The behaviour of food relative prices : An analysis across the European countries

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Abstract— **In this paper we analyze the behavior of relative food prices for a set of 24 European countries observed during the period 1996.1 - 2007.7. Using new methods for analyzing nonstationary panels, we are able to show that relative food prices have a common component which accounts for a large share of their variance. We show that this component has had a greater effects on the group of countries that adopt the Euro. We also find that countries in the Euro area are more market integrated, i.e. food prices tend to converge, than countries that have not adopted the Euro. Finally, we report that the half-live of a shock to relative food prices varies depending on the product, and that the adjustment is generally faster, on average about 10 months, than those usually reported in literature.**

Keywords— **Food relative prices, Non stationarity, Common factors.**

I. INTRODUCTION

In this paper we investigate convergence towards absolute purchasing power parity (PPP), i.e the hypothesis that the relative price of similar goods expressed in a common currency should be constant, for a set of food prices within the Eurozone and between the Eurozone and its main European partners during the last decade.

The study of the PPP is one of the most research area in international economics, as can be seen from [1] survey. We will try to address three main questions: First, How integrated is the European food market? Second, Are there differences in the behavior of European food prices? Third, If we assume that relative food price dynamics across the European countries can be decomposed into a common component and an idiosyncratic component, what is the relative importance of the two components in determining food price convergence?

The failure of the PPP is generally recognized as evidence that markets are not completely integrated. There are many factors which may prevent the prices of similar products being the same across countries. One factor is the geographical distance between the markets. In absence of tariffs and trade barriers, neighboring countries are more likely to trade, because transport costs are lower. In addition differences in consumer tastes and/or in product quality may increase with geographical separation of markets. Finally, discriminatory pricing behavior of with market power is another potential source of price dispersion.

We think that studying food prices differences in different European countries is of interest since price differentials due to geographical distance are probably small as countries are quite close to each other, there are low restrictions or not trade barriers, and since 1999 many of them have had a common currency that reduces the cost of cross-border trade.

Specifically, we analyze consumption relative food prices for 24 European countries. We focus on aggregate and disaggregated real exchange rates computed using Eurostat harmonized index of food consumer prices observed between January 1996 and July 2007. Our approach is based first on computing for each of all possible $N(N+1)/2$ pairs of countries the proportion of countries for which we can reject the null hypothesis of no adjustment to PPP. We think this procedure is a natural way to investigate the extend of market integration for countries and goods. [1] Second, we decompose the real exchange rate movements for each product and pair of countries into a common and an idiosyncratic component. This method allows us to evaluate possible differences over the impact of common and idiosyncratic shocks on real exchange rates. Finally, we analyze the half-life of the PPP deviations in order to address possible differences in the behavior for different products.

The outline of the paper is as follows. Section 2 discusses the methodology used. Section 3 presents data statistics and the empirical results. Section 4 contains some concluding comments.

[1] Using our dataset we are only able to analyze the market integration issue and we do not address the competitive market equilibrium issue, see [2].

II. METHODOLOGY

For each country $i = 0,1,2,...,N$, and using for example Germany as country 0, we define the nominal exchange rate as E_{i0t} (units of currency i per unit of currency 0), and with P_{0t} and P_{it} the food prices. Thus the logarithm of the real exchange rate between country i and country 0 is given by

$$q_{it} = q_{i0t} = e_{i0t} + p_{0t} - p_{it} = ln\left(E_{i0t}P_{0t}/P_{it}\right), \qquad (1)$$

Assume now that the real exchange rate q_{it} can be written as

$$q_{it} = d_{it} + F_t\lambda_i + \varepsilon_{it}. \qquad (2)$$

where d_{it} is a deterministic component, F_t denotes a matrix of unobserved common factors, λ_i indicates the vector of loadings and ε_{it} is an idiosyncratic component. The common factors may be associate with, for example, the European Central Bank monetary policy that may have influenced the Euro zone countries with different weights λ_i, or may be associate to international food and non food commodity prices, or to technology improvements in producing foodstuffs. By contrast, the idiosyncratic component, which is by definition a component specific to the pair of countries analyzed, may be associated with transport improvement that increases the degree of competitiveness and facilitate the convergence toward PPP.

As $E_{ijt} = E_{i0t}/E_{j0t}$, and using (2), the real exchange rate between any pair of countries q_{ijt} for $i, j \neq 0$ can be computed as

$$q_{ijt} = q_{it} - q_{jt} = \left(d_{it} - d_{jt}\right) + F_t\left(\lambda_i - \lambda_j\right) + \left(\varepsilon_{it} - \varepsilon_{it}\right). \qquad (3)$$

Looking at (3), we can see that the real exchange rate q_{ijt} will be a stationary $I(0)$ variable, i.e. PPP holds, if either the common factors F_t are I(0), i.e the common trends are stationary variables, or if the common trends are nonstationary, i.e. $I(1)$, but $\left(\lambda_i - \lambda_j\right) = 0$ and finally the difference $\left(\varepsilon_{it} - \varepsilon_{it}\right)$ is $I(0)$.

