The Introduction of the Euro and its Effects on the Agricultural Sector

Trabajo Fin de Grado

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ABSTRACT

This paper addresses how the adoption of a common currency affected the agricultural sector of the Euro-zone members. Firstly, by examining time series data of agricultural price deflators I attempt to determine whether the introduction of the euro caused a structural change within the series. In addition, I will also look at cross-country price dispersion to show that the adoption of a common currency fostered price convergence as theory predicts. I will then conclude that the introduction of the euro had positive effects for the agricultural products market favoring greater transparency and efficiency. This paper is divided as follows: Part I introduces the topic, summarizes the theory and reviews existing literature. Part II explains the empirical framework and Part III presents empirical results. Finally Part IV discusses potential problems and includes some concluding remarks.

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PART I: INTRODUCTION

The adoption of a common currency, the Euro, by 11 countries of the European Union on January the 1st, 1999 was the peak of the monetary unification process which had started with the set up of the European Monetary System back in 1979. The birth of the euro resulted in a system of fixed-exchange rates, in which countries gave up their national currencies and sovereignty over monetary policy with the prospect of gaining international power, preventing potential political confrontation, achieving the unification of markets and encouraging international trade.

However, the current sovereign debt crisis, which is hitting especially hard among Mediterranean countries, has displaced initial enthusiasm and raised pre-existing concerns on the optimality of this decision. In fact, many economists argue that Europe is not an Optimum Currency Area as defined by Mundell (1963) and as such, asymmetric shocks prevent the sustainability of the common currency in the long run. According to this theory, potential benefits from joining a common currency area increase the larger the degree of integration. This would imply labor and capital mobility, large share of intra-EU trade and inflation rate convergence. So the question is: has the euro fostered further market integration?

In order to evaluate this issue, there is a long list of literature analyzing the impact of the introduction of the euro in different markets, especially focusing on the financial sector, as well as the overall effect on trade. For example, Morana & Beltratti (2002) prove that the introduction of the euro led to the decrease of volatility of stock returns for traditionally unstable stock markets such as Italy and Spain. Similarly, Friedman & Shachmurove (2005) use vector Auto Regression models, impulses responses and variance decomposition to show how the new common currency induced further stock market integration in Europe, meaning by this the strengthening of co-movement linkages among countries. The authors more specifically look into the percentage of change in the stock indices that can be explained by external innovations, and the speed of shock transmission.

Turning towards the effects of the euro on trade, Faruqee (2004) concludes that the introduction of the euro boosted EU-trade roughly 10% based on panel data. In addition, the author shows that the EMU has trade-creating effects (trade among EU and other countries is not negatively affected by the euro), the dynamics effects are increasing with time and gains in trade have been unequally distributed among countries. For example, Spain, Netherlands and Belgium display trade gains above the average. Controlling for initial differences among countries (labor market structure and pre-Euro pattern of trade) does not change such positive results.

Despite the important role agriculture still plays within EU politics, almost no research has been conducted to draw conclusions on this sector. Therefore, this paper intends to shed some light on the impacts of the introduction of the Euro on the agricultural market: whether it entailed a fundamental change in the economy primarily and, as a second hypothesis, if it actually enhanced agricultural products price convergence improving efficiency.

1.1 Agriculture in Europe

The agricultural sector represented 2.4% of GDP for the Euro-area in 2000; this share had fallen to 1.7% by 2010. Even though its importance measured as the share of total production has been declining steadily over time, Europe is still a main exporter and largest importer of agricultural products and agricultural lobbies still have enough negotiation power to influence the Euro-area institutional agenda. In fact, the Common Agricultural Policy captures the largest share of EU's annual budget and is the oldest policy among the European integration project.

The Common Agricultural Policy (CAP) was implemented during the 1950s to ensure food supplies after the war had damaged the agricultural production for years. The initial objective was to encourage further agricultural productivity to achieve stability within food supply. It was a system of subsidies and other type of payments that guaranteed high prices to farmers as an incentive for them to produce more. During the 1980s, when the EU had reached self-sufficiency, objectives had to change given critics such as major product surpluses, market distortion international effects and high budget costs. Consequently, production limits were introduced and the importance of environmentally friendly agriculture was highlighted. The MacSharry reform of 1992 and the Agenda 2000 contributed towards this direction. At present the CAP pretends to make European farmers more market-oriented and is focusing on rural development as well.

In addition, agriculture is said to have multiple functions as explained by the Agriculture and Development European Commission. On top of covering the majority of the Member States' territory and influencing particularly the health of both rural economies and landscapes, it has recently adopted an important role in making the economy sustainable. At present, farmers do not only produce food and non-food agricultural products but are also key in other aspects such as tourism, conserving the environment and managing the countryside guaranteeing its survival.

1.2 Price convergence

According to the theory, market integration exerts downward pressure on prices and leads to a decline in price dispersion across member countries. In other words, closer integration fosters price convergence and, thus, supports the Law of One Price, by which a good should have the same price in different countries in spite of transportation costs. At the same time, inflation convergence is one of the Maastricht criteria required by the EMU to countries before becoming a Member State: "the inflation rate should be not more than 1.5 percentage points above the rate of the three best performing Member States."[1]

The European Union has clearly moved towards closer integration during the last decades: it has removed barriers to trade, established a single market and, finally, with the adoption of the euro, it has fulfilled the creation of an Economic and Monetary Union.[2] Nevertheless, whether price convergence has been finally achieved is still a matter of great controversy. Literature on this matter presents mixed results.

Sosvilla-Rivero & Gil-Pareja (2004), for example, provide empirical evidence for the degree of price dispersion among EU members in the case of traded goods for the 1975-1995 period. In addition, they find the speed of convergence is higher for the countries who earlier participated in the Exchange Rate Mechanism, while it is lower for those who joined later or suspended its participation at any given point in time.

On the other hand, Mentz & Sebastian (2003), use the Johansen test (cointegration analysis) together with traditional unit root tests to measure how the introduction of the Euro affected actual degree of inflation convergence. Their results for the 1993-2002 period suggest the common currency led to a slowdown in convergence.

PART II: EMPIRICAL FRAMEWORK

The empirical analysis is subdivided into three parts each of which explains a different stage of the investigation. To begin with, information had to be collected and put together into a database. This process was jointly conducted with my colleague Clara Martínez-Toledano Toledano who is also working on the topic. As a first approach to time series analysis, econometric software is used to detect structural breaks in the price series resulting from the adoption of the common currency. Following, price convergence is tested by looking at the trends of standard deviation and variation coefficient through time. Given the possibility of no conclusive results, a more formal technique is proposed: test for cross-country absolute β convergence.

[1] As stated by European Comission: http://ec.europa.eu/economy_finance/euro/adoption/who_can_join/index_en.htm

[2] Requests for structural reforms in labor markets and tax harmonization as a first step to the creation of a fiscal union has increased over recent years due to the effect of asymmetric shocks: debt crisis.

2.1 Database construction

The main and most important step in the project is the construction of a database regarding agricultural production values both at current and constant prices for the 1973-2011 period in the initial member states of the European Union. Specifically, information was collected for 26 products in 15 countries through the Eurostat online database.[3] Nonetheless, assistance from the European Documentation Center at the Universidad Carlos III's Library and the Spanish Ministry of Agriculture was also required.

Firstly, we defined the price deflator as the ratio between the constant and the current production values and calculated the corresponding series for each product and each country. Please note, this paper will use these price deflators as an approximation to agricultural prices for the rest of the analysis.

Given that we have two overlapping deflator series for each product, each with a different base year (1973-2006 series with base year 1995 and 1995-2011[4] series with base year 2005) the next and necessary step was to homogenize both of them i.e. to update the earliest series using the latest base year. This was done by applying a simple cross multiplication procedure described in greater detail in Appendix A1.1

Finally, in order to test whether the series were correctly joined and to dismiss the presence of outliers, we took variations of the deflators and checked the corresponding plots. No anomalies were detected and, thus, we can conclude that our database has been correctly constructed.

It is important to note that this whole procedure was especially time-consuming and could represent on its own a complete project. From this moment, this paper uses the information contained within this database to analyze the effects of the introduction of the euro currency over the agricultural sector.

2.2 Structural change

To determine whether a given event or date has a direct impact on a time series, the easiest approach is to test for structural change at time τ. Structural change is defined as a long-term and widespread shift in the fundamentals of an economy's structure, as opposed to micro-scale or short-term effects. In an econometric context, the multivariate regression function differs across two separate periods of time. This paper will look at partial structural changes which can be represented as a Threshold Autoregressive Model or using dummy variables in the following non-linear model:

[3] Exact details regarding information used are described within Appendix 1.

[4] In some cases, series provided ended in 2010. In order to update them, we simply used econometric software (TRAMO) to predict the 2011 data.

$$y_t = \begin{cases} \mu + \theta_1 y_{t-1} + \varepsilon_{t1} & if\ t \geq \tau \\ \mu + \theta_2 y_{t-1} + \varepsilon_{t2} & if\ t < \tau \end{cases} \quad (1)$$

or, equivalently,

$$y_t = \mu + \theta_1 D\, y_{t-1} + \theta_2 (1 - D) y_{t-1} + \varepsilon_t \quad (2)$$

Because the euro was introduced in two stages as described above, I present tests for two different dates, both 1999 when the euro was introduced in financial international transactions and 2002 when official coins and notes became available to agents. Furthermore, a third extra date is tested, 1997, when the Stability and Growth Pact enforced the compliance of the convergence criteria for all member states pursuing to adopt the common currency some years later.

For this exercise, the econometric software TSW, a Windows version of TRAMO-SEATS developed by G. Caporello and A. Maravall from the Bank of Spain is to be used. TRAMO, Time Series Regression with ARIMA Noise, Missing Observations and Outliers, is a program that estimates, forecasts and interpolates regression models with missing values and ARIMA errors even if several types of outliers are present without imposing restrictions of the location of missing values as explained by Maravall (2008).

The strategy implemented is the following: in the first place, by choosing the automatic model identification option and allowing for outliers, parameters for the ARIMA model are provided as well as corresponding statistics (Normality test, Ljung-Box Q-statistic etc.) and the presence of significant outliers. Using this information, the next step is to manually estimate the model by introducing these parameters and, this time, imposing the presence of level shifts in the selected dates (observations 25, 27 and 30). Exact instructions are given in Appendix 1.2; please refer here for further details.

2.3 Price convergence

Measuring the degree of price convergence implies looking at different measures of spread. This paper will focus on two of the most basic: standard deviation and coefficient variation. Standard deviation, a measure of how scattered around the mean observations are, is calculated as the square root of the variance. In mathematical terms,

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n} a_i^2}{n} - \left(\frac{\sum_{i=1}^{n} a_i}{n}\right)^2}$$

where a_i stands for the individual observations and n the total number of observations. The idea is to group countries by product and calculate the standard deviation of each product for each year.[5] In this way a time series of standard deviations for each product will be obtained. If prices actually converge, a negative trend over time is expected.

The coefficient variation is a normalized measure of dispersion which shows the extent of variability with respect to the population mean. In fact, it is defined as the ratio of the standard deviation to the mean, sometimes written as a percentage and, thus, multiplied by 100. The same procedure is followed as with the standard deviation: coefficient variation is calculated through time for every individual product. If we plot the series, convergence would imply a decreasing function. Note, however, that this measure is only valid for non-negative values, and, as this section will analyze the variations of price deflators (approximating inflation) rather than deflator series in levels (as used in the analysis of structural breaks), some inconsistencies may emerge. These potential problems are further discussed in the results summary of Section III.

