Causality between food prices and other goods prices: Evidence from the EU member-states

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Abstract

The purpose of this paper was to investigate and measure the causation between food consumer price index and all-other-items consumer price index in 14 European Union member-states, using monthly data covering the period from 1985:12 to 1998:12. For this purpose a four stages approach was employed: Firstly, the non-stationarity of the data involved was investigated using the Augmented Dickey-Fuller tests. Secondly, causation was investigated using the Granger causality tests. Thirdly, the long-run equilibrium relationship between the two variables involved was estimated employing the Johansen cointegration approach. Fourthly, the short-term disequilibrium relationship between these two variables was estimated employing the Error-Correction-Models methodology. The findings of the paper generally support the hypothesis that for the vast majority of the EU member-states there exist a unidirectional Granger causality from all-other-items consumer prices to food consumer prices.

Keywords: *Food prices, Granger causality, Cointegration, Error Correction Models, European Union.*

Introduction

Two major causes of inflation are the 'demand-side, or demand-pull, inflation' and the 'supply-side, or supply-push, inflation'. Generally, an increase in aggregate demand, whether it comes from consumers, investors, the government, or external trade, "shifts the aggregate demand curve horizontally outward", resulting in higher final prices. Similarly, a decrease in aggregate supply, whether it comes from increases in the prices of factors of production, such as wages, or from increases in the prices of materials, such as in the price of oil, "shifts the aggregate supply curve horizontally inwards", resulting in higher final prices also (Baumol and Blinder, 1994; Griffiths and Wall, 1997).

In these demand-side and supply-side theories, the cause (demand or supply) and effect (prices) are clearly stated. However, when it comes to the investigation of how final consumer prices of some goods affect final consumer prices of other goods things are no so clear. This is because we may face various phenomena such as:

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- Cost-push phenomena, where one final good is used in the production of another final good.
- Catch-up phenomena, where final prices of some goods "imitate" the behaviour of final prices of other goods.
- Hysteresis phenomena, where the effects in final prices of some goods lag behind cost-push and cutch-up changes (Atkinson *et all,* 1998).
- Chaotic phenomena, where the effects on final prices of goods are caused from combinations of the three cases stated above.

The purpose of this paper is to investigate the causation between food consumer prices and consumer prices of other goods in 14 European Union member-states. Although, this investigation is not a theory driven investigation, but it is rather a data-driven investigation, it may be valuable to economic policy makers. This is because if the direction of the causation between food prices and prices of other goods is known the policy maker can interfere at an earlier stage level which it may affect the final stage. Thus, the major hypothesis to be tested is the following:

- H_0:Food consumer prices are affected by the consumer prices of other goods.
- As a sub-hypothesis to be tested is the following:
- H_1:There exists a long-term equilibrium relationship between food consumer prices and the consumer prices of other goods.

In order to meet the purpose of the paper, monthly data referring to the food consumer price index and to the all-other-items consumer price index for 14 EU member states were used. Section 2, employing the Augmented Dickey-Fuller (ADF) tests, investigates the non-stationarity of the data used. The Granger causality tests between the food consumer price indexes and the all-other-items consumer price indexes are shown in section 3. Two-variable cointegration analysis, employing the Johansen approach, between the food consumer price indexes and the all-other-items consumer price indexes, is presented in section 4. The statistical estimates of the Error Correction Models (ECM) and discussion of the meaning of these estimates is presented in section 5. Finally, section 6 presents the conclusions and policy implications of the study. All estimates have been carried out using EViews 3.1.

The data involved

The data used in the analysis is monthly, cover the period from 1985:12 to 1998:12 and are taken from the Electronic Data Base "International Statistical Yearbook 2000". The identification of the variables used is the following:

pf_i = consumer prices index: food, base year 1992

pa_i = consumer prices index: all-other-goods, base year 1992

i = 1: Austria, 2: Belgium, 3: Sweden, 4: Finland, 5: France, 6: Germany,
7: Greece, 8: Ireland, 9: Italy, 10: Netherlands, 11: Portugal, 12: Spain,
13: United Kingdom, 14: Denmark

In examining the stationarity of these variables we used the Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF) tests as shown in Table 1 (Dickey and Fuller, 1979 and 1981; Dickey and Pantula, 1987; Dickey *et al,* 1984). The exact methodology followed is as follows (Seddighi *et al,* 2000): In order to find the proper structure of the DF/ADF equations, in terms of the inclusion in the equations of an intercept (c) and a trend (t), and in terms of how many extra augmented lagged terms to include in the ADF equations, for eliminating possible autocorrelation in the disturbances, the usual Akaikes's (1973) information criterion (AIC) and Schwartz's (1978) criterion (SC) were employed. The minimum values of AIC and SC indicated the 'best' structure of the ADF equations. With respect to testing autocorrelation in the disturbances, the usual Breusch (1978) and Godfrey (1978), or Lagrange multiplier LM(1), test was used.