The most common test for PPP is the univariate ADF test, which regresses the first difference of the logarithm of the real exchange rate on a deterministic component its lagged level and p_{ij} lagged first differences,

$$\Delta q_{ijt} = \mu_{ij} + \rho_{ij}q_{ij,t-1} + \sum_{k=1}^{p_{ij}}\gamma_{ijk}\Delta q_{ij,t-k} + e_{ijt}. \qquad (4)$$

The null hypothesis of nonstationarity of the real exchange rate q_{ijt} is rejected in favor of level stationarity if $\rho_{ij} > 0$. In order to analyze real exchange rates statistical properties, we adopt the pairwise approach proposed in [3] which is basically a vote-counting method. Specifically, let $Z_{ij} = 1$ if $ADF_{ij}\left(p_{ij}\right) < K_\alpha$ where K_α is the critical value for the $ADF_{ij}\left(p_{ij}\right)$ test of size α. We can easily compute the fraction of the $N(N+1)/2$ pairs for which the unit root hypothesis in (4) is rejected as

$$\bar{Z} = \frac{2}{N(N+1)}\sum_{i=0}^{N-1}\sum_{j=i+1}^{N} Z_{ij}. \qquad (5)$$

[3] shows that under the null hypothesis H_0, i.e. q_{ijt} is nonstationary or, in other words PPP does not hold, $\bar{Z}$ goes to α as $T \to \infty$, and the variance goes to zero as N grows large. Thus when H_0 holds everywhere, we would expect $\bar{Z}$ to be close to the size of the test. Otherwise, if the alternative H_A holds, i.e. PPP is true, then we would expect $\bar{Z}$ to be large and converging to unity for N and T which become large.

To investigate PPP hypothesis we use the standard Dickey-Fuller ADF test, the ADF-GLS test of [4] and the ADF-WS test of [5]. The latter two have been shown to have more power than the standard ADF. We also provide results for the set of unit root tests proposed by [6]. These have been proved to have an exact size close to the nominal size even in the presence of large negative moving-average component. All these tests have the null of a unit root, i.e. nonstationarity of the process.

The introduction of Euro in January 1999 has influenced the real exchange rates of the European countries. This must be taken into account as possible (known) break in (4). As is well known, not accounting for a break, when it is actually present, may result in a false acceptance of the nonstationary hypothesis. Thus, we introduce an intercept dummy in (4) to capture the euro break in the series. [2]

As seen above, allowing for the decomposition in (2) and (3), PPP may be not hold because the common factors F_t may have different impacts on the real exchange rate q_{ijt}. In order to investigate this, we compute a new real exchange rate variable. This has been computed subtracting from q_{ijt} the impact of common factors. Specifically, for

[2] We also include a dummy for the slope but the results, available upon request, do not show sensible differences relatively to the pure intercept break case.

each $i = 1, 2, ..., N$ we estimate the common factors and factor loading in (2) and define

$$q^*_{it} = \left(q_{it} - \hat{F}_t \hat{\lambda}_i \right) = d_{it} + \varepsilon_{it}. \quad (6)$$

Using (6) it is easy to compute as before

$$q^*_{ijt} = \left(q^*_{it} - q^*_{jt} \right),. \quad (7)$$

and we apply the same methodology as in (4) to investigate the stationarity or non stationarity of defactored real exchange rates computing as before the $\bar{Z}$ statistics. Using this decomposition we are able to analyze whether the proportion of stationary real exchange rates rise once the impact of the common component has been excluded.

Furthermore, in order to investigate possible differences of the rate of adjustment toward PPP across the sample of relative food prices, we compute for each real exchange rate q_{ijt} and defactored real exchange rate q^*_{ijt} the half-life of a shock. The half-life is defined as the number of periods required to a unit shock to the series to dissipate by half. Thus, the half-life is a measure of the speed of convergence toward PPP. From (4), once an estimate for $\hat{\rho}_{ij}$ has been obtained, the half life can be easily computed as

$$HL_{ij} = ln(0.5)/ln\left(1 + \hat{\rho}_{ij}\right). \quad (8)$$

The apparently very slow speed of adjustment of real exchange rates has been the source of considerable theoretical and empirical research in recent years. In a survey, [7] notes that the consensus estimate of the half-life tends to fall into the range of three to five years. Interestingly, we show in the next section that the estimates of the half-life for the European relative food prices are much lower than the consensus estimates.

A possible problem in our analysis may be given by the small time span of data. The question whether univariate unit root tests based on quarterly or monthly data are more powerful than those based on the corresponding yearly data have been investigated by among others, [8], and [9]. They find, using Monte Carlo simulations, that power depends more on the span of the data rather than on the number of observations. By contrast [10] show that using data with high sampling frequency can provide significant improvements in the finite sample power of unit root tests. However if a researcher adopts a longer time span of data in order to rise the power of unit root tests, for example using a century of annual data, this may cause another as there may be breaks in the data. It is well known that such breaks can alter the results of unit root tests.

