIVA/IMP +EXP and AAV/ AAV+FIVA, all the *T*-statistics are generally non-significant both for the whole period and the sub-periods. The dynamic of these variables determine the permanence of some strong structural differences in the Agri-food systems of the EU countries.

4.1.2 Some Cases of Divergence by Countries and by Time Periods

As we sow in the previous paragraph, only some of the variables of the Agri-food system in Europe converge in all countries and in every sub-period considered. Moreover, there are other variables which have shown an increasing trend of divergence. These variable are more or less linked to the trade and degree of openness of the Agri-food systems.[7]

The *ratio of agriculture and food industry imports and exports to food consumption*, we found that all the T_2-statistcs are significant, for the whole period and for the first sub-period (1970-80). This provides strong empirical evidence of

[7] The divergence of variables is verified when the π value is more than 1.0 and the T_3-statistic cannot be determined; moreover the variance at the beginning of the period is generally lower than the one at the end of the period, thus the T_1-statistics are insignificant and with values lower than 0. Therefore, the only statistics to be useful in this situation is the T_2-statistic which is suitable to test the null hypothesis $\sigma_1^2 = \sigma_T^2 = \sigma^2$.

divergence among countries, with some countries taking advantage of "trade creation" process in the EU. In particular, the Netherlands have registered a very rapidly increasing of the value of external food trade on total food consumption, who is greater than 80% of total food consumption in 2000. Also other countries, as Belgium, Luxembourg, Denmark, and Ireland, have rapidly increased the level of Agri-food imports-exports. Instead, other countries, and in particular the largest countries (Germany, France, Italy, Great Britain), show a stable and lightly increasing level of external trade, with food imports-exports values between 20% and 40% of food consumption in 2000.

TABLE 1 – Sigma-convergence in the Agri-food System of the EU-12

Period	T_1	T_2	T_3	$\hat{\sigma}_1^2$	$\hat{\sigma}_T^2$	$\hat{\pi}$
			AAV/GDP [(a)]			
1970-2000	**7.28** *	**16.18** *	**11.01** *	**0.002**	**0.0003**	**0.33**
1970-1980	**1.24**	**1.66**	**0.64**	**0.002**	**0.002**	**0.78**
1980-1990	**1.58**	**7.75** *	**1.53**	**0.002**	**0.001**	**0.78**
1990-2000	**3.71** *	**21.49** *	**5.37** *	**0.001**	**0.0003**	**0.54**
			FC/GDP[(a)]			
1970-2000	**5.17** *	**11.72** *	**8.06** *	**0.004**	**0.001**	**0.51**
1970-1980	**1.28**	**3.24**	**0.84**	**0.004**	**0.003**	**0.84**
1980-1990	**1.09**	**0.15**	**0.26**	**0.003**	**0.003**	**0.83**
1990-2000	**3.73** *	**9.68** *	**6.60** *	**0.003**	**0.001**	**0.73**
			AFP/FC[(a)]			
1970-2000	**1.36**	**0.71**	**0.78**	**0.04**	**0.03**	**0.68**
1970-1980	**1.15**	**0.19**	**0.59**	**0.04**	**0.03**	**0.92**
1980-1990	**0.76**	**0.87**	**-1.07**	**0.03**	**0.04**	**0.93**
1990-2000	**1.57**	**5.28** *	**1.44**	**0.03**	**0.03**	**0.78**
			AAV /AFP[(b)]			
1970-2000	**0.78**	**0.12**	**-0.77**	**0.004**	**0.005**	**0.89**
1970-1980	**0.59**	**2.91**	**-1.45**	**0.004**	**0.006**	**0.89**
1980-1990	**2.47**	**2.47**	**N.D.**	**0.006**	**0.003**	**1.06**
1990-2000	**0.54**	**1.10**	**-2.11**	**0.003**	**0.005**	**0.94**
			FIVA/FC[(a)]			
1970-2000	**1.02**	**0.002**	**N.D.**	**0.005**	**0.005**	**1.11**
1970-1980	**1.51**	**1.88**	**2.68** *	**0.005**	**0.003**	**0.95**
1980-1990	**0.70**	**1.67**	**N.D.**	**0.003**	**0.005**	**1.09**
1990-2000	**0.97**	**0.003**	**N.D.**	**0.005**	**0.005**	**1.08**

Notes: [a] Greece is not included. [b] Portugal and Greece are not included.
* Significant at the 5% level. The critical values corresponding to this level of significance are 2.81, 3.84 and 1.645 for the T_1-statistic, T_2-statistic and T_3-statistic respectively.