Following Barro and Sala-i-Martin (1995) discussion on growth empirics, two types of absolute convergence[6] can be distinguished: σ-convergence and β-convergence. There is σ-convergence when the dispersion of income across countries is falling over time. This requires looking at standard deviation as done above.

On the other hand, β-convergence makes growth conditional to the initial level: in the growth context, convergence means that poorer countries are growing faster than richer countries. If we extrapolate this concept to the paper's topic, inflation should be higher in countries where prices are originally lower. This means there is a negative correlation between the rate of price growth, inflation, and the initial price level for each country.

In order to test for the existence of β-convergence, this paper runs a regression of the rate of variation of deflators between t and t+1 on the initial level at t expecting a negative coefficient β that represents the speed of convergence:

$$g_{i\,t,T} = \alpha - \beta y_{it} + \varepsilon_{i\,t,T} \qquad (3)$$

This paper will use econometric software Gretl to run different regressions and test for the significance of corresponding coefficients. Firstly, convergence will be tested for the whole group

[5] Standard deviations are only comparable provided that the mean range is not too wide. This paper will assume that prices across countries are of the same order. Nevertheless, the variation coefficient will also be calculated to discard potential problems

[6] Barro and Sala-i-Martin continue the discussion introducing the concept of conditional convergence whereby only countries with similar characteristics tend to converge. Thus, when presenting convergence regression models a vector control should be included with specific country characteristics such as life expectancy, Gini coefficient, education expenditures as share of GDP etc.

of products for t+1=1990 (as a control date), t+1=1999 and t+1=2002. Then, same test will be performed for individual products. Nevertheless, given the small number of observations used to estimate each regression, 13 at the most, it is very likely that results are not statistically significant.

PART III: EMPIRICAL RESULTS

This section summarizes main results from each of the procedures introduced above. For further details, all results and other outputs are presented throughout the second part of the Appendix

3.1 Structural change

For the sake of simplicity, this paper only estimates ARIMA models for the products of three countries: Spain, Germany and Netherlands. Results for this section are compiled within Appendix 2.1. As can be seen, results are inconclusive: no structural changes are detected in the years analyzed (except for a small number of cases) and no clear pattern arises if results for different countries and/or products are compared.

Note that TRAMO does not only detect structural changes (represented by level shifts) but also structural breaks. These show up either as additive outliers or as transitory changes depending on the speed of adjustment back to the normal series. Again, no structural breaks are generally observed in the years of interest. These results can be explained by the fact that the effects of the euro were not abrupt but rather introduced changes in the economy gradually.

3.2 Price convergence

Firstly, recall that to study whether the introduction of the euro induced further price convergence in agricultural markets, standard deviations and variation coefficients through time are analyzed for every product. In total, the appendix presents graphs for these two measures for a total of 22 different products.

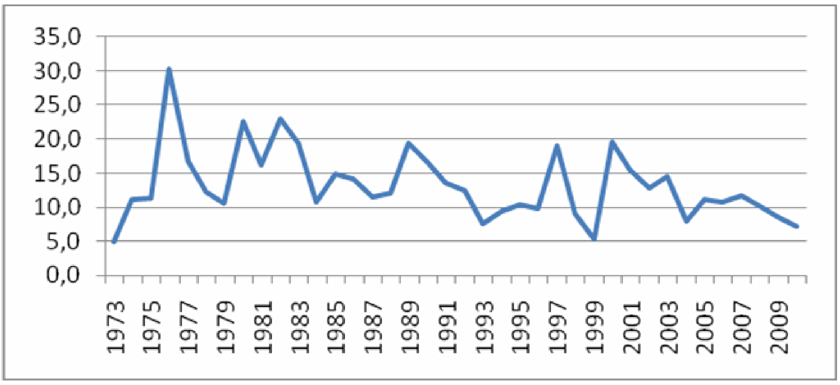
Standard deviations, the simplest measure of price dispersion, show no clear pattern for most of the products. If the hypothesis to be tested were true, one should expect that from 1999 onwards, or at least starting in 2002, the corresponding plots showed an already existing declining trend that fell even quicker[7], or, in any case, started to decrease. However, this is difficult to observe in the graphs

[7] In this case, one should expect that before the introduction of the euro a price convergence trend already existed given that the conditions established under the Maastricht criteria in 1997 as prerequisites for Member States to be allowed to join the common currency included across country inflation convergence.

obtained; in most cases, a decreasing trend dominates most part of the period analyzed, with the exception of some years that experienced a higher volatility for very different reasons. Nonetheless, neither a clear change in this general trend, nor acceleration in the decay process is observable in any of the years this paper focuses in for some of the products.

Fresh fruits (Graph 1) are a good example to analyze. Ever since 1975, standard deviation across countries has been generally declining over time i.e. prices have been slowly converging over this period. After 1999, this trend becomes even steeper; suggesting that events occurred around this time, such as the adoption of the common currency, encouraged even further price integration.

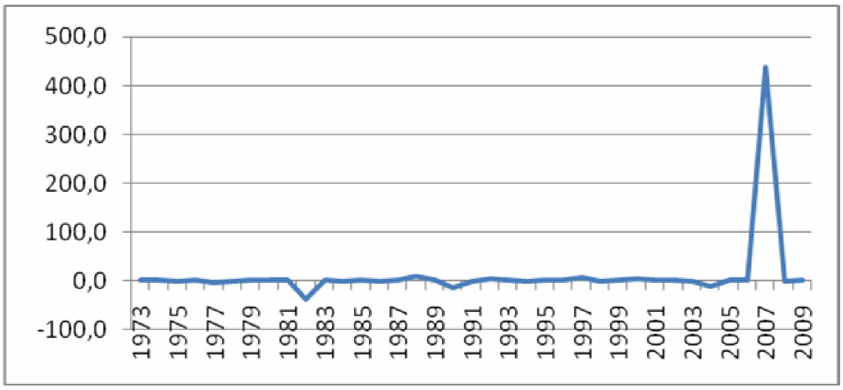
Graph 1. Fresh fruit price standard deviation through time



Products such as cattle, poultry or equines present an upward trend up to 1999 or 2002 correspondingly, after this date standard deviations appear to decline slowly still with some peaks. Other products that follow an interesting pattern are Vegetables & Horticultural products and other olives. In these cases, dispersion among countries clearly starts to decline from 1992 onwards, supporting the complementary hypothesis that price convergence had started even before the euro was implemented.

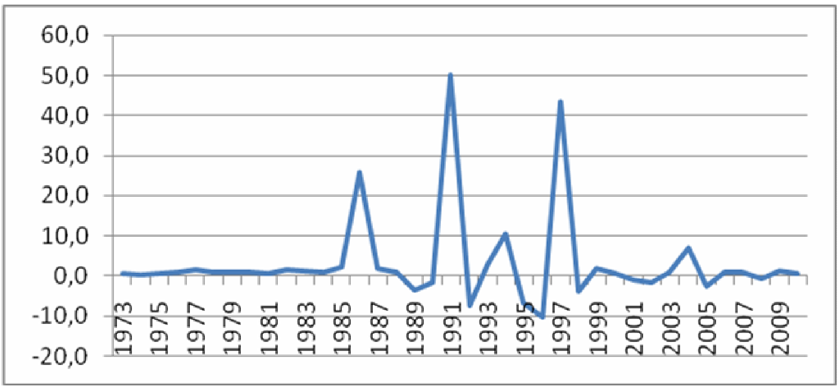
Regarding the variation coefficient a similar display is expected; negative trend would represent price convergence. And, once again, results are varied and difficult to interpret. I will here present the three most representative cases obtained, despite other possibilities. In the first case, the variation coefficient is pretty stable with the exception of one or two peak years, suggesting that there is neither price convergence nor divergence. This is the case of dessert grapes (Graph 2), table olives, other olives, eggs, cereals, potatoes, other animals, sheep & goats, equines etc.

Graph 2. Dessert grapes price variation coefficient through time



Secondly, there is a smaller number of products, for which the predicted plot applies. The variation coefficient for milk, for example, (Graph 3) clearly starts to decline once the Maastricht criteria are discussed (1997) and start to be implemented. Industrial crops follow a similar pattern with the turning point in 2002.

Graph 3. Milk price variation coefficient through time



Finally, there is a large group of products for which the variation coefficient presents no clear pattern (poultry, pigs, olive oil, citrus fruits, fresh fruit, other crop products) given no trend and a large number of outliers. This is due to the large volatility that agricultural markets present.

Please note, the variation coefficient presents two potential problems; first, as already discussed, it is not prepared for negative values, and, moreover, abrupt reductions in the level of the mean may disguise changes in the standard deviations. Therefore, given these weaknesses and the lack of conclusive results, absolute β-convergence tests are next performed.

As explained above, β-convergence regressions are run for three different t+1 dates to determine if there was converge long before the euro was introduced (1990) and once the euro was introduced (1999 and 2002). Results for an aggregate of all products in the database are the following:

$$g_{89,90} = 15{,}07 - 0{,}11y_{89} + \varepsilon_t \quad (4)$$

$$g_{98,99} = 72{,}04 - 0{,}64y_{98} + \varepsilon_t \quad (5)$$

$$g_{01,02} = 20{,}86 - 0{,}20y_{01} + \varepsilon_t \quad (6)$$

The t-statistic of the β coefficients are (2,58)**; (-1,43) and (-2,11)** correspondingly. From these results, we can conclude that prices were already converging around 1990. However, the speed of convergence (measured by the magnitude of the β coefficient) increased with the adoption of the euro in 2002. Surprisingly, 1999 had no effect over convergence, even that the coefficient is negative and pretty large, it is not statistically significant.

In the following equations, rather than considering variation between two consecutive periods we look at the rate of growth between t and t+3, to analyze long run effects:

$$g_{98,01} = -3.53 + 0{,}15y_{98} + \varepsilon_t \quad (7)$$

$$g_{01,04} = 6{,}51 - 0{,}05y_{01} + \varepsilon_t \quad (8)$$

None of the regressions are significant, t-statistics are (0,92) and (-0,83), therefore, no positive conclusion can be drawn from this estimation. In fact, in the first case, the coefficient is even positive, although small in magnitude, exactly the opposite to what was expected. According to this, no long-run effect on convergence can be observed after a 3 year period.

A similar exercise to the first one is done for different individual products: cattle, milk, vegetables and cereals. These products were selected because they are produced by (almost) all countries in our database and, thus, have the largest possible number of observations: 12. Still the number of observations is pretty low and regressions will turn out to be not significant. The exception is the second regression for vegetables, with a t-statistic equal to (-2,65)***:

$$g_{01,02} = 20{,}86 - 0{,}20y_{01} + \varepsilon_t \quad (9)$$

The following results support the hypothesis that the introduction of the euro accelerated the price convergence process that had already started years before. Longer effects, on the other hand, cannot be proved. However, it is important to keep in mind that β-convergence is a necessary but insufficient condition for general price convergence.

PART IV: CONCLUDING REMARKS

Before providing a general conclusion, this paper discusses potential problems that may emerge from the analysis conducted. First of all, it is important to consider that the data available has annual frequency, thus, providing a small number of observations for the econometric analysis. Monthly or at least quarterly data, instead, would have been highly recommendable.

In addition, it is fairly difficult to determine the effects of the adoption of the euro at a given specific date. Not only because there is no unique date at which the common currency was completely implemented, it was rather a long process which had already started with the Maastricht convergence criteria, but also because it is expected that such an event would gradually change the dynamics of the economy as opposed to having a immediate observable effect.

