Long Term Structural Changes in the EU Countries (1970-2000):

Convergence or Divergence in the Agri-Food System?

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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)[1]. 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). 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. The recent development of convergence analysis has been focused more and more on regional disparities mainly inside the largest countries2.

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.

[1] 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).

[2] Many studies has been done on the USA and China regional development to measure convergences or growing disparities. 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).

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

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)[3]. We can summarise Malassis's suggestions in the following identity:

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

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 identity are closed models and they do not directly consider the importance of the import-export variables which are particularly He suggests an analytical model composed by three principal variables, which are directly and indirectly involved in the economic growth processes. The first one is the ratio of food consumption to the gross domestic product (FC/GDP), The second variable is the relative weight of agricultural final production in food consumption (AFP/FC). 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 last variable considers the ratio of agricultural net added value to agricultural final

[3] He suggests an analytical model with three principal variables directly and indirectly involved in the economic growth processes. The first one is the ratio of food consumption to the gross domestic product (FC/GDP). The second variable is the relative weight of agricultural final production in food consumption (AFP/FC). 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 last variable considers the ratio of agricultural net added value to agricultural final production (ANVA/AFP).

production (ANVA/AFP).relevant in the structural transformations[4]. The new identity can be specified as following:

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

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. 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[5]. 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.[6]

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.[7] 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%

[4] The growing degree of openness of the Agri-food system is due both to the integration process of the European Union (intra EU) and to the globalisation of Agri-food world market (extra EU).

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

6 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 $\mu_t \sim WNn(0,\sigma_\mu)$. 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.

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

to 3.4%), Ireland (from 14% to 2.8%) and Spain (from 11% to 2.7%)[8]. 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.

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 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

[8] 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%.

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.[9]

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*

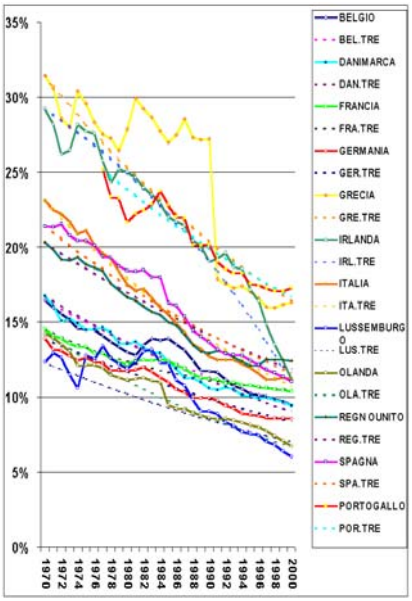
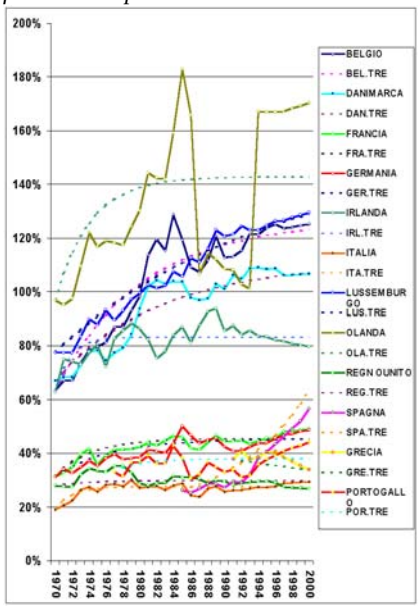


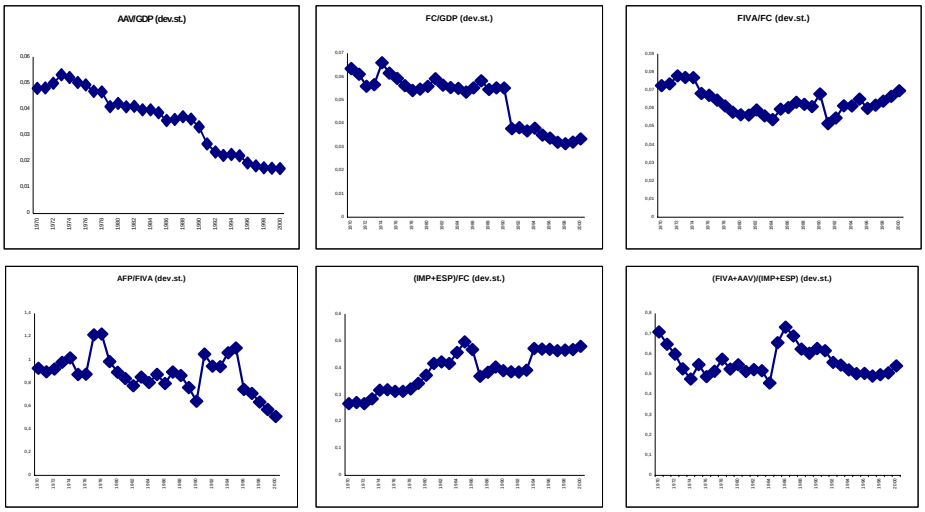
Fig.2 - *Ratio of agriculture and food industry trade to food consumption*



Source: Eurostat: CRONOS -Sec2, our processing

9 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.

Fig.3 - *Standard Deviation of Agrifood Variables for EU Convergence (1970-2000)*



Source: Eurostat: CRONOS -Sec2, our processing

4. Convergence analysis

4.1 Testing the convergence hypothesis: cross-section evidence

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.[10] 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.

[10]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).

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. 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.

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*	11.65*	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	0.0004	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).

4.1.2 Some Cases of Divergence by Countries and by Time Periods

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.[11] 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 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. 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

Therefore, to verify if there are evidence of convergence on the Agri-food variables, we use the test for unit roots in panel data, for 12 countries and over the period 1970-2000, proposed firstly by Levin and Lin (1992) and developed and specified by Bernard and Jones (1996). Considering the following general model: $y_{it} = \mu_i + \rho y_{it-1} + \varepsilon_{it}$ where the $\varepsilon_{it} \approx iid\left(0, \sigma_\varepsilon^2\right)$, $\mu_i \approx iid\left(\overline{\mu}, \sigma_\mu^2\right)$. So Bernard and Jones

[11] 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 $\sigma_1^2 = \sigma_T^2 = \sigma^2$.

(1996) proof the proposition that considering the above regression model and under the null hypothesis of a unit root with non zero drifts ($\sigma_\mu^2 \neq 0$),

$$\sqrt{N}T^{3/2}(\hat{\rho}-1) \Rightarrow \mathrm{N}\left(0{,}12\frac{\sigma_\varepsilon^2}{\sigma_\mu^2+\bar{\mu}^2}\right) \quad t_\rho \Rightarrow \mathrm{N}(0{,}1).$$

The most important finding is 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/FI VA	**0.713**	16.4	Denmark	1970
FI VA/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 the time series versus the value of the median country, with the ρ value around 0.81 and 0.88, respectively. We have to remember that all these tree variables in the cross section analysis exhibit a clear tendency to convergence. The other variables considered have ρ values very lower than 1 that could be interpreted as a tendency versus a convergence of their value to that of the benchmark countries. This particularly 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 show a clear evidence of divergence among the EU countries. A development of the time

series analysis on convergence require the utilization of methodologies that could individuate these tendencies.[12]

5. Concluding remarks

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 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 among the EU countries. This convergence is more than the previous one. In fact, 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 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

[12] To verify the existence of the convergence phenomena but also the role of polarization process among countries (convergence clubs) an appropriate approach is that developed by Quah (1993, 1966, 1997). The 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 .

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.

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.

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