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Seeking for a long-run equilibrium in rice market: a Greek perspective

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Abstract: Rice production, trade and consumption in Greece and in relation with the other EU countries are sketched. Furthermore, an attempt is made to identify long-run stable equilibrium levels in the rice market by employing cointegration analysis. Results clearly demonstrate that similarities and disparities among EU countries can be recorded. Also, cointegration analysis supports somehow the hypothesis of the presence of a long-run stable equilibrium in certain time series.

I – Introduction

Although rice today emerges as a food that can even jostle with a principal and traditional Greek food, such as the wheat made bread, it is still reckoned in Greece as a staple food only for some Asian regions. Hence, rice has not yet attracted the particular focus of agro-market research with far-reaching consequences. Nevertheless, it has become a very important agricultural product, since wheat production has sharply declined over the last ten years while rice production has demonstrated upward potentials.

Propitiously, Greek rice agro-market research could substantially be built up upon the underpinnings laid out by international and European rice research. Asian and USA rice research has been concentrated on market issues for a very long time as for some Asian countries rice constitutes the staple food of the population and for US it is deemed an important commercial commodity (Kaosa-ard and Juliano, 1992; Childs, 1989; Yumkella *et al.*, 1994). In EU, to my knowledge, an extensive rice agro-market research cannot be easily pinpointed, albeit a pioneering European research group has undertaken important initiatives towards a market-oriented rice research (Berni, 1992).

Unambiguously, from a Greek perspective, a natural way to begin the rice market research could be a succinct presentation of the past and current picture of rice production, consumption and trade in Greece and in relation with other EU countries. Moreover, several aspects regarding consumption patterns and consumer attitudes should and must extensively be explored in order to assess the future prospects of the rice market and to identify the appropriate policies to be implemented.

In this paper, an attempt is made to portray production, trade and consumption trends of the Greek rice market and in comparison with EU patterns. Furthermore, the existence of a long-run stable equilibrium is tested by employing the econometric concept of cointegration.

The study is organised as follows: first, a retrospective analysis of production and trade trends is presented. Changes in Greek consumption patterns in comparison with the rest of EU countries are discussed, followed by a cointegration analysis to identify the presence of a stable long-run equilibrium in rice market. Conclusions and extensions are addressed in the final section.

II – Production and trade outlook

In this work, the main data sources emanate from various FAO publications and unpublished information from the Greek Ministry of Agriculture. Indices were estimated primarily utilising two-year moving average to smooth year-to-year variation since a long-run equilibrium was to be determined.

Raw data on EU production over the last twenty years do not provide a solid indication of constant trends as high production is followed by low production and vice versa. Nevertheless, from the estimated indices, a trend to shrink rice production can be easily inferred *(Table 1)*. Production in Greece follows somehow the patterns of EU production, although a few high values could be viewed as a signal of an incoming turnaround.

Table 1. Rice production trends in EU and Greece

	EU		Greece	
Year	1000 MT[a]	Index	1000 MT	Index
1970	1 427	100	66	100
1975	1 214	85	64	97
1980	1 324	93	57	86
1985	1 236	87	68	104
1990	1 235	87	58	89

Source: FAO and authors' computations
[a] Figures indicate a two-year moving average.

On the other side, imports in EU have enlarged significantly over the last couple of decades counterbalancing production and consumption changes. Thus, while in 1970 approximately one billion metric tons of rice were imported by EU states, in 1980 and 1990 the imports skyrocketed at 1.7 and 2.2 billion metric tons respectively, a total increase well over one hundred percent. This import surge clearly reflects consumption increase either due to population increase (an argument that cannot strongly take hold for Europe) or due to changes in consumer attitudes.