Linked to this idea, there are also a number of other complementary policies that were agreed on during the same period. For example, the Agenda 2000 reform of the Common Agricultural Policy was introduced in 1999. This reform reformulated the set of goals pursuing greater simplification and encouraging further decentralization. The objectives included greater market orientation and competitiveness, the stabilization of incomes, guarantee of food safety and quality and the introduction of rural development as a second pillar supporting farming diversification and business restructuring. Obviously such changes would have had consequences of agricultural product prices, especially in cereals, milk and cattle where price cuts were introduced. Measuring the effect of each policy on its own is almost impossible.

There are two important factors that prevent price convergence among different countries which are present in the agricultural sector: price distortions and non-tradable goods. In fact, the agricultural market is a very protected market, as the relative importance of the CAP proves, and even though import taxes and quotas have been gradually removed by governments, non-tariff barriers still prevent further market integration. Additionally, there are a number of products that cannot be traded given their short life and, thus, enhance differences in prices.

Finally, agricultural markets have been typically characterized by large price volatility. Crises such as the crisis of 2008, skyrocket prices with no apparent reason, statistically suggesting the presence of outliers and complicating the analysis.

Despite the points previously discussed, this paper has consistently proved that the introduction of the euro did not cause a structural break in the agricultural sector. However, based on the plots of standard deviations and variations coefficients for agricultural inflation, as well as the speed of convergence measure, the euro accelerated the price convergence trend which had already started years before, making the agricultural market more transparent and efficient as theory predicts.

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APPENDIX

APPENDIX I. EMPIRICAL FRAMEWORK

A1.1 Database construction

To construct the database this paper used two series of current and constant prices, one running from 1973-2002 and the other 1995-2011. The first series was provided directly by Eurostat, previous request, the second is available in the online statistics under the following name: Economic Accounts for Agriculture – values at current prices (act_eaa01)/ values at constant prices (2005=100) (act_eea03).

Online access: http://epp.eurostat.ec.europa.eu/portal/page/portal/agriculture/data/database

Calculations of the price deflator series are available within the Database Construction file:

1. Construction of price deflator 73-02
2. Construction of price deflator 95-11

The following step is to assemble both series using a cross-multiplication procedure which can be explained using an example. Say you know that for Austria:

- The price deflator with base year 1995 in 1995 is 99,7
- The price deflator with base year 1995 in 1996 is 92,6
- The price deflator with base year 2005 in 1996 is 98,3

To calculate the price deflator with base year 2005 in 1995 we would do the following calculation:

$$D_{1995}^{2005} = \frac{D_{1996}^{2005}}{D_{1996}^{1995}} * D_{1995}^{1995} = \frac{98{,}3}{92{,}6} * 99{,}7$$

These calculations are displayed in the worksheet 3. Assembling price deflator series.

Finally, in the last step, this paper uses TRAMO to calculate missing observations, especially, data for 2011. Please note that if non-linearity is detected by the program, it automatically determines that the best predictor corresponds to the previous year value. Predictions are written in red in the worksheet 4. Series checkup where variation of the series and corresponding plots are used to detect any possible errors incurred as the database was constructed.

A1.2 Structural changes

This part of the Appendix summarizes the options selected in the TRAMO program when estimating corresponding models:

- For the automatic model:

  Automatic procedure →RSA=3

  Other → IATIP=1, AIO=1

- For the manual model:

  Automatic procedure → RSA=0

  Arima Model → P=#, Q=#, D=#; BP=0, BQ=0, BD=0; LAM=0 (if logs are taken)

  Other →IATIP=1, AIO1=1, IREG=1.

  Then, IUSER=2, NSER=1, ILONG=length of series, Outlier position=#, Type of outlier=LS

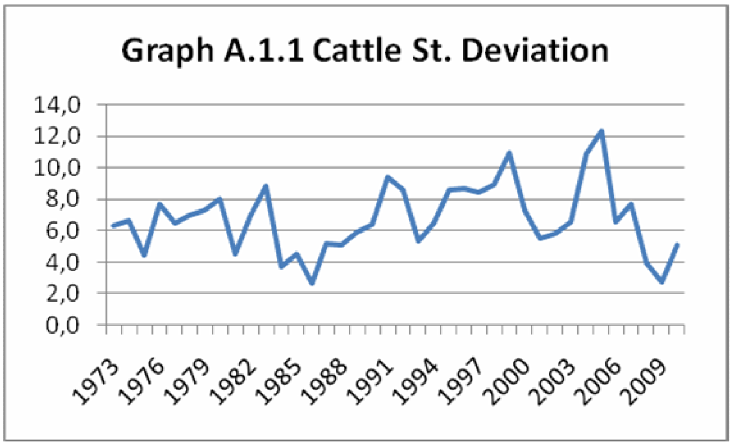
APPENDIX II. RESULTS

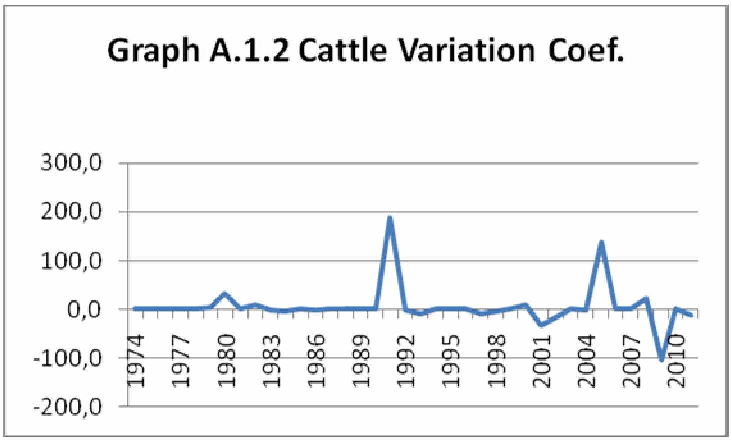
A2.1 Structural changes

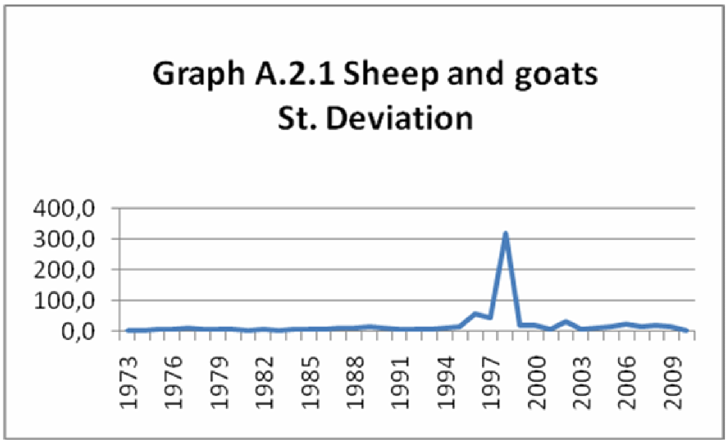
AUTOMATIC MODEL						MANUAL MODEL T-statistic for LS		
COUNTRY	**PRODUCT**	**ARIMA MODEL**	**NORMALITY TEST**	**LJUNG BOX Q VALUE**	**OUTLIERS**	**1997**	**1999**	**2002**
SPAIN	Wine	(2,1,0) L	1,747	5,53	1976 (TC), 1977(TC), 1981 (TC), 1989 (TC)	0,72	0,84	0,22
SPAIN	Vegetable	(1,1,0) L	1,33	5,51	NONE	0,6	0,11	0,76
SPAIN	Olive Oil	(0,1,0) L	0,9578	9,97	NONE	0,9	0,87	-0,97
SPAIN	Citrus fruit	(1,0,0) L	1,283	4,8	1985 (TC)	-1,45	-0,09	-0,59
SPAIN	Cereals	(1,1,0) L	0,5738	10,16	1995 (AO), 2006 (AO), 2009 (AO)	-0,96	-0,04	-0,53
GERMANY	Cattle	(1,0,0) L	0,8459	7,11	1973 (TC)	-0,38	-0.9	0,21
GERMANY	Sheep and goats	(1,0,0) L	1,661	3,64	1973 (TC)	-0,54	-0,96	0,04
GERMANY	Poultry	(2,0,0)	3,531	5,89	NONE	1,14	1,31	**-2,38**
GERMANY	Pigs	(0,0,1) L	5,31	2,65	1973 (TC)	-	-	-
GERMANY	Potatoes	(0,1,2) L	0,5553	7,65	1976 (TC), 2000 (AO)	-0,81	-0,35	-0,71
HOLLAND	Cattle	(1,0,0) L	1,395	9,9	1973 (TC)	0,67	-0,53	**2,00**
HOLLAND	Pigs	(0,0,1) L	1,333	3,46	1973 (TC), 1993 (AO), 1998 (TC)	-	-	-
HOLLAND	Fresh fruit	(0,1,2) L	2,138	7,7	NONE	-0,77	-0,55	-0,38
HOLLAND	Vegetables	(0,1,0)	0,3003	7,8	NONE	1,23	0,07	**2,78**
HOLLAND	Seeds	(0,1,0) L	0,7974	3,31	1973 (TC), 1994 (AO), 2005 (AO)	**2,63**	0,11	**-1,81**

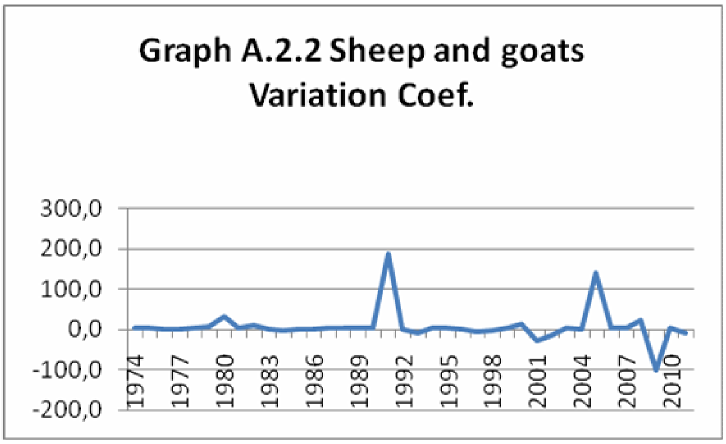
A2.2 Price convergence I

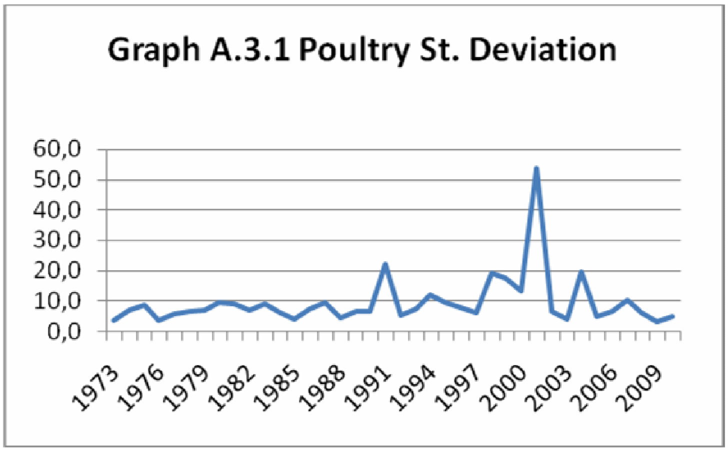
This section presents plots of standard deviations and variation coefficients across countries through time (1973-2011 period).