The structure of the figures presented in Table 1 is as follows: For each country and for each variable the figures show the DF/ADF statistics. Next to each figure there are three indicators; the first shows the corresponding numbers of the lagged terms used to eliminate possible autocorrelations in the disturbances, the second shows the inclusion in the equations of an intercept (c) and the third shows the inclusion of a trend (t).

Table 1. DF/ADF unit root tests for all the variables involved in estimation

EU	**Variables in levels**				**Variables in 1st differences**			
member-states	**Food price index**		**All-other- items price index**		**Food price index**		**All-other- items price index**	
1. A	0.5726	2,c	-9.6935	2,c	-1.3613	2,c,t	-9.2430	2,c
2. B	-1.0108	1,c	-9.7090	1,c	-0.6359	2,c	-10.5337	1,c
3. S	-2.9661	2,c,t	-10.1063	2,c	-2.3586	2,c	-7.4815	1,c
4. FIN	-1.3782	2,c,t	-6.5082	2,c	-0.1692	3,c,t	-6.1804	2,c,t
5. F	-1.7973	2,c	-5.1615	2,c	1.1931	2,c,t	-11.0813	1,c,t
6. D	-1.8327	1,c	-9.4830	1,c	-1.6553	2,c,t	-7.7468	1,c
7. EL	-0.8470	2,c	-7.6385	1,c	-1.9769	2,c,t	-12.5154	1,c
8. IRL	-2.5241	1,c,t	-10.3150	1,c	-0.8360	1,c	-10.3714	1,c
9. I	-0.3619	2,c	-6.3903	1,c	-1.4011	2,c	-5.9552	1,c
10. N	-1.3245	1,c	-6.2214	1,c	0.7786	1,c	-9.4313	1,c
11. P	-2.9823	2,c,t	-8.6630	1,c	-2.0211	1,c	-6.6381	1,c
12. E	-0.3426	2,c,t	-9.2313	1,c,t	-1.9051	2,c	-9.7126	1,c
13. UK	-2.3481	3,c,t	-7.6525	2,c	-1.1724	1,c	-8.0591	1,c
14. DK	-1.3682	1,c	-8.2125	1,c	-2.6996	1,c,t	-12.2497	1,c,t

Critical values (including intercept): -3.47(1%); -2.88(5%); -2.58(10%).
Critical values (including intercept and time trend): -4.02(1%); -3.43(5%); -3.14(10%).

Comparing the DF/ADF statistics in Table 1, with the MacKinnon (1991) critical values, shown at the bottom of Table 1, the following conclusions may be derived:
The statistics referring to the actual levels show that all variables are non-stationary.
The statistics referring to the 1st differences show that all differenced variables are stationary.

In other words, all the consumer price indexes (food and all-other-items) are integrated of order one, i.e. they are I(1).

Testing for causality

When in a regression equation we say that the "explanatory" variable pa_t affects the "dependent" variable pf_t we indirectly accept that variable pa_t "causes" variable pf_t, in the sense that changes in variable pa_t induce changes in variable pf_t. However, because in most cases the direction of causality is not known ("unidirectional causality" when pa_t causes pf_t, but pf_t does not cause pa_t, and "bilateral causality" when variables pa_t and pf_t are jointly determined) various tests have been suggested to identify this direction. In this paper we will employ the most well-known test proposed by Granger (1969) to investigate the direction of causality between pf_t and pa_t.

Table 2 presents the results of this test on pf_t and pa_t. The methodology followed in order to get the figures in Table 2 is the following. First, a VAR model including variables pf_t and pa_t in their original levels was used for each EU member-state, in order to determine the size of lag that minimises the AIC and SC criteria. Secondly, using this size of lag, i.e. the order of the VAR model, the actual Granger test was performed, using variables pf_t and pa_t in their 1[st] differences, because we saw in section 2 that variables pf_f and pa_t are integrated of order one. In Table 2 the critical probabilities for the F-statistic are reported, corresponding to the two null hypotheses.

Table 2. Granger causality tests between pf_t and pa_t.