A possible solution of increasing the power of unit root tests with a short time span of data is to use panel unit tests, see for a survey [11]. However there are the following problems when using panel unit tests to investigate relative food prices. First, when using a panel of data, all prices must be measured in the same currency and thus the results will in general depend on the numerary currency used. Second, the null hypothesis of panel unit root tests is that all the series are nonstationary, and the alternative is that some of the series are stationary, i.e. in our case for these series PPP holds. Thus, panel unit root tests do not provide information on the number of series that are stationary and those that are non stationary, whereas using the method proposed in [3], we are able to address this question.

III. DATA STATISTICS AND EMPIRICAL RESULTS

We analyze real exchange rates obtained from the Eurostat dataset. Specifically, we focus on harmonized indices of consumer price (HICP) for food goods observed during the period 1996.1 - 2007.7. The HICP provides data on comparative prices in the European Economic Area. The list of goods used in the analysis are printed in each of the following tables, and the set of countries comprises: Belgium, Denmark, Germany, Estonia, Ireland, Greece, Spain, France, Italy, Cyprus, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Austria, Poland, Portugal, Slovakia, Finland, Sweden, United Kingdom, Iceland, Norway. We split this set of countries into two groups. The first group consists in the countries that adopted the Euro during the period of analysis, i.e. 11 countries starting from January 1999 plus Greece that adopted the euro from January 2001. The remaining countries, including Malta, which only adopted the Euro in 2005, are placed in the group of non-Euro countries.

Our first task was to analyze the common factor components. We first asked how many ommon factors are behind the relative food price dynamics for each food item. We use the information criteria as suggested by [12]. These criteria are similar in spirit to the common AIC and BIC criteria for time series. [12] propose twelve different criteria to estimate the true number of factors. In the paper we adopt their IC criteria. [3] Specifically, the method minimizes the following criteria function

$$IC(K) = ln(\hat{\sigma}^2_{\varepsilon}(K)) + K\left(\frac{ln(min(N,T))}{min(N,T)} \right), \quad (9)$$

where K is the number of common factors and $\hat{\sigma}^2_{\varepsilon}(K)$ is

[3]Actually the twelve criteria usually give the same results, with the exception of the BIC criteria that on average detects a smaller number of factors. However the BIC criteria does not satisfy the consistency property.

merely the sum of squared idiosyncratic components in (2)

$$\hat{\sigma}_{\varepsilon}^{2}(K) = (NT)^{-1}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{\varepsilon}_{it}^{2}. \qquad (10)$$

Following [12], the differenced idiosyncratic residuals are computed as

$$\Delta\hat{\varepsilon}_{it} = \Delta q_{it} - \Delta\hat{F}_t\hat{\lambda}_i, \qquad (11)$$

with $\Delta\hat{F}_t$ and factor loadings $\hat{\lambda}_i$ obtained from the principal components of the covariance matrix of Δq_{it}. Because in (11) both $\hat{F}_t$ and $\hat{\varepsilon}_{it}$ are expressed in difference, the level are recovered cumulating $\Delta\hat{F}_t$ and $\Delta\hat{\varepsilon}_{it}$. Thus the $IC(K)$ criteria in (9) estimates the true number of factors minimizing $\hat{\sigma}_{\varepsilon}^{2}(K)$, which is a measure of fit, subject to a penalty that depends on the number of factors and the size T of data.

In Table 1 we report the number of estimated factors, allowing for a maximum number of 3 factors, for each food items as well as for the aggregate of all-items in the HICP indexes. We also present the percentage of variance accounted for by the first factors, i.e. the first principal component, and then the percentage of variance explained by the full set of factors chosen using [12] procedure. These statistics have been compute for the full set of countries and for the two subgroups of Euro area countries and non-Euro area countries.

Looking at the results in Table 1 we note first that the number of factors chosen are not equal across products. Second, the percent of variance accounted for by the first factor is usually large. On average and for the total set of countries, 71% of the variance of real exchange rates is explained by the first factor. This value increases to 83% for the set of Euro countries and decreases to 61% for the subgroup of non-Euro countries. Thus the first common component is much more important in explaining real exchange rate dynamics of Euro countries than non-Euro countries. Thirdly, the percent of variance explained by the additional factors is usually small and on average not larger than 20%.

It is now of interest to ask the question of how many common components are nonstationary. To do this we used the modified Q_c test procedure proposed in [13]. This analyzes the rank of long-run covariance matrix of the factors. The procedure tests whether the smallest eigenvalue of the matrix of a first-order VAR is unity and proceeds in a sequential fashion, as in the standard Johansen technique. For reason of space we do not present the test statistics, but they are available upon request. Interestingly, the result highlights that all items are characterized by only one common nonstationary factor whatever the group of countries analyzed.

In synthesis, we foundnd that real exchange rates for food prices are influenced mainly by a common nonstationary factor and the importance of this factor is higher for the subgroup of countries in the Euro area than the subgroup of non-Euro countries. Probably this common component can be attributed to the monetary policy of the European Central Bank, which clearly have a greater influence on food prices in the Euro zone.

Tables 2 to 7 present the results of the proportion of pairs of real exchange rates for which the null hypothesis of nonstationarity can be rejected. As previously reported, we use six unit root tests, setting the nominal size of the tests at 10%. Due the importance of the critical value in discriminating between nonstationary and stationary real exchange rates, for all tests the exact critical values for $T = 139$ have been computed using a Monte Carlo experiment with 10.000 rounds. Their values are available upon request.