Table 2. Changes in rice imports

Year	EU[a]	GR	F	BL	NL	I	S	P	DM	DL	IR	UK
1970	100	100	100	100	100	100	0	100	100	100	100	100
	(1009)[b]	(3)	(112)	(223)	(210)	(3)		(23)	(15)	(117)	(5)	(118)
1975	115	200	154	61	97	233	0	235	100	97	80	118
							(1)					
1980	174	0	247	29	34	5 533	100	348	100	98	80	79
1985	228	300	304	22	33	9500	6 000	448	53	96	60	64
1990	218	167	279	30	33	2 967	19 800	322	53	78	60	65

Source: FAO and authors' computations.
[a] **EU** = European Union, **GR** = Greece, **F** = France, **BL** = Belgium-Luxemburg, **NL** = Netherlands, **I** = Italy, **S** = Spain, **P** = Portugal, **DM** = Denmark, **DL** = Deutchland, **IR** = Ireland, **UK** = United Kingdom.
[b] Figures in parenthesis indicate real values (000MT) at the base year (1970).

A thorough examination of the occurred changes in demand for rice imports in each individual EU country reveals significant changes that do not follow the same pattern in every EU country. That is to say, intriguing import variations recorded in France, Belgium and Netherlands can probably indicate remarkable changes in consumption patterns. Also, uneven scattered changes are noted in countries like Greece, Portugal; and Italy suggested further changes in domestic rice demand and supply.

Differences in import variations are clearly highlighted by the estimates of the correlation matrix *(Table 3)*. The sign and magnitude of the correlation coefficient reflect the direction of change and the rate of change that pertain to a particular trend. By the same token, the average EU import change can be matched with import change in France (0.98), Italy (0.81), Portugal (0.89) and Spain (0.69). On the contrary, Netherlands (-0.93), Ireland (-0.91) and UK (-0.94) pursue totally opposite import changes. Thus it can be surmised that while in the former states rice consumption could have increase, in the latter countries it could have diminish. Definitely, a further analysis on trade flows could also reveal alterations in consumer preference.

Table 3. Correlation matrix of rice imports

	EU[a]	GR	F	BL	NL	I	S	P	DM	DL	IR	UK
EU	1											
GR	0.37	1										
F	0.98	0.31	1									
BL	-0.89	-0.23	-0.96	1								
NL	-0.93	-0.05	-0.96	0.91	1							
I	0.81	0.33	0.84	-0.79	-0.81	1						
S	0.69	0.29	0.60	-0.47	-0.56	0.15	1					
P	0.89	0.38	0.95	-0.96	-0.87	0.91	0.35	1				
DM	-0.88	-0.65	-0.79	0.63	0.67	-0.59	-0.82	-0.66	1			
DL	-0.60	-0.19	-0.52	0.44	0.49	-0.02	-0.98	-0.27	0.71	1		
IR	-0.91	-0.57	-0.92	0.88	0.78	-0.66	-0.72	-0.86	0.87	0.67	1	
UK	-0.94	-0.17	-0.88	0.73	0.92	-0.78	-0.65	-0.74	0.81	0.54	0.72	1

[a] **EU** = European Union, **GR** = Greece, **F** = France, **BL** = Belgium-Luxemburg, **NL** = Netherlands, **I** = Italy, **S** = Spain, **P** = Portugal, **DM** = Denmark, **DL** = Deutchland, **IR** = Ireland, **UK** = United Kingdom.

Ultimately, a noteworthy point is that correlation coefficients reveal that Greece's import changes are significantly diverted from any other EU country. The higher correlation coefficient was recorded only with Portugal and is still very low (0.38). Accordingly, similarities and disparities in demand for rice imports can be traced out by examining the relative column of correlation coefficient for any particular EU country.

III – Consumption patterns

Consumption per capita varies substantially among EU countries as it can be seen in *Table 4*. Portugal is placed on the top amongst all EU countries since the average per capita consumption is roughly 15 kg/capita. France, Greece and Spain are placed somehow in the second group with an average consumption per capita relatively high (7.0–5.5 kg/capita). Finally, the rest of the EU countries consume relatively very small quantities of rice. In addition, it can be easily noticed from the computed consumption indices *(Table 4)* that although significant consumption per capita changes among EU countries are registered, the overall average EU consumption per capita sustains on almost the same levels.