EU member-states	Lags minimizing AIC and/or SC criteria in the VAR model	H_0: pa does not Granger cause pf (Probability)	H_0: pf does not Granger cause pa (Probability)
1. Austria	3	0.00000	0.94258
2. Belgium	2	0.00000	0.08654
3. Sweden	1	0.72229	0.17045
4. Finland	1	0.05989	0.12955
5. France	1	0.05374	0.53846
6. Germany	1	0.00466	0.96188
7. Greece	2	0.00000	0.30342
8. Ireland	1	0.81351	0.94893
9. Italy	2	0.09047	0.46578
10. Netherlands	3	0.00152	0.66340
11. Portugal	2	0.06011	0.79542
12. Spain	2	0.01014	0.26026
13. United Kingdom	3	0.00246	0.11578
14. Denmark	2	0.00000	0.06612

From the probabilities reported in Table 2, using a significant level not more than 10%, the following conclusions may be derived:

- In all EU member-states, except Sweden and Ireland, pa_t does Granger cause pf_t.
- In all EU member-states, except Belgium and Denmark, pf_t does not Granger cause pa_t.

- Combining 1 and 2, we may say that:
- For the EU member-states of Austria, Finland, France, Germany, Greece, Italy, Netherlands, Portugal, Spain and United Kingdom there exists a unidirectional causality from pa_t to pf_f.
- For the EU member-states of Belgium and Denmark there exists a bilateral causality between pa_t and pf_f.
- For the EU member-states of Sweden and Ireland does not exist causation between pa_t and pf_f.
- Generally we could say that in the European Union the consumer prices of all-other-items affect food consumer prices and not the opposite.

Testing for cointegration

Having found in the previous section that for the vast majority of the EU member-states a unidirectional Granger causality exists from pa_t to pf_t, we will continue in this section by investigating if this causation is an equilibrium one. This can be done by testing cointegration between pf_t and pa_t.

The Johansen (1988) and Johansen and Juselius (1990) procedure in testing cointegration between two or more variables, integrated of order one, depends on the various specifications of the VAR model and of the cointegrating vector. In this paper we employed the following procedure:

- The cointegrating vector has the two variables pf_t and pa_t.
- The specification choices with respect to data of the VAR model employed is the following (EViews, 1998):
- VAR assumes no deterministic trend:
  Case 1: No intercept or trend in Cointegrating Equation (CE)
  Case 2: Intercept (no trend) in CE
  VAR assumes linear trend in data:
  Case 3: Intercept (no trend) in CE
  Case 4: Intercept and trend in CE

The overall decision about the specification of the VAR model was based on Akaikes's information criterion (AIC) and Schwartz's criterion (SC) in the VAR context with respect to the lag length (Seddighi *et all,* 2000) and on the economic meaning derived from the restricted VAR model.

According to the AIC and SC criteria the "best" specifications of the VAR model for the EU member-states are shown in Table 3. Table 3 presents the estimated cointegrating vectors, for each of the 14 EU member-states, using Johansen's procedure.

From Table 3 it is seen that the food price index (pf_t) and the all-other-items price index (pa_t) are cointegrated for all 14 EU member-states. This means that these two variables drift together, although which individually non-stationary in the sense that they tend upwards or downwards over time. This common drifting of the variables makes linear relationships between them exist over long periods of time, thereby giving thus insight into their equilibrium relationship.

Although in all EU member-states the long-run relationship between food price index and all-other-items price index is positive and significant (except Sweden and United Kingdom), the extent of this relationship differs between member-states.

Using computed two quartiles of the estimated cointegrated coefficients in Table 3, Q_1 = 0.5487 and Q_2 = 0.8185, the 14 EU member-states may be categorized into the following groups:

"*Less sensitive*" (less than Q_1 in absolute numbers): S, EL, UK, I, D. This means that an increase by one unit in the all-other-items price index will produce a less than 0.5 units increase in the food price index.

"*Average sensitive*" (between Q_1 and Q_2 in absolute numbers): P, F, B, A. This means that an increase by one unit in the all-other-items price index will produce a between 0.5 and 0.8 units increase in the food price index.

"*More sensitive*" (more than Q_2 in absolute numbers): FIN, DK, E, N, IRL. This means that an increase by one unit in the all-other-items price index will produce a more than 0.8 units increase in the food price index.

Table 3. Estimated cointegrating vectors using Johansen's procedure.