For the three ADF type tests, ADF, $ADF-GLS$ and $ADF-WS$, the results are for the lag orders p_{ij} in (4) determined by the Schwarz Bayesian Criterion. Similar results are obtained using the Akaike Information Criterion. Unfortunately due to space limitation we are not able to provide the tables for three of the tests proposed in [6], MZa, MSB and MZt. For all tests, we set the maximum p_{ij} lag to be 12. Finally, the deterministic component includes an intercept. Results with intercept and a linear trend are available upon request.

In synthesis, looking at the results in the tables 2-7, we note first that the fraction of pairs of q_{ijt} for which the null hypothesis of nonstationarity is rejected is usually higher than the nominal size of the tests. The largest rejection is for fruits and vegetables where the ADF tests show a rejection rates around 70% and the Ng and Perron's tests a rejection rate about 40%. The lowest rejection rate is for Spirits where Ng and Perron's tests show a value less than the nominal size. Interestingly, the rejection rates rise if we net the real exchange rates from the common components. As we have seen, this may meansthat the common components have different impacts on q_{ijt} and this may induces nonstationarity of real exchange rates or, in other terms, non convergence of relative food prices. On average, the rejection rates were higher for the group of Euro countries than for the group of non-Euro countries. Thus, we can conclude that the adoption of Euro and a common monetary policy have encourageded the convergence of relative food prices in the euro zone.

In table 8 we present the median half-life for each food item and aggregates using (8). We present the values computed using the $ADF-WS\left(\hat{\rho}_{ijt}\right)$ estimates. Similar values are obtained using the ADF, and $ADF-GLS$ estimates. The median half-life computed from the set of pairs q_{ijt} for which we reject the null hypothesis of unit roots, i.e. the PPP holds, are shown in bracket. The results show that, on average the median half-life is around 10 months if all the q_{ijt} are considered, and decrease to 5 months when only stationary are considered. Interestingly, the median half-life estimates were lower than those reported in [7], who noted that the consensus estimate of the half-life tends to fall into the range of three to five years.

Table 1 Number of factors (a) and Variance explained by factor(s)

Harmonized indices of consumer prices (HICP)		Total countries			Euro countries			Non Euro countries		
		number factors	% Var. 1st fact.	% Var. tot. fact.	number factors	% Var. 1st fact.	% Var. tot. fact.	number factors	% Var. 1st fact.	% Var. tot. fact.
CP00	All-items HICP	3	0.86	0.96	2	0.98	0.99	3	0.76	0.94
CP01	Food and non-alcoholic beverages	3	0.79	0.94	3	0.94	0.99	3	0.65	0.92
CP011	Food	3	0.80	0.94	3	0.95	0.99	3	0.65	0.92
CP0111	Bread and cereals	3	0.80	0.95	3	0.96	0.99	3	0.64	0.92
CP0112	Meat	3	0.73	0.92	3	0.90	0.97	3	0.56	0.89
CP0113	Fish and seafood	3	0.83	0.94	1	0.95	0.95	2	0.72	0.86
CP0114	Milk, chease and eggs	3	0.74	0.93	3	0.90	0.98	3	0.59	0.92
CP0115	Oil and fats	1	0.57	0.57	2	0.63	0.88	3	0.54	0.91
CP0116	Fruit	1	0.63	0.63	2	0.82	0.88	1	0.46	0.46
CP0117	Vegetables	1	0.55	0.55	1	0.74	0.74	1	0.40	0.40
CP0118	Sugar, jam, honey, chocolate and confectionery	1	0.82	0.82	3	0.93	0.98	1	0.73	0.73
CP0119	Food products n.e.c.	3	0.76	0.92	3	0.88	0.98	3	0.65	0.92
CP012	Non Alcoholic beverages	3	0.52	0.85	2	0.62	0.83	3	0.46	0.84
CP0121	Coffee, tea and cocoa	1	0.41	0.41	3	0.44	0.92	1	0.44	0.44
CP0122	Mineral waters, soft drinks, fruit and vegetable juices	3	0.70	0.89	3	0.77	0.93	3	0.64	0.91
CP02	Alcoholic beverages, tobacco and narcotics	2	0.82	0.92	3	0.89	0.99	2	0.77	0.87
CP021	Alcoholic beverages	3	0.71	0.91	3	0.84	0.97	3	0.61	0.90
CP0211	Spirits	3	0.67	0.89	3	0.83	0.94	3	0.55	0.88
CP0212	Wine	2	0.72	0.85	1	0.78	0.78	2	0.66	0.86
CP0213	Beer	2	0.70	0.83	2	0.82	0.95	2	0.61	0.78
CP022	Tobacco	2	0.91	0.94	2	0.95	0.98	2	0.87	0.92

(a) Three maximum number of factors allowed
Data Source: Eurostat

Table 2 Fraction of pairs of q_(ijt) for which the null hypothesis of unit root is rejected at 10% significance level, 24 European countries, 1996.1-2007.7

