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Price Transmission in the German Sugar Market

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Contributed paper prepared for presentation at the 56th AARES annual conference, Fremantle, Western Australia, February7-10, 2012

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Abstract

The German sugar market is governed by the European Union's common market organization (CMO). In 2006, the CMO was subject to its first major reform. Among others, the administered price for sugar was reduced by 36%. We use a data set with monthly prices for sugar and sugar containing products to perform a cointegration analysis. Results show that the reduction of the institutional price has led to a reduction of wholesale prices and of retail prices for table sugar. Prices for sugar containing products are barely integrated with the sugar price, though. Some are found to be integrated with the CPI for food and soft drinks. In none of the cases where linear cointegration could not be detected, threshold cointegration could be found.

Keywords

Sugar, EU's Common Agricultural Policy, Price Transmission, Co-integration

Introduction

The German market for sugar and other caloric sweeteners (mainly isoglucose/high-fructose syrup) is part of the EU common market. The sugar sector is governed by the Common Market Organization (CMO) which since 2008 is part of the CMO for all agricultural products, the so-called single CMO.

The CMO sugar was established in 1967 and until 2006 did not undergo significant changes apart from the incorporation of isoglucose in 1977 and inulin syrup in 1994 and several rounds of accession of new member states. The sugar sector was different from other arable sectors in that price support *vis-a-vis* the world market was much higher and in that the CMO proved very reform-resistant.

The CMO assigned production quotas to member states which in turn distributed the quotas to sugar manufacturers and beet growers. This would limit internal competition significantly. In order to also shield the sector against competition from the world market, prohibitive tariffs were applied (variable levies prior to the Uruguay Round (UR) of the World Trade Organization (WTO)). With these instruments in place, prices could be lifted to roughly three times the world market level. Production quotas for sugar, isoglucose and inulin syrup exceeded domestic consumption. In addition, a number of countries were granted the right to export sugar under preferential tariff rate quotas (TRQ) to the EU, adding to that surplus. To keep the market in equilibrium at the high desired price level, exporters were granted a subsidy bringing revenues from export on par with sales to the domestic market and such allowing to dispose of the emerging surplus.

The sector was politically well-organized and additionally, the cost for export subsidies were carried by the producers themselves via a production levy and thus without direct burden to the community budget and taxpayers. Consequently, the sector was spared in the reforms of the arable sector in 1992, 1999 and 2003. However, in 2001 the EU promised to open its markets to all imports from least developed countries (LDC) after a phase-in period ending in 2009 in the framework of the ‘everything but arms’ initiative (EBA). The existing arrangements on TRQ with countries from Africa, the Caribbean and the Pacific Region (ACP) were in conflict with the WTO rules and had to be amended. The only legal possibility – apart from breaking up the preferential ties – was converting the agreements into customs unions. The limits on imports from ACP countries posed by the TRQ would then have to be removed and imports from these countries could be expected to rise. Finally, a WTO panel ruled in 2004 that the EU had misinterpreted its export competition commitments in the sugar sector and would have to reduce exports (which were limited by the UR-Agreement) greatly in future. Exports had been a reliable valve for any oversupply in the past

of the CMO, which was now effectively closed and at the same time the new import rules would increase the structural surplus.

The system had thus to be reformed in order to prevent a serious and costly market disequilibrium. In 2006, the reference price for sugar was reduced by 36% and production quotas were reduced during a three-year buy-out scheme from 18.2 million t to 14.0 million t. Since the reduced institutional price discouraged some of the preferential imports as well, the reform succeeded to bring the market into equilibrium at the envisaged price, even without any subsidized exports.[1]

The reference price was reduced in two steps from its pre-reform level of 631.90 €/t to 404.40 €/t. The price for sugar on the wholesale market, which had been around 700 € per ton before the reform, followed this institutional price rather closely in the first years after the reform. As of 2009, however, when the world market price increased to levels above the reference price, the market and the institutional prices lost touch, as can be seen in Figure 1.