Country	Case	Likelihood Ratio	5 percent Critical Value	Hypothesized No. of CE (s)	Normalised Cointegrating Coefficients		
					pf_t	pa_t	constant
1. A	3	16.79 0.35	15.41 3.76	None At most 1	1	-0.748706 [-26.266]	-22.96467
2. B	1	38.77 0.67	12.53 3.84	None At most 1	1	-0.721397 [-3.098]	
3. S	2	31.68 5.96	19.96 9.24	None At most 1	1	-0.045278 [-0.153]	-104.4775 [-2.739]
4. FIN	1	40.43 0.01	12.53 3.84	None At most 1	1	-0.888385 [-30.934]	
5. F	1	50.67 1.01	12.53 3.84	None At most 1	1	-0.717930 [-10.937]	
6. D	3	21.67 2.18	15.41 3.76	None At most 1	1	-0.530172 [-10.294]	-43.42506
7. EL	3	23.07 0.00	15.41 3.76	None At most 1	1	-0.127474 [-22.401]	-84.26876
8. IRL	3	14.70 0.14	15.41 3.76	None At most 1	1	-4.644666 [-21.871]	355.0299
9. I	2	214.98 4.86	19.96 9.24	None At most 1	1	-0.344838 [-3.007]	-93.26645 [-3.076]
10. N	3	39.63 2.49	15.41 3.76	None At most 1	1	-1.561930 [-20.749]	59.92974
11. P	1	46.72 2.02	12.53 3.84	None At most 1	1	-0.567190 [-6.387]	
12. E	2	80.68 4.08	19.96 9.24	None At most 1	1	-1.209849 [-11.790]	51.48141 [3.271]
13. UK	2	57.63 6.52	19.96 9.24	None At most 1	1	-0.291157 [-0.170]	-138.4277 [-0.431]
14. DK	1	48.60 0.00	12.53 3.84	None At most 1	1	-1.137047 [-20.749]	

Note: t-ratios in brackets.

The error- correction models

We saw in the previous section that variables pf_t and pa_t are cointegrated. Therefore, according to the Granger representation theorem (Granger, 1986; Engle and Granger, 1987) these variables can be described by an error correction model (ECM). This means that although a long-run equilibrium relationship exists between them, in the short-term these variables may be in disequilibrium, with the disturbances being the equilibrating error. For our case, this error correction model which connects the short-run and the long-run behaviour of the two variables is given by

$$\Delta pf_t = lagged(\Delta pf_t, \Delta pa_t) + \lambda e_{t-1} + v_t \quad , \; -1 < \lambda < 0 \tag{1}$$

where λ = short-term adjustment coefficient and e = equilibrating error.

Table 4 presents the estimated error correction equations for the food price index.

Table 4. Food price index (Δpf_t) error correction equations

States	e_{t-1}	Δpf_{t-1}	Δpf_{t-j}	Δpa_{t-1}	Δpa_{t-2}	Δpa_{t-3}	constant	R^2	Probability of Q-statistic (j)*	
									(j=1)	(j=2)
1	-0.120 [3.26]	0.113 [1.40]		0.143 [1.29]			0.145 [2.07]	0.084	0.256	0.524
2	-0.006 [2.87]			1.575 [8.72]				0.329	0.108	0.151
3	-0.014 [2.13]	-0.016 [0.20]		-0.067 [0.60]				0.010	0.966	0.467
4	-0.000 [0.01]	0.144 [1.79]		0.474 [1.92]				0.048	0.858	0.580
5	-0.002 [0.57]	0.154 [1.92]		0.493 [1.81]				0.052	0.481	0.187
6	-0.036 [2.34]			0.451 [3.49]			0.066 [1.51]	0.085	0.442	0.505
7	-0.140 [4.80]	0.561 [7.78]		0.042 [1.50]			0.007 [0.17]	0.314	0.688	0.661
8	-0.057 [2.32]	-0.143 [1.81]					0.941 [4.72]	0.560	0.810	0.501
9	-0.004 [3.53]	0.505 [7.28]						0.258	0.745	0.945
10	-0.007 [1.07]	0.397 [5.46]	0.279 $[3.82]_{-3}$	-0.060 [1.10]	0.158 [2.89]	0.122 [2.21]	0.057 [1.54]	0.333	0.676	0.807
11	-0.002 [1.26]			0.313 [2.75]				0.040	0.766	0.804
12	0.008 [1.98]	0.122 [1.50]		0.452 [2.72]				0.084	0.894	0.589
13	-0.009 [5.83]	0.141 [1.79]	-0.193 $[2.50]_{-2}$	-0.587 [3.40]		-0.351 [2.28]		0.139	0.524	0.812
14	-0.013 [4.50]			0.418 [3.65]				0.111	0.708	0.340

Notes: t-ratios in brackets.