Harmonized indices of consumer prices (HICP)		Non defactored			Defactored		
		ADF OLS	ADF GLS	ADF WS	ADF OLS	ADF GLS	ADF WS
CP00	All-items HICP	21.38	31.88	22.46	51.09	60.14	52.90
CP01	Food and non-alcoholic beverages	17.75	26.81	21.74	46.01	54.35	48.91
CP011	Food	19.20	28.99	22.83	48.19	56.16	51.09
CP0111	Bread and cereals	12.68	19.20	16.30	35.51	51.45	39.13
CP0112	Meat	11.59	28.99	15.58	43.12	67.39	39.13
CP0113	Fish and seafood	17.75	23.19	18.12	22.83	35.87	21.38
CP0114	Milk, chease and eggs	9.78	18.84	15.22	34.78	50.36	41.67
CP0115	Oil and fats	9.78	14.49	14.49	23.91	31.16	16.30
CP0116	Fruit	33.33	39.49	36.59	42.75	51.09	43.84
CP0117	Vegetables	40.94	58.33	42.75	48.19	65.94	46.38
CP0118	Sugar, jam, honey, chocolate and confectionery	7.97	18.84	12.32	9.06	22.10	18.48
CP0119	Food products n.e.c.	9.78	15.58	15.22	32.97	51.81	36.23
CP012	Non Alcoholic beverages	9.78	17.75	12.32	25.36	49.28	19.57
CP0121	Coffee, tea and cocoa	18.12	28.26	21.01	20.65	32.61	23.91
CP0122	Mineral waters, soft drinks, fruit and vegetable juices	10.51	21.74	12.68	24.64	38.77	19.93
CP02	Alcoholic beverages, tobacco and narcotics	11.23	24.28	14.49	26.45	43.48	19.20
CP021	Alcoholic beverages	12.68	21.01	23.19	40.94	53.62	35.87
CP0211	Spirits	10.87	20.65	17.03	11.96	25.00	20.65
CP0212	Wine	13.77	26.45	25.00	18.12	31.52	21.38
CP0213	Beer	16.67	23.19	13.41	44.57	63.04	32.25
CP022	Tobacco	9.06	24.28	14.86	11.23	26.09	17.75

Data Source: Eurostat

Table 3 Fraction of pairs of q_(ijt) for which the null hypothesis of unit root is rejected at 10% significance level, 24 European countries, 1996.1-2007.7

Harmonized indices of consumer prices (HICP)		Non defactored			Defactored		
		Mza GLS	MSB GLS	MZt GLS	Mza GLS	MSB GLS	MZt GLS
CP00	All-items HICP	22.83	20.29	22.46	51.45	50.36	49.28
CP01	Food and non-alcoholic beverages	26.09	26.45	23.91	40.94	42.03	40.58
CP011	Food	27.90	29.35	27.17	44.57	46.01	43.12
CP0111	Bread and cereals	7.97	8.33	8.33	26.81	23.91	26.09
CP0112	Meat	13.77	11.96	15.22	40.22	40.22	38.04
CP0113	Fish and seafood	36.23	35.51	37.32	56.52	54.35	56.52
CP0114	Milk, chease and eggs	17.03	15.58	16.67	34.42	37.68	31.88
CP0115	Oil and fats	11.96	10.87	12.32	6.52	6.16	6.52
CP0116	Fruit	69.93	69.57	67.03	69.93	70.65	68.12
CP0117	Vegetables	70.65	71.38	69.57	80.07	78.99	81.16
CP0118	Sugar, jam, honey, chocolate and confectionery	17.39	17.39	15.94	15.94	14.49	15.94
CP0119	Food products n.e.c.	11.59	10.87	11.96	32.97	30.43	31.52
CP012	Non Alcoholic beverages	14.13	11.96	14.49	51.09	48.19	52.17
CP0121	Coffee, tea and cocoa	19.93	18.84	20.65	12.68	12.32	12.68
CP0122	Mineral waters, soft drinks, fruit and vegetable juices	14.49	13.41	14.86	50.36	53.26	47.10
CP02	Alcoholic beverages, tobacco and narcotics	15.22	14.49	14.49	36.23	39.13	33.70
CP021	Alcoholic beverages	14.49	14.49	13.41	52.54	50.00	51.81
CP0211	Spirits	6.52	4.71	5.43	52.17	51.45	51.45
CP0212	Wine	15.94	14.49	16.30	24.64	23.91	25.36
CP0213	Beer	20.65	21.74	18.84	38.04	39.49	38.04
CP022	Tobacco	23.19	23.19	23.91	36.59	39.49	35.14

Data Source: Eurostat

Table 4 Fraction of pairs of q_(ijt) for which the null hypothesis of unit root is rejected at 10% significance level, 12 Euro countries, 1996.1-2007.7