Table 4. Rice consumption patterns (indices) in EU countries

Year	EU[a]	GR	F	I	S	P	DL	BL	NL	UK	DM	IR
1970	100	100	100	100	100	100	100	100	100	100	100	100
	(4.05)[b]	(6.20)	(4.25)	(5.35)	(6.20)	(16.30)	(2.23)	(5.50)	(3.95)	(2.50)	(2.25)	(1.30)
1975	95	81	82	99	102	101	93	75	100	94	104	125
1980	84	89	67	79	90	93	92	25	90	74	98	150
1985	83	105	51	93	87	96	122	28	86	52	71	150
1990	83	110	52	105	101	92	84	31	75	54	69	163

Source: FAO and authors' computations.
[a] **EU** = European Union, **GR** = Greece, **F** = France, **I** = Italy, **S** = Spain, **P** = Portugal, **DL** = Deutchland, **BL** = Belgium-Luxemburg, **NL** = Netherlands, **UK** = United Kingdom, **DM** = Denmark, **IR** = Ireland.
[b] *Figures in parenthesis indicate real values (kg/year/per capita) at the base year (1970).*

In hindsight, shifts in consumption per capita and in demand for rice imports among various EU countries strongly indicate that consumers in accordance with their income level and their particular preference switched to different rice quality. Therefore, quality aspects could explain the underscored above variations in both consumption and imports. Overall, it can be concluded that though data restraints cannot allow any inferences withstanding scientific scrutiny imports, consumption and variety shifts denote substantial changes in consumer preferences. Yet, it should be underlined that the limelight of the rice research should be not only rice consumption-quality changes, but also relative consumption changes in relation with other substitutes in human diet (wheat, maize...).

Table 5. Annual averages of rice production and yield, with respective indices in Greece, 1981–1994

Year	Production *Japon. + Indica* Tons (1000)	Index	Production *Japonica* Tons(1000)	Production *Indica* Tons (1000)	Indica/ *Japonica* % share	Yield *Japon. + Indica* Tons/ha	Index
1981	87.00	100	76.05	10.95	14.40	5.45	100
1982	83.38	96	78.00	5.38	6.90	5.37	99
1983	82.20	95	80.42	1.78	2.21	5.90	108
1984	89.84	103	84.06	5.78	6.88	6.43	118
1985	106.41	122	97.97	8.44	8.61	6.47	119
1986	119.34	137	108.49	10.85	10.00	6.79	125
1987	130.01	149	117.00	13.01	11.12	6.83	125
1988	114.10	131	91.94	22.16	24.10	5.53	102
1989	99.84	115	80.73	19.11	23.67	6.18	113
1990	95.98	110	82.18	13.80	16.79	6.00	110
1991	89.00	102	65.38	23.62	36.13	6.06	111
1992	110.00	126	72.82	37.18	51.06	7.54	138
1993	142.00	163	88.75	53.25	60.00	7.38	135
1994	174.00	200	87.76	86.24	98.27	7.64	140

Source: Unpublished data from Cereal Institute of Greece.

IV – Identifying the presence of a long-run stable equilibrium

A recently developed econometric technique, the so-called integration and cointegration (Johannsen and Juselius, 1987; Engle and Granger, 1987; Hakkio and Rush, 1990), has been used to check the existence of a long-run stable equilibrium in various macroeconomic variables (Moss, 1992; Choe and Koo, 1993; Heifner and Kinoshita, 1994). Series identified as cointegrated could represent long-run equilibrium although short-run variation can definitely occur. Hence, the cointegration concept could be applied to test the presence of cointegration in the available time series on rice production/trade/consumption and afterwards to postulate plausible and valuable premises.

The first step is to perform the Augmented Dickey-Fuller test for unit roots[1] to evaluate the order of integration. This is a test of whether a series tends to converge towards its mean or trend level. Values of ADF test *(Table 6)* clearly indicate that all time series are 1. Thus, series can be represented satisfactory only by their first differences.