TABLE 2 - Sigma-convergence in the Agri-food System of the EU-12

Period	T_1	T_2	T_3	$\hat{\sigma}_1^2$	$\hat{\sigma}_T^2$	$\hat{\pi}$
			AFP/FIVA[(b)]			
1970-2000	**5.04 ***	**11.66 ***	**7.57 ***	**0.77**	**0.15**	**0.54**
1970-1980	**1.00**	**0.00**	**2.45 ***	**0.77**	**0.77**	**0.94**
1980-1990	**1.87**	**3.89 ***	**2.29 ***	**0.77**	**0.41**	**0.80**
1990-2000	**2.69**	**8.07 ***	**3.73 ***	**0.41**	**0.15**	**0.70**
			AAV /FC[(b)]			
1970-2000	**1.50**	**0.88**	**1.06**	**0.02**	**0.01**	**0.62**
1970-1980	**1.01**	**0.004**	**0.02**	**0.02**	**0.02**	**0.86**
1980-1990	**1.13**	**0.16**	**0.67**	**0.02**	**0.01**	**0.94**
1990-2000	**1.32**	**2.04**	**0.82**	**0.01**	**0.01**	**0.77**
			(Imp+Exp)/FC [(c)]			
1970-2000	**0.27**	**14.32 ***	**N.D.**	**0.06**	**0.23**	**1.66**
1970-1980	**0.48**	**13.35 ***	**N.D.**	**0.06**	**0.13**	**1.37**
1980-1990	**0.96**	**0.03**	**N.D.**	**0.13**	**0.13**	**1.03**
1990-2000	**0.58**	**3.00**	**N.D.**	**0.13**	**0.23**	**1.16**
			(AAV+FIVA)/(Imp+Exp) [(c)]			
1970-2000	**2.58**	**3.40**	**2.84 ***	**0.46**	**0.18**	**0.55**
1970-1980	**1.92**	**5.60 ***	**1.90 ***	**0.46**	**0.24**	**0.69**
1980-2000	**1.35**	**0.77**	**0.87**	**0.24**	**0.18**	**0.81**
1990-2000	**1.11**	**0.21**	**0.31**	**0.18**	**0.18**	**0.84**
			AAV /AAV * FIVA[(a)]			
1970-2000	**1.84**	**2.79**	**1.98 ***	**0.02**	**0.01**	**0.72**
1970-1980	**0.97**	**0.05**	**-0.17**	**0.02**	**0.02**	**0.94**
1980-1990	**1.14**	**0.83**	**0.77**	**0.02**	**0.02**	**0.95**
1990-2000	**1.66**	**4.06 ***	**1.84 ***	**0.02**	**0.01**	**0.80**

Notes: [a] Portugal is not included. [b] Portugal and Greece are not included. [c] The variables with Import and Export do not include Portugal, Greece and Spain. * Significant at the 5% level (see table1).

The *food industry added value in food consumption*, also show a divergence pattern among countries, but however it is not significative by the tests values. Among the countries that are more strongly developing food industry, we can find on one hand the Netherlands, and Denmark, on the other hand Portugal, Ireland, Italy and Greece, which show a much slower development.

The existence of divergence process among same variables of the agri-food system of the EU countries confirms the fact that the food model stands out among EU countries, instead of reaching convergence in all the components.

4.2 Testing for Unit Roots in Panel Data: time series evidence

The cross-section analysis of the long run changes in the Agri-food system in the EU countries, presented in the previous paragraphs, shows the presence of some relevant phenomena of convergence in some variables and divergence in other ones.

To take advantage of the availability of time series data, we analysed the cross-countries deviations of the level of the variables described in paragraph 2. However, in our case it is not advisable to apply the common unit root test in a limited length time horizon with only thirty years (1970-2000). Therefore, to verify if there are evidence of convergence on the Agri-food variables, we use the panel data test for unit roots , for 12 countries and over the period 1970-2000, first proposed by Levin and Lin (1992) and developed and specified by Bernard and Jones (1996).

The following general model is considered:

$y_{it} = \mu_i + \rho y_{it-1} + \varepsilon_{it}$ where the $\varepsilon_{it} \approx iid\left(0,\sigma_\varepsilon^2\right),\ \mu_i \approx iid\left(\overline{\mu},\sigma_\mu^2\right).$

Bernard and Jones (1996) proof the proposition that considering the above regression model and under the null hypothesis of a unit root with non zero drifts $(\sigma_\mu^2 \neq 0),\ \sqrt{N}T^{3/2}(\hat{\rho}-1) \Rightarrow \mathrm{N}\left(0,12\frac{\sigma_\varepsilon^2}{\sigma_\mu^2+\overline{\mu}^2}\right)$

$t_\rho \Rightarrow \mathrm{N}(0,1).$

The most important finding is that the limiting distribution of the unit roots estimator is centred and normal if N and T go to infinity. To test the presence of convergence between countries we choose as benchmark the country with the median value of the considered variables in 1970 (except for some variables 1977, see table 3). The estimation of the parameter ρ is done on the ratio between the variable of each countries and the benchmark country.