Harmonized indices of consumer prices (HICP)		Non defactored			Defactored		
		ADF OLS	ADF GLS	ADF WS	ADF OLS	ADF GLS	ADF WS
CP00	All-items HICP	39.39	51.52	37.88	33.33	45.45	43.94
CP01	Food and non-alcoholic beverages	39.39	42.42	43.94	48.48	42.42	56.06
CP011	Food	39.39	42.42	50.00	45.45	51.52	54.55
CP0111	Bread and cereals	36.36	42.42	37.88	31.82	40.91	34.85
CP0112	Meat	25.76	40.91	27.27	54.55	75.76	56.06
CP0113	Fish and seafood	21.21	30.30	22.73	25.76	37.88	24.24
CP0114	Milk, chease and eggs	21.21	37.88	30.30	34.85	48.48	39.39
CP0115	Oil and fats	13.64	25.76	19.70	19.70	25.76	24.24
CP0116	Fruit	36.36	40.91	42.42	43.94	59.09	42.42
CP0117	Vegetables	40.91	42.42	36.36	33.33	54.55	30.30
CP0118	Sugar, jam, honey, chocolate and confectionery	18.18	33.33	27.27	39.39	42.42	43.94
CP0119	Food products n.e.c.	15.15	22.73	21.21	7.58	25.76	19.70
CP012	Non Alcoholic beverages	12.12	25.76	16.67	34.85	51.52	21.21
CP0121	Coffee, tea and cocoa	22.73	24.24	25.76	33.33	45.45	16.67
CP0122	Mineral waters, soft drinks, fruit and vegetable juices	19.70	28.79	16.67	19.70	24.24	16.67
CP02	Alcoholic beverages, tobacco and narcotics	15.15	27.27	10.61	39.39	71.21	25.76
CP021	Alcoholic beverages	19.70	28.79	36.36	33.33	60.61	27.27
CP0211	Spirits	7.58	25.76	9.09	15.15	19.70	12.12
CP0212	Wine	21.21	28.79	39.39	27.27	37.88	18.18
CP0213	Beer	19.70	34.85	13.64	40.91	65.15	27.27
CP022	Tobacco	12.12	36.36	16.67	13.64	33.33	16.67

Data Source: Eurostat

Table 5 Fraction of pairs of q_(ijt) for which the null hypothesis of unit root is rejected at 10% significance level, 12 Euro countries, 1996.1-2007.7

Harmonized indices of consumer prices (HICP)		Non defactored			Defactored		
		Mza GLS	MSB GLS	MZt GLS	Mza GLS	MSB GLS	MZt GLS
CP00	All-items HICP	15.15	16.67	12.12	28.79	27.27	27.27
CP01	Food and non-alcoholic beverages	31.82	33.33	25.76	63.64	65.15	66.67
CP011	Food	31.82	33.33	30.30	66.67	60.61	65.15
CP0111	Bread and cereals	10.61	12.12	10.61	40.91	42.42	40.91
CP0112	Meat	28.79	30.30	30.30	63.64	63.64	63.64
CP0113	Fish and seafood	53.03	56.06	53.03	50.00	56.06	43.94
CP0114	Milk, chease and eggs	12.12	12.12	12.12	37.88	36.36	31.82
CP0115	Oil and fats	10.61	6.06	12.12	13.64	13.64	12.12
CP0116	Fruit	57.58	56.06	60.61	84.85	84.85	89.39
CP0117	Vegetables	86.36	87.88	87.88	90.91	90.91	90.91
CP0118	Sugar, jam, honey, chocolate and confectionery	18.18	21.21	15.15	30.30	30.30	30.30
CP0119	Food products n.e.c.	13.64	15.15	13.64	30.30	25.76	31.82
CP012	Non Alcoholic beverages	19.70	16.67	21.21	36.36	30.30	40.91
CP0121	Coffee, tea and cocoa	30.30	28.79	31.82	31.82	31.82	31.82
CP0122	Mineral waters, soft drinks, fruit and vegetable juices	16.67	15.15	18.18	43.94	43.94	37.88
CP02	Alcoholic beverages, tobacco and narcotics	15.15	13.64	10.61	59.09	54.55	60.61
CP021	Alcoholic beverages	21.21	21.21	18.18	36.36	31.82	31.82
CP0211	Spirits	3.03	3.03	3.03	48.48	45.45	50.00
CP0212	Wine	18.18	18.18	18.18	4.55	4.55	4.55
CP0213	Beer	9.09	10.61	4.55	50.00	48.48	53.03
CP022	Tobacco	19.70	19.70	18.18	51.52	54.55	50.00

Data Source: Eurostat

Table 6 Fraction of pairs of q_(ijt) for which the null hypothesis of unit root is rejected at 10% significance level, 12 Non Euro countries, 1996.1-2007.7