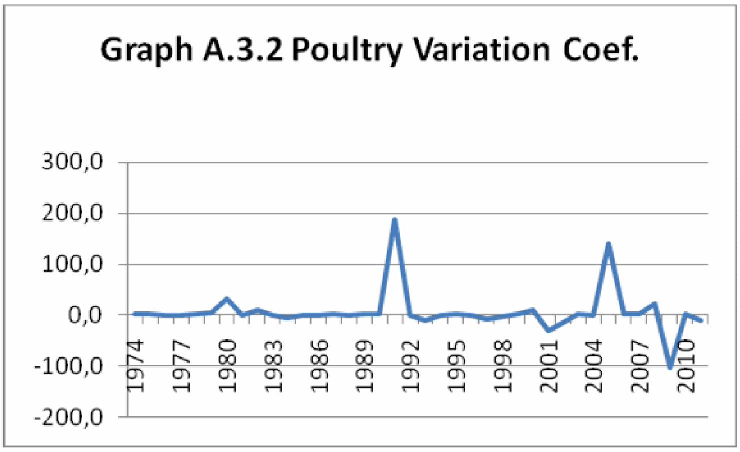


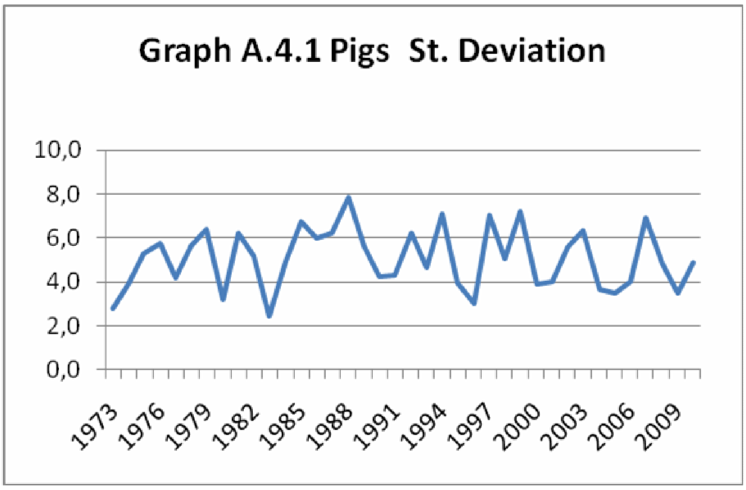


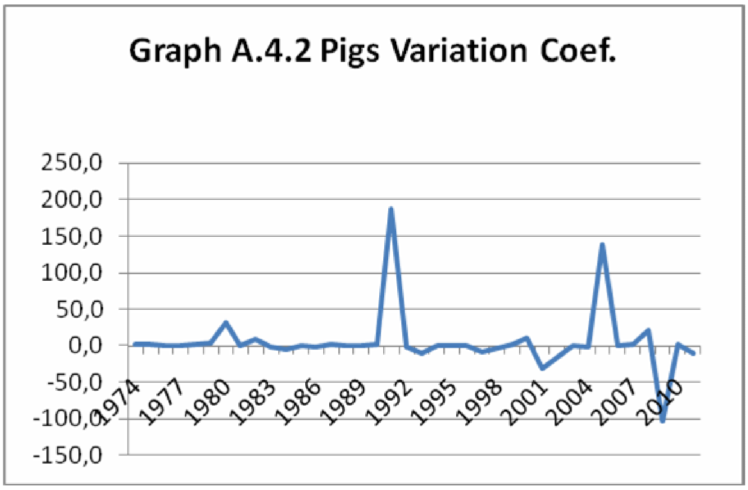


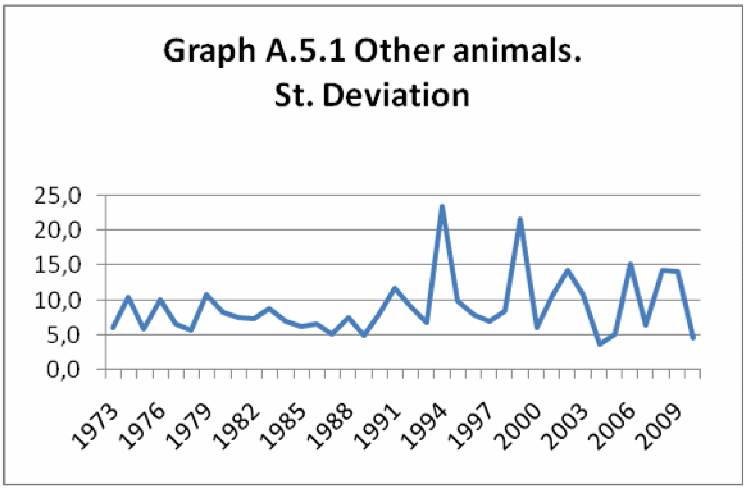


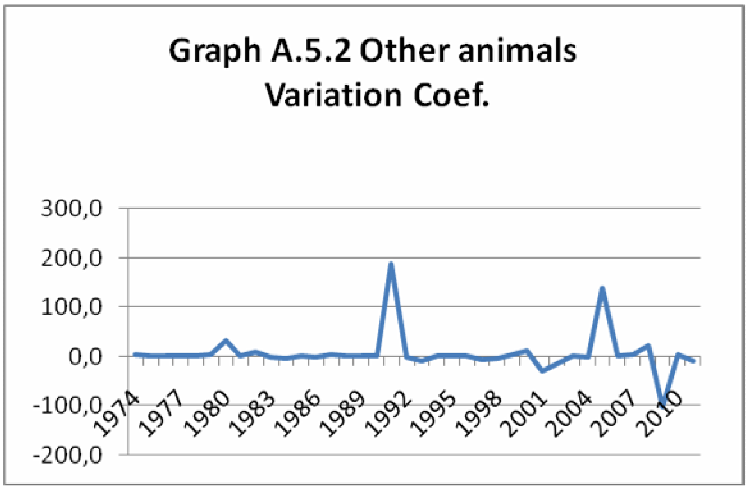


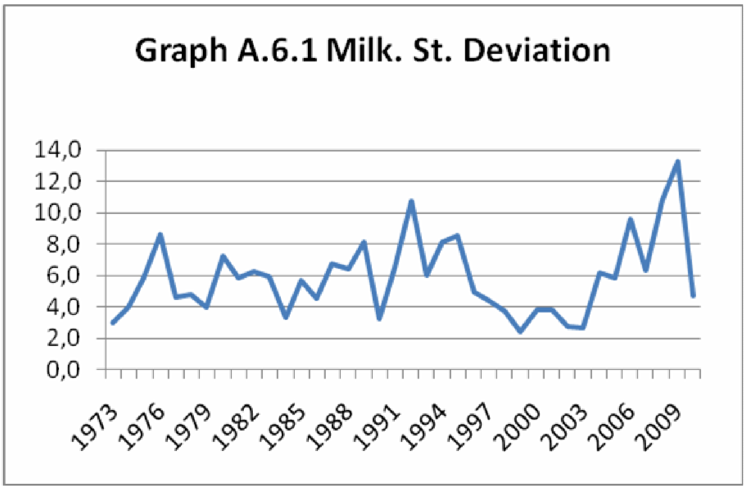


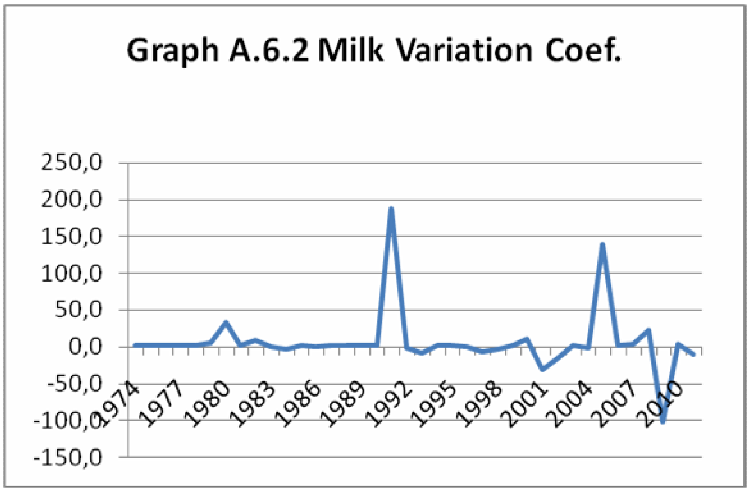

Graph A.4.1 Pigs St. Deviation
10,0
8,0
6,0
4,0
2,0
0,0
1973
1976
1979
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009

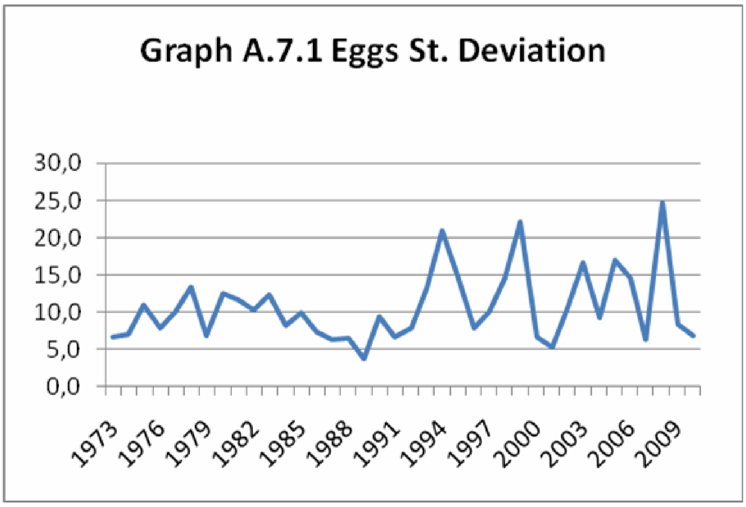

Graph A.4.2 Pigs Variation Coef.
250,0
200,0
150,0
100,0
50,0
0,0
-50,0
-100,0
-150,0
1974
1977
1980
1983
1986
1989
1992
1995
1998
2001
2004
2007
2010

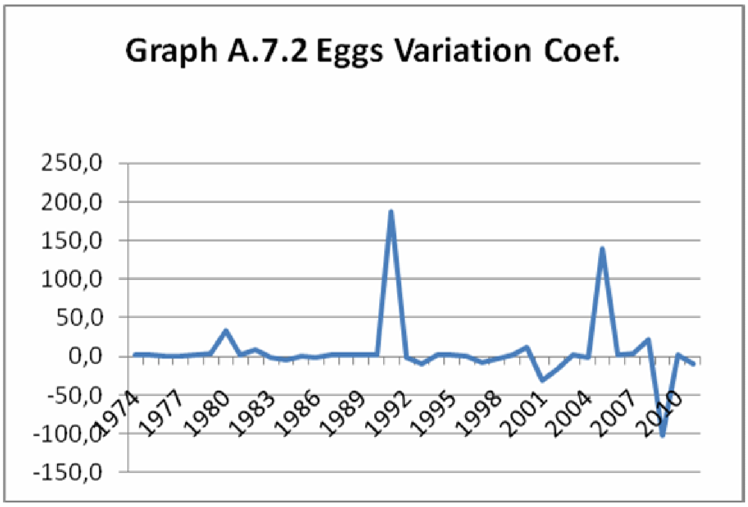

Graph A.5.1 Other animals.
St. Deviation
25,0
20,0
15,0
10,0
5,0
0,0
1973
1976
1979
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009