In November 2010, the European Court of Auditors (2010) published an assessment report evaluating the success of the reform. One of the points the report focussed upon was the question whether the reduced producer prices for sugar would in fact benefit consumers. The report concluded from previous studies that the price reductions for bulk products were unlikely to be passed on to consumers. For the case of sugar in processed products, making up more than two thirds of sugar consumption in the EU, it was expected that reduced input prices would simply lead to higher profit margins for food manufacturers. In the case of table sugar representing the remaining third of consumption, concentration in the distribution and food retail sectors were expected to inhibit a full pass-through of price reductions at the wholesale level.

[1] 1.374 million t of subsidized exports could legally still happen.

The objective of our paper is to test these hypotheses against the observed development of prices in Germany, which is the biggest EU member state in terms of population and hence sugar consumption and the second biggest in terms of sugar production. In particular we examine the following questions: Have price reductions for sugar been passed through to the retail level for (a) table sugar and (b) sugar in processed products? Furthermore, in cases, where the value share of sugar in the retail price of the product in question is too small to lead to a significant effect in case of input price reductions, can the observed movement of such retail prices statistically be attributed to other cost developments or is it due to the competitive structure of the manufacturing, distribution and retail sectors?

To that end, we apply techniques of cointegration analysis to the retrieved price series. In the next chapter we will present our data and explain the methods we used. In the third chapter we will present our results and in the last chapter we will interpret the results with respect to the initially identified research objectives, draw conclusions and critically discuss a few caveats.

Methods

Data

For our analysis, we use retail prices for table sugar and a range of sugar containing products: pralines, jam, ice cream, hard candy, carbonated soft drinks (CSD) with and without caffeine, chocolate and chocolate bars. Additionally we retrieved the consumer price index (CPI) for all consumer products and the CPI for food and soft drinks only. The monthly data is indexed, ranging from January 2000 until October 2011 and retrieved from Statistisches Bundesamt Deutschland (2011).

In Germany as in the rest of the EU, the major part of annual sugar production is traded in forward contracts of six to twelve months between manufacturers and food

processors or, in the case of table sugar, between manufacturers and retailers. As a consequence, the spot market for sugar is too thin to observe prices that can serve as a reliable wholesale price and hence, corresponding statistics do not exist. After the 2006 reform, the European Commission was obliged to maintain a price information system (European Commission, 2012) and manufacturers were obliged to supply their sales data to the Commission. We use this data in our analysis instead of the missing wholesale price. The major problem is that data is available only as of July 2006. Figure 2 illustrates the movement of the time series.

Johansen co-integration

In the case of non-stationarity of the time-series, cointegration provides appropriate statistical techniques to investigate if there is a statistically significant relationship between the non- stationary time-series. Therefore we test the price series for stationarity in levels and in first differences. In time series econometrics, it is said that prices are integrated of order one denoted by $P_t \sim I(1)$ and prices are integrated of order zero denoted by $P_t \sim I(0)$. When price series are found to be non-stationary in levels but stationary in first differences, cointegration tests may be applied. The cointegration procedure is based upon an unrestricted vector autoregressive (VAR) model specified in error-correction form (Johansen (1988) and Johansen and Juselius (1990)):

$$\Delta X_t = \Pi X_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-i} + \Phi D_t + v_t \quad (1)$$

Where X_t includes all n variables of the model which are $\sim I(1)$, the Π, Γ_i and Φ are parameter matrices to be estimated, D_t is a vector with deterministic elements (constant, trend and dummy) and v_t is a vector of random errors which follow a Gaussian white noise process. Equation (1) implies that there can never be any relationship between a variable with a