Harmonized indices of consumer prices (HICP)		Non defactored			Defactored		
		ADF OLS	ADF GLS	ADF WS	ADF OLS	ADF GLS	ADF WS
CP00	All-items HICP	6.06	16.67	7.58	46.97	46.97	45.45
CP01	Food and non-alcoholic beverages	6.06	13.64	10.61	50.00	34.85	33.33
CP011	Food	7.58	15.15	12.12	48.48	37.88	34.85
CP0111	Bread and cereals	1.52	3.03	3.03	42.42	24.24	22.73
CP0112	Meat	6.06	21.21	10.61	57.58	34.85	31.82
CP0113	Fish and seafood	19.70	16.67	19.70	33.33	19.70	18.18
CP0114	Milk, chease and eggs	6.06	7.58	7.58	43.94	28.79	28.79
CP0115	Oil and fats	3.03	9.09	6.06	34.85	16.67	15.15
CP0116	Fruit	34.85	45.45	36.36	63.64	56.06	59.09
CP0117	Vegetables	48.48	65.15	59.09	77.27	48.48	50.00
CP0118	Sugar, jam, honey, chocolate and confectionery	3.03	18.18	4.55	36.36	21.21	19.70
CP0119	Food products n.e.c.	6.06	7.58	12.12	48.48	27.27	30.30
CP012	Non Alcoholic beverages	4.55	12.12	6.06	43.94	18.18	18.18
CP0121	Coffee, tea and cocoa	15.15	21.21	21.21	36.36	27.27	28.79
CP0122	Mineral waters, soft drinks, fruit and vegetable juices	4.55	19.70	6.06	48.48	16.67	16.67
CP02	Alcoholic beverages, tobacco and narcotics	4.55	19.70	13.64	22.73	16.67	15.15
CP021	Alcoholic beverages	7.58	13.64	15.15	56.06	27.27	28.79
CP0211	Spirits	9.09	16.67	13.64	48.48	28.79	25.76
CP0212	Wine	7.58	21.21	12.12	27.27	27.27	25.76
CP0213	Beer	9.09	15.15	3.03	34.85	19.70	19.70
CP022	Tobacco	10.61	12.12	15.15	13.64	22.73	22.73

Data Source: Eurostat

Table 7 Fraction of pairs of q_(ijt) for which the null hypothesis of unit root is rejected at 10% significance level, 12 Non Euro countries, 1996.1-2007.7

Harmonized indices of consumer prices (HICP)		Non defactored			Defactored		
		Mza GLS	MSB GLS	MZt GLS	Mza GLS	MSB GLS	MZt GLS
CP00	All-items HICP	16.67	7.58	7.58	43.94	40.91	43.94
CP01	Food and non-alcoholic beverages	13.64	13.64	10.61	30.30	31.82	30.30
CP011	Food	15.15	13.64	12.12	34.85	36.36	33.33
CP0111	Bread and cereals	3.03	3.03	3.03	15.15	16.67	15.15
CP0112	Meat	21.21	9.09	10.61	30.30	30.30	31.82
CP0113	Fish and seafood	16.67	13.64	19.70	48.48	48.48	48.48
CP0114	Milk, chease and eggs	7.58	4.55	7.58	50.00	48.48	51.52
CP0115	Oil and fats	9.09	6.06	6.06	42.42	46.97	40.91
CP0116	Fruit	45.45	34.85	36.36	71.21	75.76	68.18
CP0117	Vegetables	65.15	63.64	59.09	72.73	72.73	72.73
CP0118	Sugar, jam, honey, chocolate and confectionery	18.18	4.55	4.55	16.67	15.15	19.70
CP0119	Food products n.e.c.	7.58	10.61	12.12	34.85	37.88	34.85
CP012	Non Alcoholic beverages	12.12	4.55	6.06	42.42	33.33	42.42
CP0121	Coffee, tea and cocoa	21.21	19.70	21.21	10.61	7.58	9.09
CP0122	Mineral waters, soft drinks, fruit and vegetable juices	19.70	6.06	6.06	54.55	53.03	56.06
CP02	Alcoholic beverages, tobacco and narcotics	19.70	13.64	13.64	21.21	27.27	18.18
CP021	Alcoholic beverages	13.64	15.15	15.15	54.55	56.06	56.06
CP0211	Spirits	16.67	12.12	13.64	59.09	65.15	59.09
CP0212	Wine	21.21	10.61	12.12	28.79	27.27	28.79
CP0213	Beer	15.15	4.55	3.03	53.03	53.03	51.52
CP022	Tobacco	12.12	12.12	15.15	25.76	24.24	24.24

Data Source: Eurostat

Table 8 Median half-life values (months) - ADF WS test (*)