Graph A.5.2 Other animals
Variation Coef.
300,0
200,0
100,0
0,0
-100,0
-200,0
1974
1977
1980
1983
1986
1989
1992
1995
1998
2001
2004
2007
2010

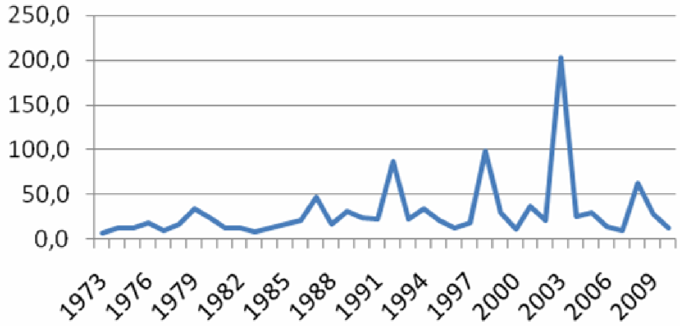

Graph A.6.1 Milk. St. Deviation
14,0
12,0
10,0
8,0
6,0
4,0
2,0
0,0
1973
1976
1979
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009


Graph A.6.2 Milk Variation Coef.
250,0
200,0
150,0
100,0
50,0
0,0
-50,0
-100,0
-150,0
1974
1977
1980
1983
1986
1989
1992
1995
1998
2001
2004
2007
2010

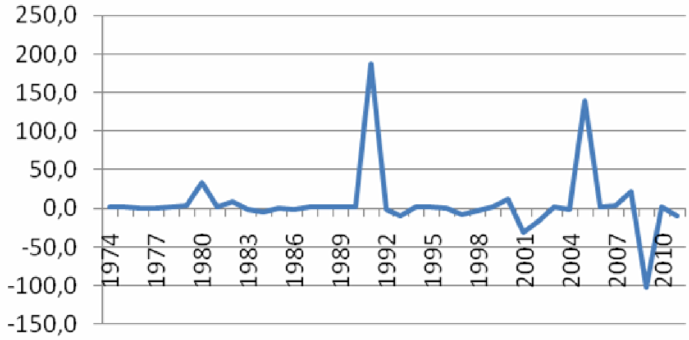

Graph A.7.1 Eggs St. Deviation
30,0
25,0
20,0
15,0
10,0
5,0
0,0
1973
1976
1979
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009


Graph A.7.2 Eggs Variation Coef.
250,0
200,0
150,0
100,0
50,0
0,0
-50,0
-100,0
-150,0
1974
1977
1980
1983
1986
1989
1992
1995
1998
2001
2004
2007
2010

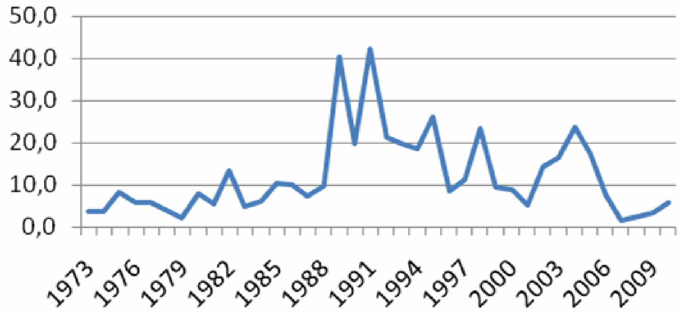
Graph A.8.1 Equines St. Deviation



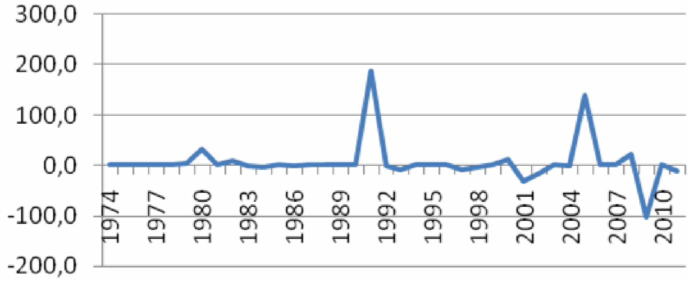
Graph A.8.2 Equines Variation Coef.



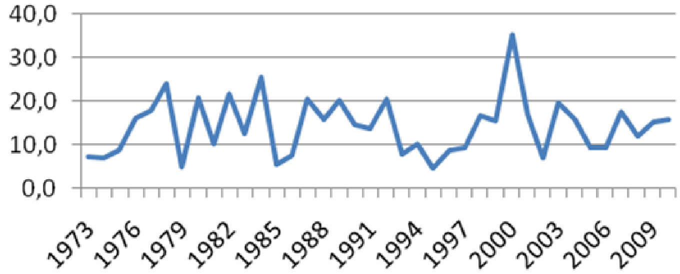
Graph A.9.1 OLIVE OIL St. Deviation



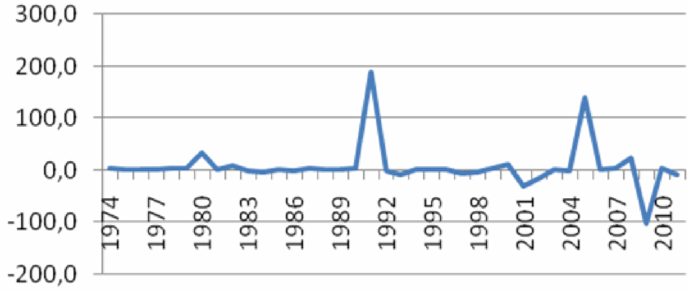
Graph A.9.2 OLIVE OIL Variation Coef.



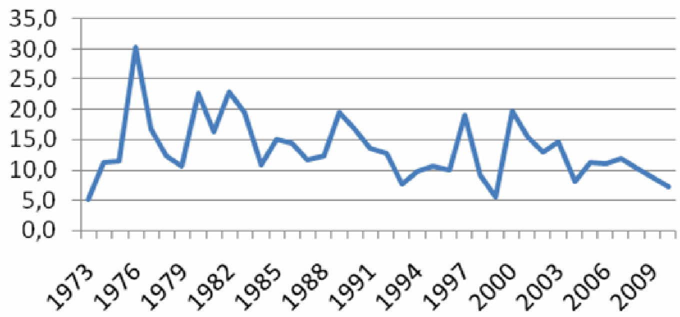
Graph A.10.1 Citrus fruits St. Deviation



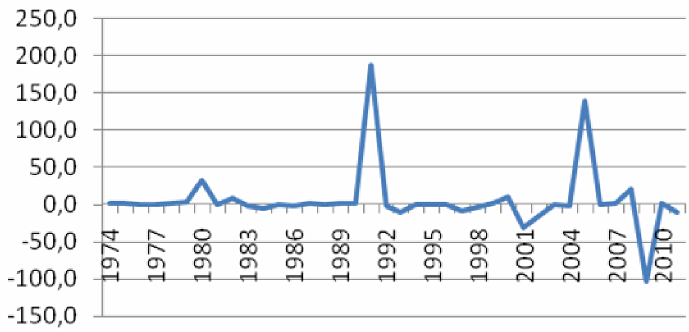
Graph A.10.2 Citrus fruits Variation Coef.

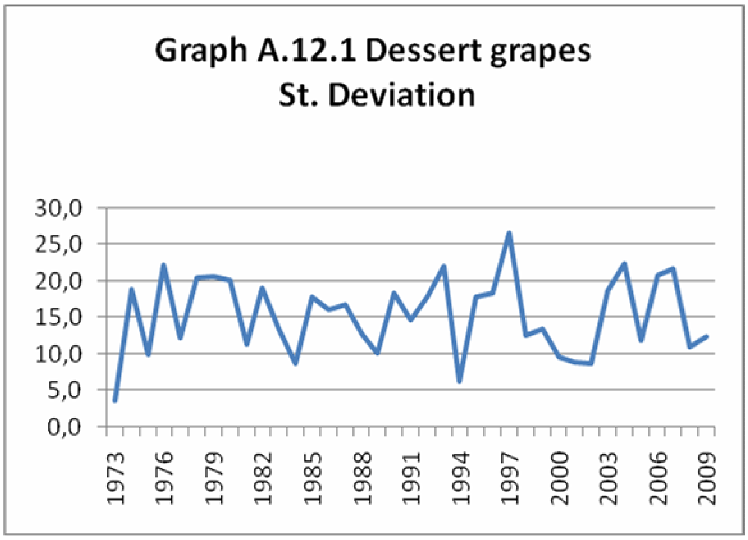


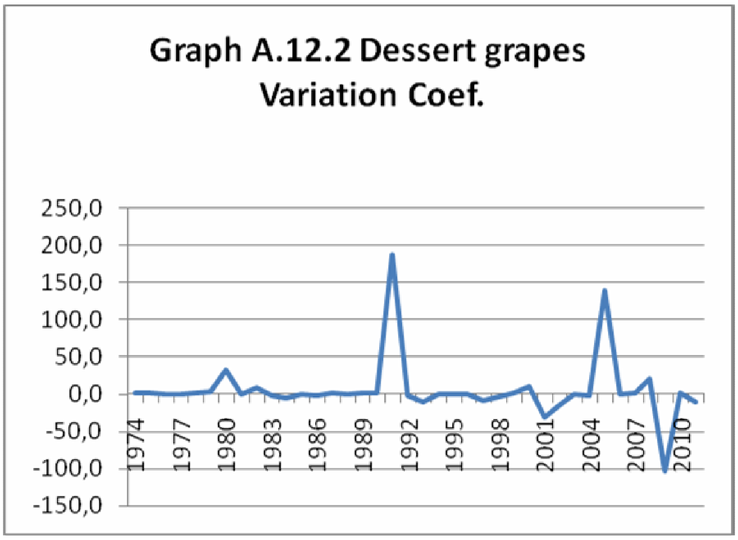
Graph A.11.1 Fresh fruit St. Deviation

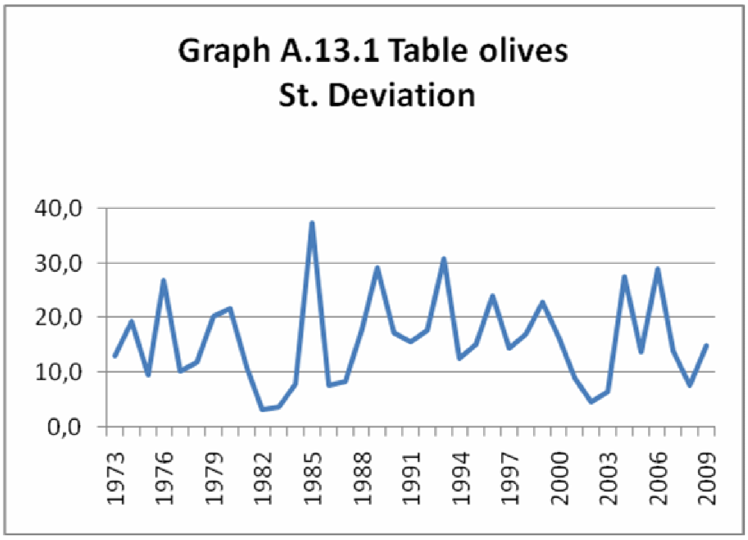


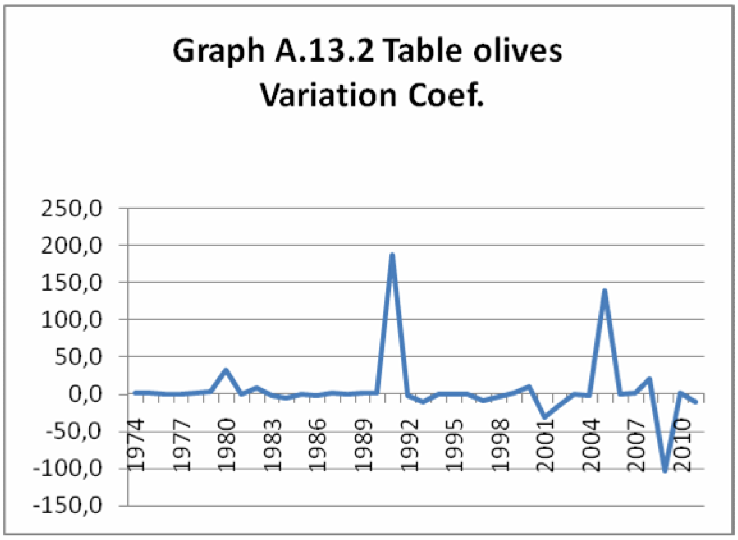
Graph A.11.2 Fresh fruit Variation Coef.