Table 3 - Unit Root in the Panel data in the Agri-food System of the EU-12

Variable	ρ	t- Statistics	Benchmark country	year
AAV/GDP	**0.809**	24.1	Denmark	1970
FC/GDP	**0.879**	27.7	Belgium	1970
AFP/FIVA	**0.713**	16.4	Denmark	1970
FIVA/FC	**0.884**	28.1	Netherlands	1970
(Imp+Exp)/FC	**0.649**	17.3	France	1977

The analysis on the time series show that for the two ratios related to GDP (AAV/GDP and FC/GDP) there are evidence of strong convergence versus the value of the median country, with the ρ value around 0.81 and 0.88, respectively. This also true for the trend of the variable related to food industry added value on food consumption (FIVA/FC) , which also exhibits a value of ρ inferior to 1 (0.88). We have to remember that all of these tree variables in the cross section analysis exhibit a clear tendency to convergence[8]. The other considered variables have ρ values much lower than 1, which could be interpreted as a stronger tendency versus a convergence of their value to that of the benchmark countries. This is especially true for the value of the variables linked to importance of trade (Imp+Exp/FC) which has the lowest value of ρ (0.65). In the previous cross section analysis this last variables shows a

[8] The estimates reported in the paper suffer from the small sample Hurwicz-Nickell bias, moreover, if the drift is small the limiting normal distribution may prove to be a poor approximation. In this case the point estimates of ρ and t-statistics will be biased downward. For these reason we are working to adjust the bias trough a Monte Carlo simulation.

clear evidence of divergence among the EU countries. This could be partially due to the fact that the time series analysis refer to the convergence or divergence of all twelve countries respect to the benchmark country, and it could not take into account the performance of smaller groups of countries[9].

The time series analysis essentially confirms the results obtained on cross section variance among EU countries. In the plot analysis, but also in the estimation of the value of μ in the previous model, there is evidence that in the Agri-food system of the twelve EU countries there are groups of countries that exhibit common trends. A development of the time series analysis on convergence require the utilization of methodologies that could individuate these tendencies.

5. Concluding remarks

The general process of integration of the EU countries and the evolution of the common agricultural policy have played an important role in the changes in the structure of the Agri-food system within the EU countries. In the last 30 years there have been several long-run changes that have transformed the Agri-food system related to the evolution of the economy. The analysis of main variables that describe the Agri-food system for the period 1970-2000 shows that there are significative process of convergence and divergence among the EU countries.

In particular, two main variables linked to the general development of the EU economy, such the share of food consumption and the added value of agriculture in gross domestic product (GDP) have shown a clear trend toward a more homogeneous and similar structure of the Agri-food system in the EU countries. The value of food consumption in total GDP has decreased rapidly and the convergence has been particularly intensive during the Nineties, when the Single European Market as been applied in 1993. The ratio of agricultural added value to GDP shows a clear reduction and convergence process. This convergence is more relevant than the previous one and it continues throughout the whole time period considered 1970-2000, although more evident after the 80s.

Other important variable that show strong convergence process is the ratio of final agricultural production to food industry added value. This variable has declined rapidly in the last decades with the growing importance of industrial transformation. The convergence of this variable, which is strongest respect to the other variables and it is relevant in the eighties and nineties. This underline a really long run structural change in the relation among agriculture and industrial transformation inside the EU Agri-food system.

The greater importance of the food industry is becoming evident not only in relation to agriculture, but also for the growing of added value of the food industry to total food consumption. But in this case, the growth of this variable is accompanied by

[9] An appropriate approach to test the existence of the convergence and the polarization process among countries (*convergence clubs*) has been developed by Quah (1993, 1966, 1997). The cross-section data required to apply this methodology are much more than that available for the EU countries, and probably require to deep the analysis at regional level.

a divergence process among the EU countries, also if it is not statistically significative. The countries with the larger increase are not only the northern countries such as the Netherlands, Denmark and Ireland, but also Spain and Portugal.

The openness of the Agri-food system in the EU countries has registered a remarkably growth according to the ratio of imports–exports to food consumption. The growth of this variable in the last thirty years show a great divergence between countries. The greater increase in the degree of openness of the Agri-food system is registered by the smaller countries, with a dominant position of Nederland, followed by Denmark and Belgium, who seem to be more reactive to take advantage of the "trade creation" among the EU countries.

The structural change of the Agri-food system in the last 30 years has shown many convergence patterns but also some divergences among the EU countries. The convergence process concerns the more general variables like the share of food consumption and agricultural final production in GDP, who are strictly related to the process of development of the EU countries. The divergence process, instead, concern the growing importance of food industry and food trade inside the Agri-food system, with some countries acquiring a greater specialisation in food industry and other taking an advantage in food trade.

We can conclude that the long run structural changes in the Agri-food system, also if they show important process of convergence and divergence, they are still characterised by the persistence of relevant diversities among the EU countries. The persistence of these diversities, also in presence of convergence process, is due to the fact that the changes often interest in a different way groups of countries, such as the Northern and Mediterranean countries, or the small and larger countries.

The difference pattern of structural changes among EU countries suggest to develop new and deeper analysis of structural change in the Agri-food system in two main directions. On the one hand we have to compare changes in the European Agri-food system with the other great world areas, and on the other hand, we have to consider the structural changes at regional level, where the process of specialization and the changes are more profound.

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