stochastic trend, $I(1)$ and a variable without a stochastic trend, $I(0)$. So, if $\Delta P_t \sim I(0)$, then Π will be a matrix of zeros, except when a linear combination of the variables in P_t is stationary. The Johansen test for cointegration evaluates the rank (r) of the matrix Π. If r = 0, all variables are I(1) and thus not cointegrated. In case 0 < r < N, there exist r cointegrating vectors. In the third case, if r = N all the variables are I(0) and thus stationary, and any combination of stationary variables will be stationary. Π represents the long response matrix and is defined as the product of two matrices: α and β', of dimension (g x r) and (r x g) respectively. The β matrix contains the long-run coefficients of the cointegrating vectors; α is known as the adjustment parameter matrix and is similar to an error correction term. The linear combination(s) $\beta' x_{t-k}$ of this matrix will be I(0) in the case where the times series are cointegrated. In other words, if rank of Π = r = K, the variables in levels are stationary meaning that no integration exist; if rank Π = r = 0, denoting that all the elements in the adjustment matrix have zero value. Therefore, none of the linear combinations are stationary. According to the Granger representation theorem (Engle and Granger, 1987), when K > 0 and rank of Π (r) < K, there are r cointegrating vectors or r stationary linear combinations of the variables. The Johansen cointegration method estimates the Π matrix through an unrestricted VAR and tests whether one can reject the restriction implied by the reduced rank of Π. Two methods of testing for reduced rank of Π are the trace test and the maximum eigenvalue, respectively:

$$\lambda_{\text{trace}} = -T \sum_{i=r+1}^{n} \ln(1 - \hat{\lambda}^2_i) \quad (2)$$

$$\lambda_{\max}(r, r+1) = -T\ln(1 - \lambda_{r+1}) \quad (3)$$

Where, λ_i is the estimated values of the ordered eigenvalues obtained from the estimated matrix and T is the number of the observations after the lag adjustment. The trace statistics

test the null hypothesis that the number of distinct cointegrating vectors (r) is less than or equal to r against a general alternative. The maximum eigenvalue tests the null that the number of cointegrating vectors is r against the alternative of r +1 cointegrating vectors.

Threshold Cointegration

Threshold cointegration allows for the extension of the classical case of linear cointegration. The adjustment from equilibrium may take place only after the deviation exceeds a certain threshold. Through the perspective of economic theory, the assumption of non-linearity may not be valid in the presence of transaction costs (Balke and Fomby, 1997) or certain policies (Lo and Zivot, 2001) that may influence and buffer markets until the deviations exceed a certain threshold. Threshold cointegration analysis may indicate that once a threshold level is surpassed, prices will adjust back to a long-run equilibrium.

Following Hansen and Seo (2002) a two-regime threshold cointegration model takes the form

$$\Delta X_t = \begin{cases} B'_1 X_t + \mu_t & \text{if } \beta' X_{t-1} \leq \gamma \\ B'_2 X_t + \mu_t & \text{if } \beta' X_{t-1} > \gamma \end{cases} \quad (7)$$

where γ represents the threshold parameter. Equation (7) can be written as

$$\Delta X_t = B'_1 X_{t-1}(\beta) d_{1t}(\beta, \gamma) + B'_2 X_{t-1}(\beta) d_{2t}(\beta, \gamma) + \mu_t \quad (8)$$

with $d_{1t}(\beta, \gamma) = 1$ (if $\beta' X_{t-1} \leq \gamma$) and $d_{2t}(\beta, \gamma) = 1$ (if $\beta' X_{t-1} > \gamma$) and with coefficient matrices B_1 and B_2 determining the dynamics in the two regimes. Besides the coingrating vector β, all coefficients are permitted to switch between the two regimes.

Hansen and Seo note that the threshold effect is only consistent if $0 < P(\beta' X_{t-1} \leq \gamma) < 1$, otherwise the model would reduce to a linear cointegration model. This constraint is imposed by assuming

$$\pi_0 \leq P(\beta' X_{t-1} \leq \gamma) \leq 1 - \pi_0 \quad (9)$$

where $\pi_0 > 0$ is a trimming parameter. In the empirical application $\pi_0 = 0.15$ to ensure sufficient sample variation for every alternative of γ. The estimation of model (8) is conducted through maximum likelihood, under the assumption of independent and identically distributed Gaussian errors.