*Probabilities of Ljung and Box (1978) Q-statistic (j) for testing autocorrelation (j = 1st and 2nd order)

These error correction equations correspond to the Johansen's methodology for testing cointegration explained in section 3. From the results in Table 4 it is seen that most estimates are generally acceptable, according to the usual statistical criteria.

With respect to the adjustment coefficients λ we see that, in broad terms, this coefficient for Austria, Belgium, Sweden, Germany, Greece, Ireland, Italy, United Kingdom and Denmark are much significant, for Netherlands, Portugal and Spain are moderately significant, and for Finland and France are not significant. In more detail the results in Table 4 suggest the following:

With respect to the adjustment mechanism that brings food price index to its long-run equilibrium state: Using computed two quartiles of the estimated adjustment coefficients in Table 4, Q_1 = -0.0065 and Q_2 = -0.0135, the 14 EU member-states may be categorized into the following groups: "*more out of equilibrium*" (Sweden, Germany, Ireland, Austria and Greece); "*moderately out of equilibrium*" (Netherlands, Spain, United Kingdom and Denmark); "*less out of equilibrium*" (Finland, Portugal, France, Italy and Belgium).

With respect to the lagged food price index: In most member-states, except Belgium, Sweden, Germany, Portugal and Denmark, the coefficients show some significance. In all these cases, except Ireland, the positive sign of the coefficients of the lagged food price index shows a persistent effect.

With respect to the lagged all-other-items price index: In the vast majority of the member-states, except Sweden, Ireland and Italy, the coefficients show some significance. In all these cases, except United Kingdom, the positive sign of the coefficients of the lagged all-other-items price index shows that an increase in the all-other-items price index it is transferred to the food prices index. This result reinforces the causation results found in section 2.

Concluding remarks

The purpose of this paper was to investigate and measure the causation between food consumer price index and all-other-items consumer price index in 14 European Union member-states, using monthly data covering the period from 1985:12 to 1998:12. For this purpose a four stages approach was employed:

Firstly, the stationarity of both variables for the 14 EU member-states was investigated using the Augmented Dickey-Fuller tests. It was found that all variables are integrated of order 1.

Secondly, the causation between the two variables was investigated employing the Granger causality test. It was found that there exists a unidirectional Granger causality form pa_t to pf_t for all EU member-states, except for Belgium and Denmark where a bilateral causality exists between pf_t and pa_t, and except Sweden and Ireland where there is no any causality at all. Generally, we may accept the hypothesis H_0 set at the introduction of the paper that food consumer prices are affected by the consumer prices of other goods in EU.

Thirdly, having established that causation exists from pa_t to pf_t, the long-run equilibrium relationship between the two variables was estimated employing the Johansen cointegration approach. It was found that the variables of food consumer price index and all-other-items consumer price index are cointegrated for all EU member-states. Thus, this result supports the sub-hypothesis H_1 set at the introduction of the paper that there exists a long-run equilibrium relationship between food consumer prices and the consumer prices of other goods. Specifically it was found that the extent of this long-run relationship differs between member-states. In more detail it was found that pf_t is less sensitive to changes in pa_t for the member-states of S, EL, UK, I, D; average sensitive for the member-states of P, F, B, A; and more sensitive for the member-states of FIN, DK, E, N, IRL.

Fourthly, having found that a long-run equilibrium exists between the two variables involved, the short-term disequilibrium relationship between these two variables was estimated employing the Error-Correction-Models methodology. The econometric results were relatively good for all equations. In all cases the variables were generally significant and the signs were the expected ones. In terms of the estimated short-term adjustment coefficients, which show the part of the deviation of the actual variable from its long-term equilibrium level that is corrected each month, Sweden, Germany, Ireland, Austria and Greece indicated the largest monthly adjustment, Netherlands, Spain, United Kingdom and Denmark indicated a moderate monthly adjustment, and finally, Finland, Portugal, France, Italy and Belgium indicated the smallest monthly adjustment.

The result that, in the vast majority of the EU member-states, food consumer prices are affected by the consumer prices of other goods without affecting the consumer prices of these other goods, is important for economic policy makers. This is because the policy makers know that by imposing any policies to food products these policies will not have any side effects on the prices of other products. On the contrary, when some policies must be imposed on other than food products, the effects of these policies on food products must also be considered.

Generally, the paper did not answer if the causation between the various prices is of the cost-push or catch-up type. However, the error correction models showed some hysteresis phenomenon. Thus, a further research is needed to analyse the specific effects of the unidirectional causation of specific products to specific food products.

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