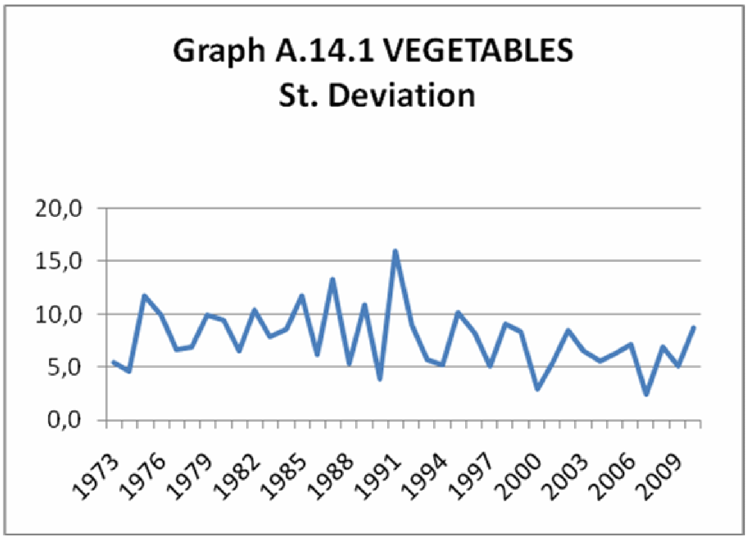


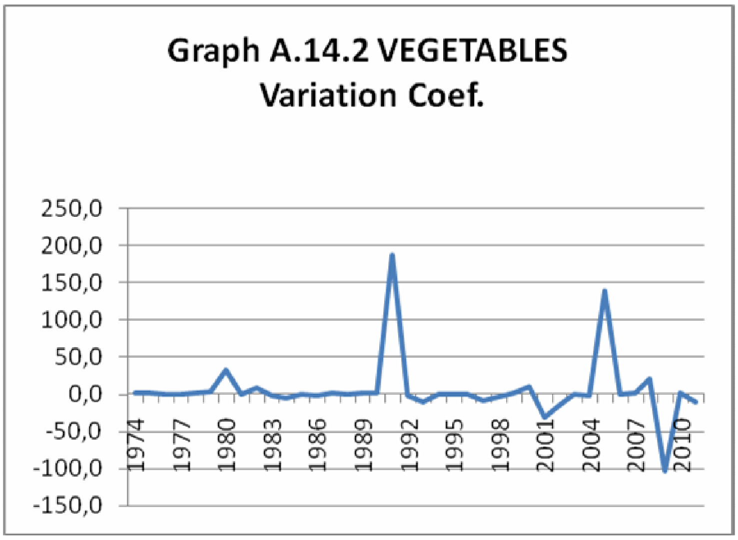

Graph A.12.1 Dessert grapes
St. Deviation

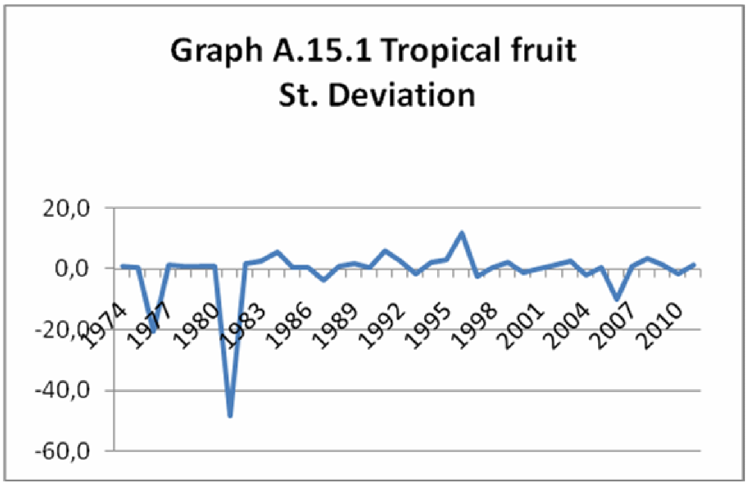

Graph A.12.2 Dessert grapes
Variation Coef.

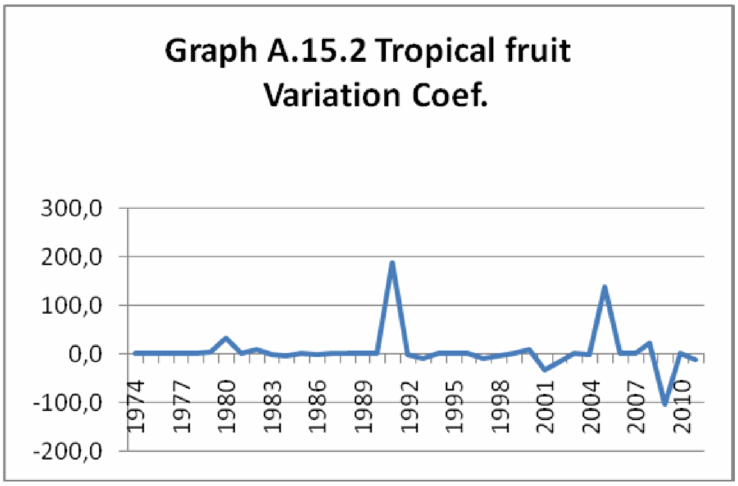

Graph A.13.1 Table olives
St. Deviation


Graph A.13.2 Table olives
Variation Coef.

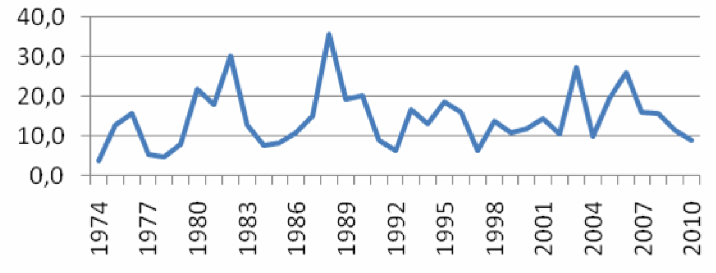

Graph A.14.1 VEGETABLES
St. Deviation


Graph A.14.2 VEGETABLES
Variation Coef.

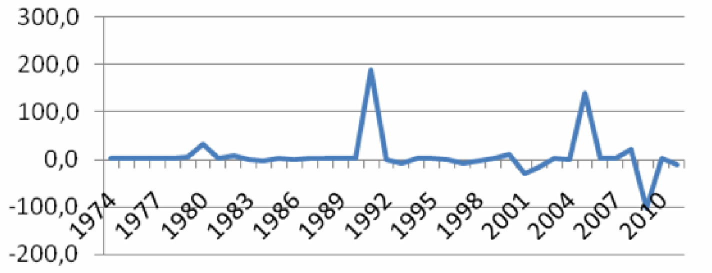

Graph A.15.1 Tropical fruit
St. Deviation


Graph A.15.2 Tropical fruit
Variation Coef.

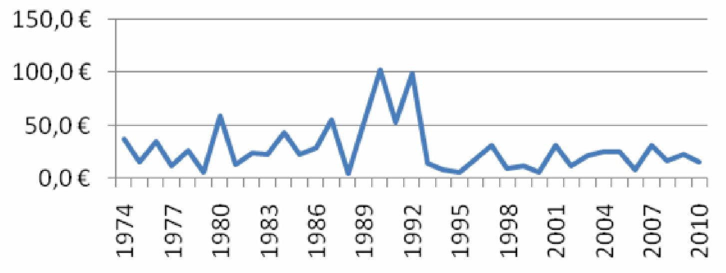
Graph A.16.1 Other grapes
St. Deviation



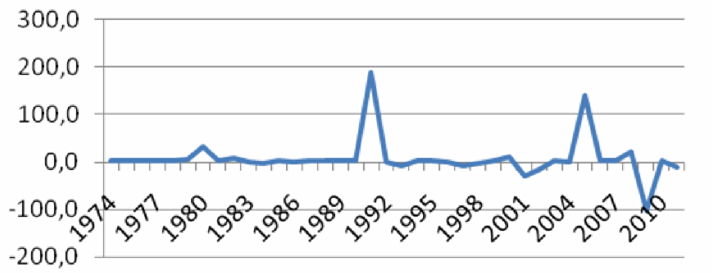
Graph A.16.2 Other grapes
Variation Coef.



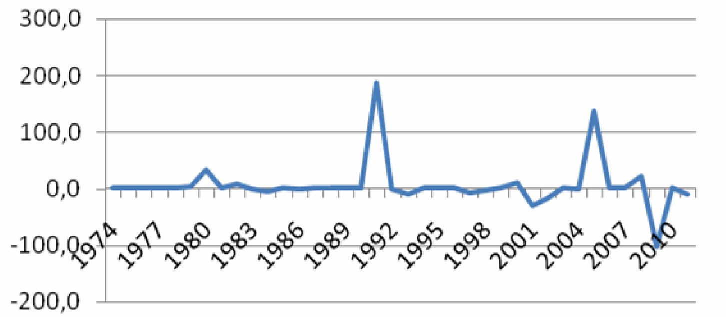
Graph A.17.1 Other olives
St. Deviation



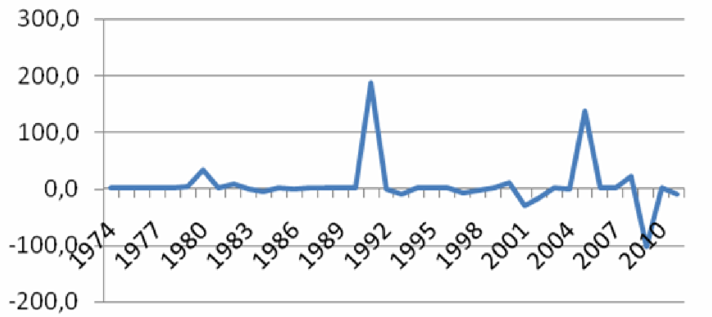
Graph A.17.2 Other olives
Variation Coef.