Table 6. Augmented Dickey-Fuller Test (ADF)

Levels	ADF		DW
EU rice production (PE)	-3.193	[1][a]	1.938
Greek rice production (PG)	-2.368	[2]	2.163
EU rice imports (ME)	-2.516	[0]	2.082
Greek rice imports (MG)	-2.623	[1]	1.931
Greek rice exports (XG)	-2.945	[2]	2.017
Greek rice consumption (kg/cap.) (RCG)	-1.283	[3]	1.914
First Differences			
EU Rice production (DPE)	-7.004	[0]	2.094
Greek Rice production (DPG)	-6.075	[1]	2.243
EU Rice Imports (DME)	-6.558	[0]	2.045
Greek Rice Imports (DMG)	-6.353	[0]	2.017
Greek Rice Exports (DXG)	-7.063	[0]	2.048
Greek Rice consumption (kg/cap.) (DRCG)	-3.982	[2]	1.970

Data period is 1961-1990.
Critical Values at 5% are: for (PE, PG, ME, MG, XG)=-3.57, FOR (RCG)=-2.97.
[a] Figures indicate number of lags.

The next step is to check the presence of cointegration in a couple of time series and see if a long-run stable equilibrium can be asserted. Thus, the Johannsen Cointegration Test clearly proves that Greek rice production and EU rice production are cointegrated at 5% significance level *(Table 7)*. In other words, it can be inferred that both Greek and EU rice production are trending similarly. Therefore, there exist a long-run equilibrium that can describe the relation among the two series (see also section 2).

By contrast, Johannsen Cointegration test shows that Greek and EU rice imports are not cointegrated and probably the underlined utility demarcates the long-run path of the two series.

Table 7. Johannsen Cointegration Test

Variables	LR	CV 5%	CV 1%
PE, PG[a]	16.70	15.41	20.04
	3.52	3.76	6.65
MG, ME	19.47	25.32	30.45
	5.98	12.25	16.26
PG, MG, XG	31.23	29.68	35.65
	11.37	15.41	20.04
	2.62	3.76	6.65

[a] Variables have defined in *Table 6.*

Finally, Greek rice production and rice imports were tested by employing also the Johannsen Cointegration test and the two series have proved non-cointegrated. The inclusion of Greek rice imports in addition to the two earlier mentioned series altered the results; and the contention that production, imports and exports are all cointegrated is supported by the test. This means that the three time series are moved around a long-run stable equilibrium. That is to say, long-run variations are counterbalanced by the movement of the three associated time series.

Certainly, several options are left out since the analysis was focused on particular objectives taking into account the limitations on raw data and the lack of previous work on Greek rice consumption. No doubt, a further investigation is required to assess the dovetail of consumption and quality in the rice market.

V – Conclusions and policy implications

Rice, a major food product and a very important commodity for the Greek economy and Greek agriculture has not attracted the focus of agricultural economists. Nevertheless, changing consumption patterns will affect both the production and the market side of rice and bring about a sequence of direct and indirect effects. Thus, research on rice consumption should be considered as first priority and should cover several aspects.

In this initial work, production, trade and consumption are examined and described for the Greek economy in comparison with the other EU countries. Consumption patterns were associated with changes in imports and the presence of a long-run stable equilibrium is tested.

Import trends vary significantly among various EU countries and Greece's import patterns divert significantly from the patterns followed by any of the other EU countries, as the correlation matrix illustrates. Though consumption has not undergone through substantial changes, there is strong evidence that quality preferences suffered major changes. Further and thorough investigation is required to explore and record in detail consumers' behaviour.

The question of the presence of a long-run stable equilibrium was raised to assert the significance of random year to year variations. The recently developed cointegration techniques were employed and results interpreted in the context of the aims and scope of this paper. Overall, results indicate that several series regarding rice production and import can be visualised as pursuing similar time path. This could probably support the hypothesis of cointegration between Greek and EU rice production. Also, imports, production and exports of rice in the Greek economy form a long-run stable set of time series.

Note

1. A unit root is present if the first order auto-correlation coefficient for a series is 1, which is the condition for a random walk. In such cases the coefficient of regression of the first difference in the series on the lagged value of the series is zero.

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