Harmonized indices of consumer prices (HICP)		Non defactored			Defactored		
		Total countries	Euro countries	Non Euro countries	Total countries	Euro countries	Non Euro countries
CP00	All-items HICP	8 (5)	12 (4)	9 (6)	4 (3)	4 (3)	4 (4)
CP01	Food and non-alcoholic beverages	9 (6)	9 (4)	9 (6)	4 (4)	3 (2)	5 (4)
CP011	Food	8 (6)	7 (4)	9 (6)	4 (3)	3 (2)	5 (3)
CP0111	Bread and cereals	10 (6)	14 (5)	10 (6)	5 (4)	4 (3)	6 (4)
CP0112	Meat	10 (6)	9 (5)	12 (6)	4 (4)	4 (3)	5 (4)
CP0113	Fish and seafood	8 (4)	6 (4)	9 (3)	4 (3)	7 (4)	5 (3)
CP0114	Milk, chease and eggs	12 (6)	17(5)	11 (5)	5 (4)	4 (3)	4 (3)
CP0115	Oil and fats	13 (6)	25 (4)	10 (6)	15 (6)	9 (5)	6 (4)
CP0116	Fruit	4 (3)	4 (2)	5 (3)	4 (3)	4 (2)	4 (3)
CP0117	Vegetables	4 (2)	3 (2)	4 (3)	3 (2)	2 (2)	3 (3)
CP0118	Sugar, jam, honey, chocolate and confectionery	12 (6)	12 (5)	12 (6)	11 (5)	4 (3)	10 (6)
CP0119	Food products n.e.c.	10 (6)	12 (5)	10 (6)	5 (4)	5 (4)	5 (4)
CP012	Non Alcoholic beverages	12 (6)	11 (6)	13 (7)	5 (4)	8 (5)	6 (4)
CP0121	Coffee, tea and cocoa	10 (6)	10 (5)	11 (5)	14 (5)	4 (3)	13 (5)
CP0122	Mineral waters, soft drinks, fruit and vegetable juices	11 (6)	12 (5)	12 (6)	5 (4)	5 (4)	5 (4)
CP02	Alcoholic beverages, tobacco and narcotics	11 (6)	8 (6)	12 (7)	6 (4)	3 (3)	8 (5)
CP021	Alcoholic beverages	13 (6)	14 (4)	13 (7)	4 (4)	4 (3)	5 (4)
CP0211	Spirits	15 (6)	15 (5)	15 (9)	5 (4)	6 (3)	5 (4)
CP0212	Wine	11 (6)	14 (3)	10 (6)	7 (5)	12 (6)	7 (5)
CP0213	Beer	12 (5)	17 (5)	10 (5)	5 (4)	4 (3)	6 (3)
CP022	Tobacco	9 (5)	9 (5)	10 (7)	6 (4)	5 (3)	8 (5)

Data Source: Eurostat

(*) In parentheses median half-life values for the set of pairs for which the test is able to reject the null of a unit root.

IV. Conclusions

In this paper we analyze relative food prices behavior in 24 European countries during the period 1996.1 - 2007.7. We split the group of countries into two subgroups. The first is a group of 12 countries that adopted the Euro. The second group is non-Euro countries.

Some interesting results seems to emerge from the analysis. First, we find signs of market integration, i.e. food prices convergence, among the countries. Moreover, market integration is more marked for the Euro area countries than non-Euro area countries. Second, we find that relative food prices mainly have a common trend variable which accounts for a large share of their variance. The importance of this common component is more pronounced for the set of countries included in the Euro area. We think that this can be attributed to the effects of the common monetary policy of the European Central Bank. Third, the half-live of a shock to relative food prices varies according to the products, and the adjustment is generally faster, on average 10 months, than those usually reported in literature, which tend to fall into the range of three to five years.

Further research is needed to understand the influence of the CAP financial support policy on the process of convergence of food prices in the European area better. As is well known, CAP support for agricultural production is different for different products and countries. Looking at our results, we note that there are strong differences in the process of price convergence. This is because while many of our products are supported by the CAP, others are not, such as, for example alcoholic and non alcoholic beverages. At present we are conducting research on the effects of CAP financial support on the food price convergence process for a set of 15-EU countries, using FADN data.

References

1. Taylor, A.M., and M.P. Taylor (2004). The Purchasing parity debate, *Journal of Economic Perspectives*,18,135-158.

2. Barrett, C.B., and Li, J.R. (2002). Distinguishing between equilibrium and integration in spatial price analysis. *Amer. J. of Agr. Econ*, 84, 292-307.

3. Pesaran, M.H. (2007). A pair-wise approach to testing for output and growth convergence. *Journal of Econometrics*, 138, 312-355.

4. Elliot, G., Rothenberg, T.J. and J.H. Stock (1996). Efficient tests for an autoregressive unit root. *Econometrica*, 64, 813-836.

5. Park, H.J. and W.A. Fuller (1995). Alternative estimators of unit root tests for autoregressive process.*Journal of Times Series Analysis*, 16, 449-459.

6. Ng, S., and P. Perron (2001) Lag length selection and construction of unit root tests with good size and power. *Econometrica*, 69, 1519-1554.

7. Rogoff, K.S. (1996). The purchasing power parity puzzle. *Journal of Economic Literature*, 34,647-668.

8. Shiller, R. and Perron, P. (1985) Testing the random walk hypothesis: Power versus frequency of observations, *Economics Letters*, 18, 381-386.

9. Perron, P. (1989). Testing for a random walk: A simulation experiment of power when the sampling interval is varied, in B. Ray (ed.), *Advances in Econometrics and Modeling*, Kluwer Academic Publishers.

10. Choi, I. and Chung B. S. (1995). Sampling frequency and the power of tests for a unit root: A simulation study, *Economics Letters*, 49, 131-136.

11. Gutierrez, L. (2006). Panel unit root tests for cross-sectional correlated panels: A Monte Carlo comparison. *Oxford Bulletin of Economics and Statistics*, 68, 519-540.

12. Bai, J. and Ng, S. (2002). Determining the number of factors in approximate factor models, *Econometrica*, 70, 191-221.

13. Bai, J. and Ng, S. (2004). A PANIC attack on unit roots and cointegration, *Econometrica*, 72, 1127-1177.

14. Perron, P., and Z. Qu (2007). A simple modification to improve the finite sample properties of Ng and Perron's unit root tests. *Economics Letters*, 94, 12-19.

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