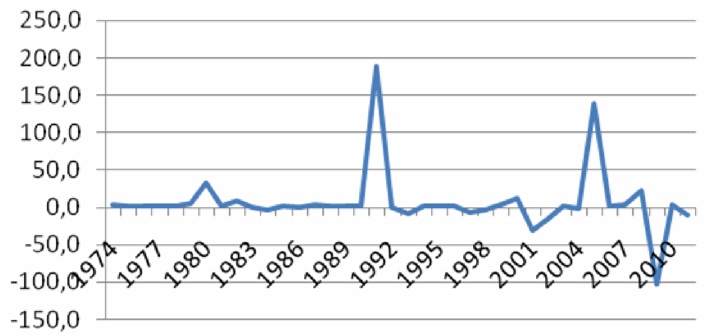
Graph A.18.1 WINE St. Deviation



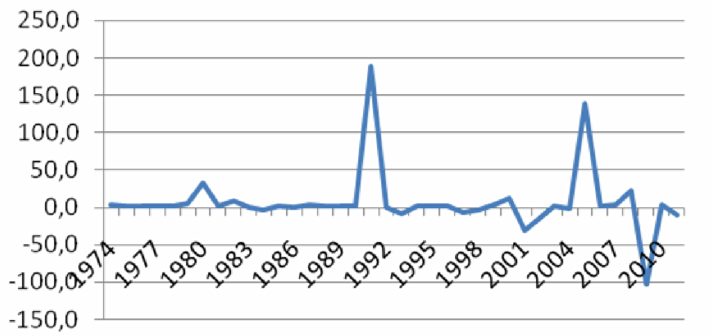
Graph A.18.2 WINE Variation Coef.

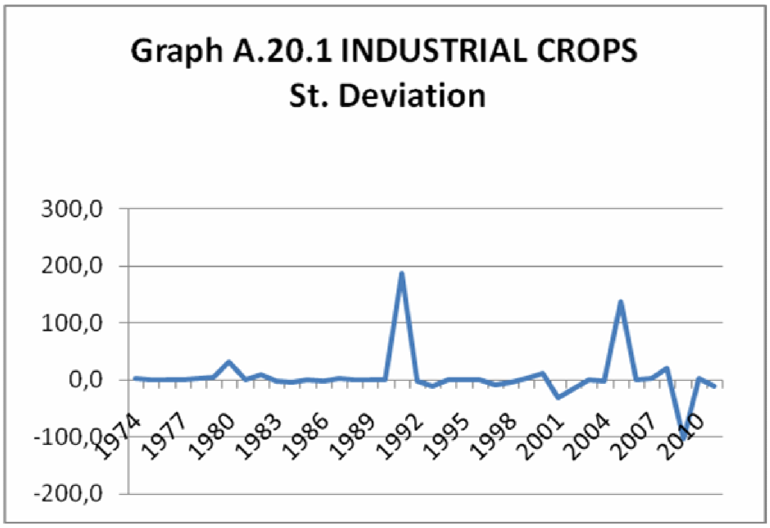


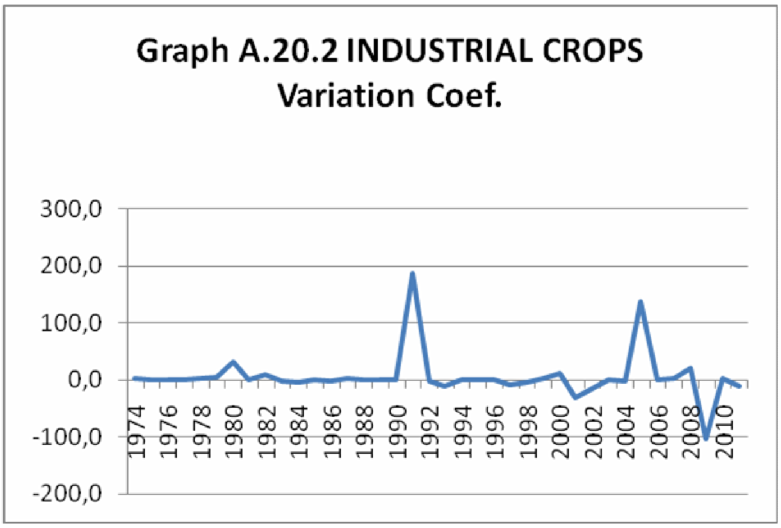
Graph A.19.1 CEREALS St. Deviation

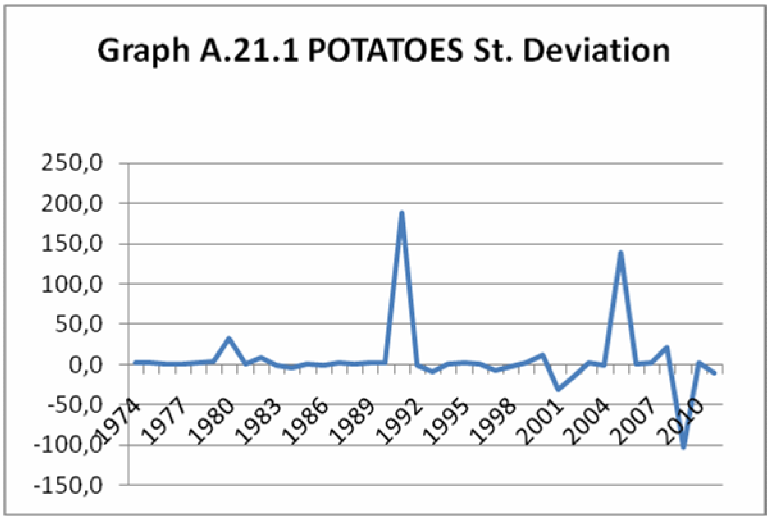


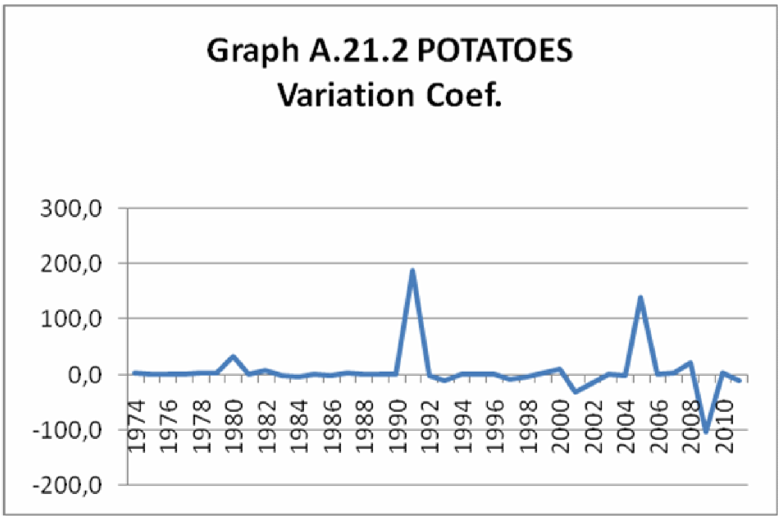
Graph A.19.2 CEREALS Variation Coef.

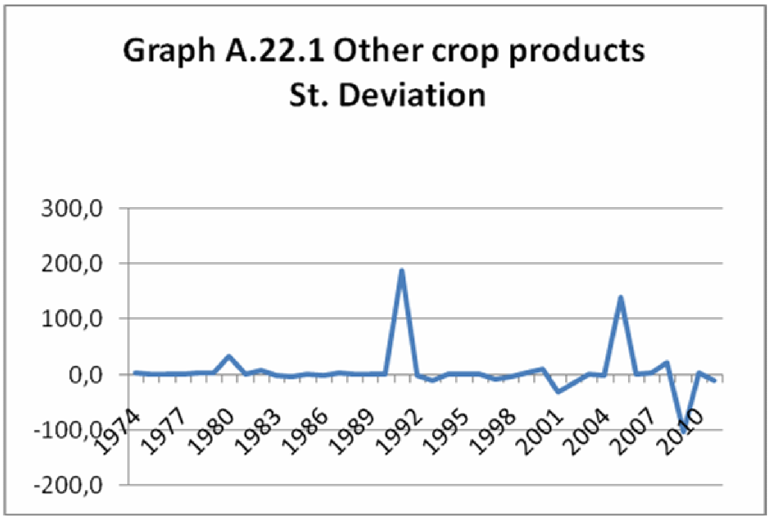


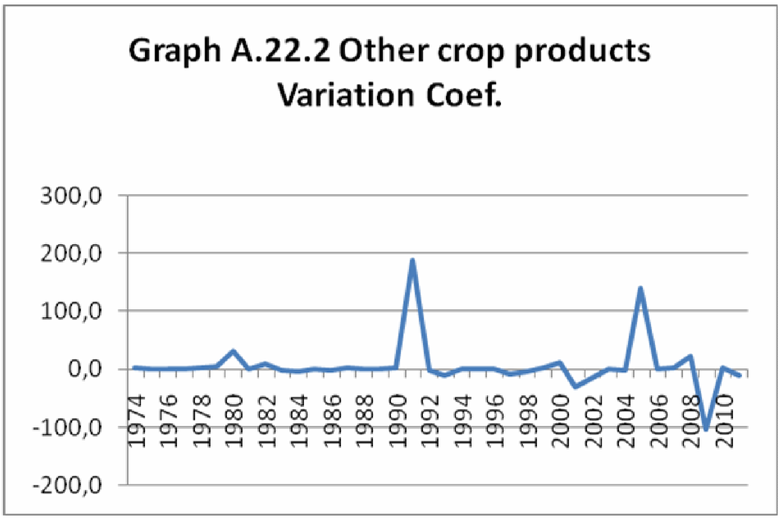

Graph A.20.1 INDUSTRIAL CROPS
St. Deviation
300,0
200,0
100,0
0,0
-100,0
-200,0
1974
1977
1980
1983
1986
1989
1992
1995
1998
2001
2004
2007
2010


Graph A.20.2 INDUSTRIAL CROPS
Variation Coef.
300,0
200,0
100,0
0,0
-100,0
-200,0
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010


Graph A.21.1 POTATOES St. Deviation
250,0
200,0
150,0
100,0
50,0
0,0
-50,0
-100,0
-150,0
1974
1977
1980
1983
1986
1989
1992
1995
1998
2001
2004
2007
2010


Graph A.21.2 POTATOES
Variation Coef.
300,0
200,0
100,0
0,0
-100,0
-200,0
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010


Graph A.22.1 Other crop products
St. Deviation
300,0
200,0
100,0
0,0
-100,0
-200,0
1974
1977
1980
1983
1986
1989
1992
1995
1998
2001
2004
2007
2010


Graph A.22.2 Other crop products
Variation Coef.
300,0
200,0
100,0
0,0
-100,0
-200,0
1974
1976
1978
1980
1982
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010

A.2.3 Price convergence II

This section presents β-convergence regression estimates by Gretl, first for an aggregate including all products and then for individual products at different times t+1.