The Hansen and Seo (2002) threshold model has the hull hypothesis of threshold against the alternative hypothesis of linear cointegration. However, in our analysis we are interested to apply threshold cointegration model in case we cannot find linear cointegration. Seo (2006) offers a test which would complement our analysis and enables us to determine the consistency of our results. In his paper, Seo offers a test of no cointegration versus threshold cointegration based on a Band - Threshold Vector Error Correction Model (TVECM) as specified in equation (8):

$$\Delta X_t = \delta_1(\gamma) d_{1t}(\beta, \gamma) + \delta_2(\gamma) d_{2t}(\beta, \gamma) + \mu(\gamma) + \phi_1(\gamma) \Delta X_{t-1} + \cdots + \phi_q(\gamma) \Delta X_{t-q} + \varepsilon_t(\gamma) \quad (10)$$

where ϕ is a qth-order polynomial in the lag operator defined as $I - \phi_1 - \ldots - \phi_q$. For a detailed description we refer to Seo's (2006) paper.

Results

To determine whether the series are stationary, the Augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test are carried out. For time series the tests point to the existence of one unit root I(1). Thus, the difference of each time series can be regarded as stationary. Detailed results are presented in Appendix 1.

Since the time series are integrated in the same order, cointegration techniques can be used to determine whether a stable long-run relationship exists between each pair. Johansen's tests for cointegration are performed. The VAR specification is estimated by applying one to 6 lags. As we utilize monthly frequencies a potential lag of up to half a year may be

noticeable. The Akaike Information Criterion (AIC) was utilized to select optimal lag length. Consequently the inverse root of AR characteristic polynomial is evaluated (see Appendix 2 and 3) to confirm a proper lag selection for each bi-bariate system. The trace and maximum eigenvalues tests are based on likelihood ratio from the estimated restricted VAR model.

Table 2 offers the results of bivariate systems, pairing retail sugar price with each time series. Since we lack data for ex-factory sugar price for the full period, we first test whether ex-factory and retail sugar prices (2006-2011 period) are cointegrated. As we find cointegration and the VECM results (Table 3) indicate that the direction of the cointegrating vector is positive, we proceed by using the retail price as a proxy for the ex-factory price. Scrutinizing the results of other biviariate systems in Table 2 we notice that besides pralines and CPI no linear cointegrating relationship is found for other series. Taking the movements of retail sugar; CPI; and pralines into account (Figure 2), it might seem contradictory at first glance, however considering the VECM-results in Table 3 one can observe that both for retail-pralines and retail-CPI the time series have an opposite movement.

If not sugar, the question arises whether energy, transport and storage costs are the main driver of the prices of these sweet products. We assume that the CPI for food and soft drinks might be a useful proxy to test such a hypothesis. Table 4 presents the results of the bi-variate Johansen cointegration test. We find a cointegrating relationship the CPI for food and soft drinks and pralines; hard candy; CSD without caffeine; CPI. In case of cocoa-based products (chocolate and chocolate bars); ice-cream; jam; and CSD with caffeine no linear cointegrating vector can be found. The VECM results in Table 5 show for each system the β coefficient is close to one and a relatively small error correction term, which implies a strong cointegrating relationship.

Since the Johansen test, investigates linear cointegration it is appropriate to consider asymmetric cointegration for those pairs where no linear cointegration could be detected.

Hansen and Seo (2002) offer a model to test for threshold cointegration. The null hypothesis of the test is linear cointegration, versus threshold cointegration. Considering that we rejected the hypothesis of linear (Johansen) cointegration it is *a priori* likely that we might find results for threshold cointegration. To keep our analysis consistent, we implement the Seo (2006) test, with the null of no-cointegration versus threshold cointegration. Table 6 shows the results of the test of no cointegration versus threshold cointegration. We observe, however, that for each bivariate system we cannot reject the null hypothesis of no cointegration.

Discussion

For the case of retail table sugar, our results suggest that price reductions on the wholesale level are indeed passed on to the consumer. The concerns of the Court of Auditors about concentration of retail and distribution sectors inhibiting a transmission appear thus to be unfounded.