Figure A.1.1 Aggregate all products years 1989-1990

```
gretl versión 1.9.7
Sesión actual: 2012-05-31 21:06
? ols variacion const y1989 --robust

Modelo 1: MCO, usando las observaciones 2-205 (n = 204)
Variable dependiente: variacion
Desviaciones típicas robustas ante heterocedasticidad, variante HC1

             Coeficiente   Desv. Típica   Estadístico t   Valor p
  ---------------------------------------------------------------
  const       15,0653       5,52707          2,726        0,0070  ***
  y1989       -0,108580     0,0421277       -2,577        0,0107  **

Media de la vble. dep.   3,243574   D.T. de la vble. dep.    20,21877
Suma de cuad. residuos   76280,40   D.T. de la regresión     19,43260
R-cuadrado               0,080805   R-cuadrado corregido     0,076255
F(1, 202)                6,642995   Valor p (de F)           0,010667
Log-verosimilitud       -893,7167   Criterio de Akaike       1791,433
Criterio de Schwarz      1798,070   Crit. de Hannan-Quinn    1794,118
```

Figure A.1.2 Aggregate all products years 1998-1999

```
gretl versión 1.9.7
Sesión actual: 2012-05-21 23:43
? ols variacion const y1998 --robust

Modelo 1: MCO, usando las observaciones 2-240 (n = 239)
Variable dependiente: variacion
Desviaciones típicas robustas ante heterocedasticidad, variante HC1

             Coeficiente   Desv. Típica   Estadístico t   Valor p
  ---------------------------------------------------------------
  const       72,0363       50,1960          1,435        0,1526
  y1998       -0,642520      0,448695       -1,432        0,1535

Media de la vble. dep.   5,503490   D.T. de la vble. dep.    76,46101
Suma de cuad. residuos    1291210   D.T. de la regresión     73,81153
R-cuadrado               0,072018   R-cuadrado corregido     0,068102
F(1, 237)                2,050546   Valor p (de F)           0,153469
Log-verosimilitud       -1366,184   Criterio de Akaike       2736,368
Criterio de Schwarz      2743,321   Crit. de Hannan-Quinn    2739,170
```

Figure A.1.3 Aggregate all products years 2001-2002

```
gretl versión 1.9.7
Sesión actual: 2012-05-22 00:11
? ols variacion const y2001 --robust

Modelo 1: MCO, usando las observaciones 2-240 (n = 239)
Variable dependiente: variacion
Desviaciones típicas robustas ante heterocedasticidad, variante HC1

             Coeficiente   Desv. Típica   Estadístico t   Valor p
  ---------------------------------------------------------------
  const       20,8612       10,6273          1,963        0,0508  *
  y2001       -0,202301      0,0959580      -2,108        0,0361  **

Media de la vble. dep. -1,451558   D.T. de la vble. dep.    18,21764
Suma de cuad. residuos  64420,87   D.T. de la regresión     16,48690
R-cuadrado              0,184423   R-cuadrado corregido     0,180981
F(1, 237)               4,444617   Valor p (de F)           0,036062
Log-verosimilitud      -1007,935   Criterio de Akaike       2019,871
Criterio de Schwarz     2026,824   Crit. de Hannan-Quinn    2022,673
```

Figure A.2.1 Aggregate all products years 1999-2001

```
gretl versión 1.9.7
Sesión actual: 2012-06-01 02:18
? ols var98_01 const y1998 --robust

Modelo 1: MCO, usando las observaciones 2-205 (n = 204)
Variable dependiente: var98_01
Desviaciones típicas robustas ante heterocedasticidad, variante HC1

             Coeficiente   Desv. Típica   Estadístico t   Valor p
  ---------------------------------------------------------------
  const       -3,52664      13,8424         -0,2548       0,7992
  y1998        0,153033      0,165809        0,9229       0,3571

Media de la vble. dep.  12,09431   D.T. de la vble. dep.    59,10512
Suma de cuad. residuos  704439,4   D.T. de la regresión     59,05357
R-cuadrado              0,006661   R-cuadrado corregido     0,001744
F(1, 202)               0,851826   Valor p (de F)           0,357137
Log-verosimilitud      -1120,461   Criterio de Akaike       2244,923
Criterio de Schwarz     2251,559   Crit. de Hannan-Quinn    2247,607
```

Figure A.2.2 Aggregate all products years 2001-2004

```
gretl versión 1.9.7
Sesión actual: 2012-06-01 02:21
? ols var01_04 const y2001 --robust

Modelo 1: MCO, usando las observaciones 2-205 (n = 204)
Variable dependiente: var01_04
Desviaciones típicas robustas ante heterocedasticidad, variante HC1

             Coeficiente   Desv. Típica   Estadístico t   Valor p
  ---------------------------------------------------------------
  const       6,50671      8,47417          0,7678        0,4435
  y2001      -0,0476052    0,0572635       -0,8313        0,4068

Media de la vble. dep.  1,413321   D.T. de la vble. dep.    42,92381
Suma de cuad. residuos  373433,6   D.T. de la regresión     42,99629
R-cuadrado              0,001563   R-cuadrado corregido    -0,003380
F(1, 202)               0,691118   Valor p (de F)           0,406766
Log-verosimilitud      -1055,726   Criterio de Akaike       2115,452
Criterio de Schwarz     2122,088   Crit. de Hannan-Quinn    2118,136
```

Figure A3.1 Catlle years 1998-1999 / years 2001-2002

```
Modelo 1: MCO, usando las observaciones 1-12
Variable dependiente: Rate_of_growth
Desviaciones típicas robustas ante heterocedasticidad, variante HC1

                Coeficiente  Desv. Típica  Estadístico t  Valor p
  ---------------------------------------------------------------
  const         10,8774      5,60571         1,940        0,0810  *
  Initial_level -0,0789466   0,0446170      -1,769        0,1073

Media de la vble. dep. -0,320682   D.T. de la vble. dep.    6,367076
Suma de cuad. residuos  355,4332   D.T. de la regresión     5,961822
R-cuadrado              0,202951   R-cuadrado corregido     0,123246
F(1, 10)                3,130879   Valor p (de F)           0,107252
Log-verosimilitud      -37,35785   Criterio de Akaike       78,71569
Criterio de Schwarz     79,68551   Crit. de Hannan-Quinn    78,35663
```

```
Modelo 1: MCO, usando las observaciones 1-12
Variable dependiente: Rate_of_growth
Desviaciones típicas robustas ante heterocedasticidad, variante HC1

                Coeficiente  Desv. Típica  Estadístico t  Valor p
  ---------------------------------------------------------------
  const         -7,11945     6,81250        -1,045        0,3206
  Initial_level  0,00221872  0,0554732       0,04000      0,9689

Media de la vble. dep. -6,797238   D.T. de la vble. dep.    9,616835
Suma de cuad. residuos  1017,245   D.T. de la regresión     10,08586
R-cuadrado              0,000073   R-cuadrado corregido    -0,099920
F(1, 10)                0,001600   Valor p (de F)           0,968883
Log-verosimilitud      -43,66694   Criterio de Akaike       91,33388
Criterio de Schwarz     92,30370   Crit. de Hannan-Quinn    90,97482
```

Figure A3.2 Milk years 1998-1999 / years 2001-2002

```
Modelo 1: MCO, usando las observaciones 1-12
Variable dependiente: Rate_of_growth
Desviaciones típicas robustas ante heterocedasticidad, variante HC1

                 Coeficiente  Desv. Típica  Estadístico t  Valor p
  ---------------------------------------------------------------
  const           22,1847      14,5704          1,523      0,1588
  Initial_level  -0,240141     0,144749        -1,659      0,1281

Media de la vble. dep. -0,910663   D.T. de la vble. dep.    3,687963
Suma de cuad. residuos  91,34500   D.T. de la regresión     3,022333
R-cuadrado              0,389453   R-cuadrado corregido     0,328398
F(1, 10)                2,752320   Valor p (de F)           0,128103
Log-verosimilitud      -29,20568   Criterio de Akaike       62,41137
Criterio de Schwarz     63,38118   Crit. de Hannan-Quinn    62,05231
```

```
Modelo 1: MCO, usando las observaciones 1-12
Variable dependiente: Rate_of_growth
Desviaciones típicas robustas ante heterocedasticidad, variante HC1

                 Coeficiente  Desv. Típica  Estadístico t  Valor p
  ---------------------------------------------------------------
  const           18,9171      15,3677          1,231      0,2465
  Initial_level  -0,222826     0,145338        -1,533      0,1562

Media de la vble. dep. -3,932292   D.T. de la vble. dep.    3,810608
Suma de cuad. residuos  112,4824   D.T. de la regresión     3,353840
R-cuadrado              0,295788   R-cuadrado corregido     0,225367
F(1, 10)                2,350574   Valor p (de F)           0,156242
Log-verosimilitud      -30,45460   Criterio de Akaike       64,90921
Criterio de Schwarz     65,87902   Crit. de Hannan-Quinn    64,55015
```

Figure A3.3 Vegetables years 1998-1999 / years 2001-2002

```
Modelo 1: MCO, usando las observaciones 1-11
Variable dependiente: Rate_of_growth
Desviaciones típicas robustas ante heterocedasticidad, variante HC1

                 Coeficiente  Desv. Típica  Estadístico t  Valor p
  ---------------------------------------------------------------
  const           30,9339      26,0571          1,187      0,2656
  Initial_level  -0,348488     0,270630        -1,288      0,2300

Media de la vble. dep. -0,429860   D.T. de la vble. dep.    9,150113
Suma de cuad. residuos  627,2046   D.T. de la regresión     8,348018
R-cuadrado              0,250872   R-cuadrado corregido     0,167635
F(1, 9)                 1,658140   Valor p (de F)           0,229978
Log-verosimilitud      -37,84690   Criterio de Akaike       79,69380
Criterio de Schwarz     80,48959   Crit. de Hannan-Quinn    79,19217
```

```
Modelo 1: MCO, usando las observaciones 1-11
Variable dependiente: Rate_of_growth
Desviaciones típicas robustas ante heterocedasticidad, variante HC1

                 Coeficiente  Desv. Típica  Estadístico t  Valor p
  ---------------------------------------------------------------
  const           27,0859      8,85521          3,059      0,0136  **
  Initial_level  -0,244813     0,0923848       -2,650      0,0265  **

Media de la vble. dep.  3,953345   D.T. de la vble. dep.    5,418859
Suma de cuad. residuos  202,5632   D.T. de la regresión     4,744157
R-cuadrado              0,310166   R-cuadrado corregido     0,233517
F(1, 9)                 7,022113   Valor p (de F)           0,026479
Log-verosimilitud      -31,63069   Criterio de Akaike       67,26137
Criterio de Schwarz     68,05716   Crit. de Hannan-Quinn    66,75974
```

Figure A3.4 Cereals years 1998-1999 / years 2001-2002

```
Modelo 1: MCO, usando las observaciones 1-12
Variable dependiente: Rate_of_growth
Desviaciones típicas robustas ante heterocedasticidad, variante HC1

                 Coeficiente  Desv. Típica  Estadístico t  Valor p
  ---------------------------------------------------------------
  const           10,8774      5,60571          1,940      0,0810  *
  Initial_level  -0,0789466    0,0446170       -1,769      0,1073

Media de la vble. dep. -0,320682   D.T. de la vble. dep.    6,367076
Suma de cuad. residuos  355,4332   D.T. de la regresión     5,961822
R-cuadrado              0,202951   R-cuadrado corregido     0,123246
F(1, 10)                3,130879   Valor p (de F)           0,107252
Log-verosimilitud      -37,35785   Criterio de Akaike       78,71569
Criterio de Schwarz     79,68551   Crit. de Hannan-Quinn    78,35663
```

```
Modelo 1: MCO, usando las observaciones 1-12
Variable dependiente: Rate_of_growth
Desviaciones típicas robustas ante heterocedasticidad, variante HC1

                 Coeficiente  Desv. Típica  Estadístico t  Valor p
  ---------------------------------------------------------------
  const           13,9145      14,3836          0,9674     0,3562
  Initial_level  -0,0825750    0,151928        -0,5435     0,5987

Media de la vble. dep.  6,053406   D.T. de la vble. dep.    5,522040
Suma de cuad. residuos  324,7611   D.T. de la regresión     5,698782
R-cuadrado              0,031784   R-cuadrado corregido    -0,065038
F(1, 10)                0,295408   Valor p (de F)           0,598682
Log-verosimilitud      -36,81636   Criterio de Akaike       77,63272
Criterio de Schwarz     78,60254   Crit. de Hannan-Quinn    77,27366
```