For the case of sugar in processed products, no cointegration was found between retail prices and wholesale sugar prices in most cases. As an alternative, we tested for cointegration between the respective series and the CPI for food and soft drinks. Implicitly, we hereby test the hypothesis that input cost for the product in question are indeed passed through to the consumer, but that sugar does not occupy a share of these costs large enough to be detectible in the movement of the respective prices. These input costs are an aggregate of labour, capital and other, physical input cost such as energy and water. The test showed cointegration in roughly half of the cases.

For the remainder, we tested for threshold cointegration with the retail price for sugar and with the CPI for food and soft drinks, which could be detected in none of the cases, though. Besides adjustment costs, the presence of threshold cointegration could have hinted at

imperfect competition in the value chain, in our case the food manufacturing and the food retail sectors.

To examine the case of Germany is useful since it is the largest EU member state and the second largest sugar producer after France. Furthermore, data quality and availability is much better than in other member states. On the other hand, generalizing the conclusions of this paper to the EU level could be premature. The German retail sector is notorious for its tough competition. Detecting linear cointegration and thus reasonable pass-through of changes in costs, in our case the wholesale price for sugar, to consumers does not necessarily allow for the conclusion that in other member states this is happening as well.

We failed to detect cointegration between the sugar price and prices of sugar containing products in most cases. This might be due to a data problem. The price information system of the European Commission, which served as a source for wholesale prices, records only prices by domestic producers and refiners, but not for imported white sugar. Furthermore, most of the volume traded is contracted in advance, so the spot market price, which is a better indicator of current scarcity, has a small influence on the recorded data only (Nolte and Grethe, 2012). The practice of long term contracts leads to a lag of wholesale prices in comparison with retail prices, which theoretically could be adjusted instantaneously.

Finally, our assumption that the CPI for food and soft drinks is a proxy for operating costs of the retail sector and that hence presence of cointegration of retail prices of sugar containing products and that CPI hint at perfect pass-through of costs might proof circular reasoning. In the case of very strong imperfections in the competitive structure of the food retail sector, the CPI for food and soft drinks could be largely determined by imperfect competition itself in the first place.

The current CMO is set to expire in 2015. As an option for the future, the European Commission proposed recently to abolish the production quotas for sugar, as it has been

agreed upon for milk. Effectively that would mean bringing the sugar policy in line with policies for the rest of the arable sector. Existing *ex-ante* studies diverge in their assessments of the expected effect on the wholesale price (Nolte et al. 2012). Once data become available for the post-quota period, it will be interesting again to examine the effects of abolition on the wholesale and retail prices.

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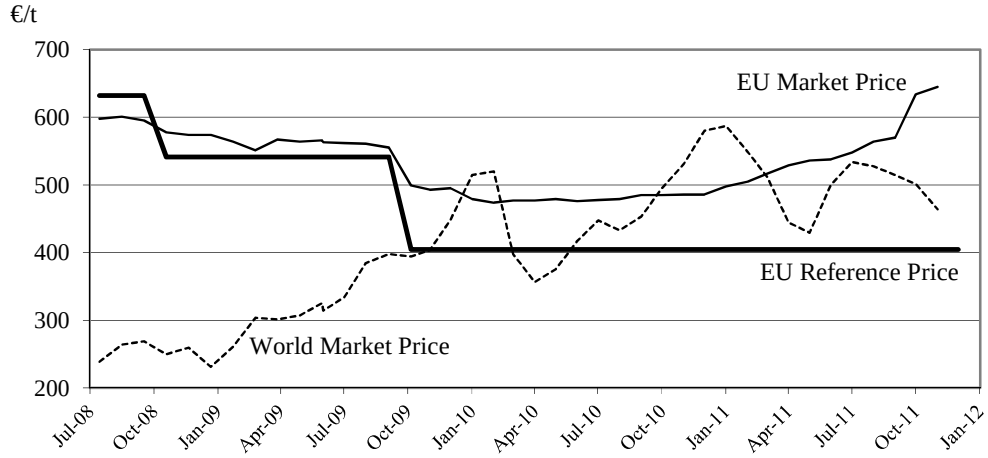
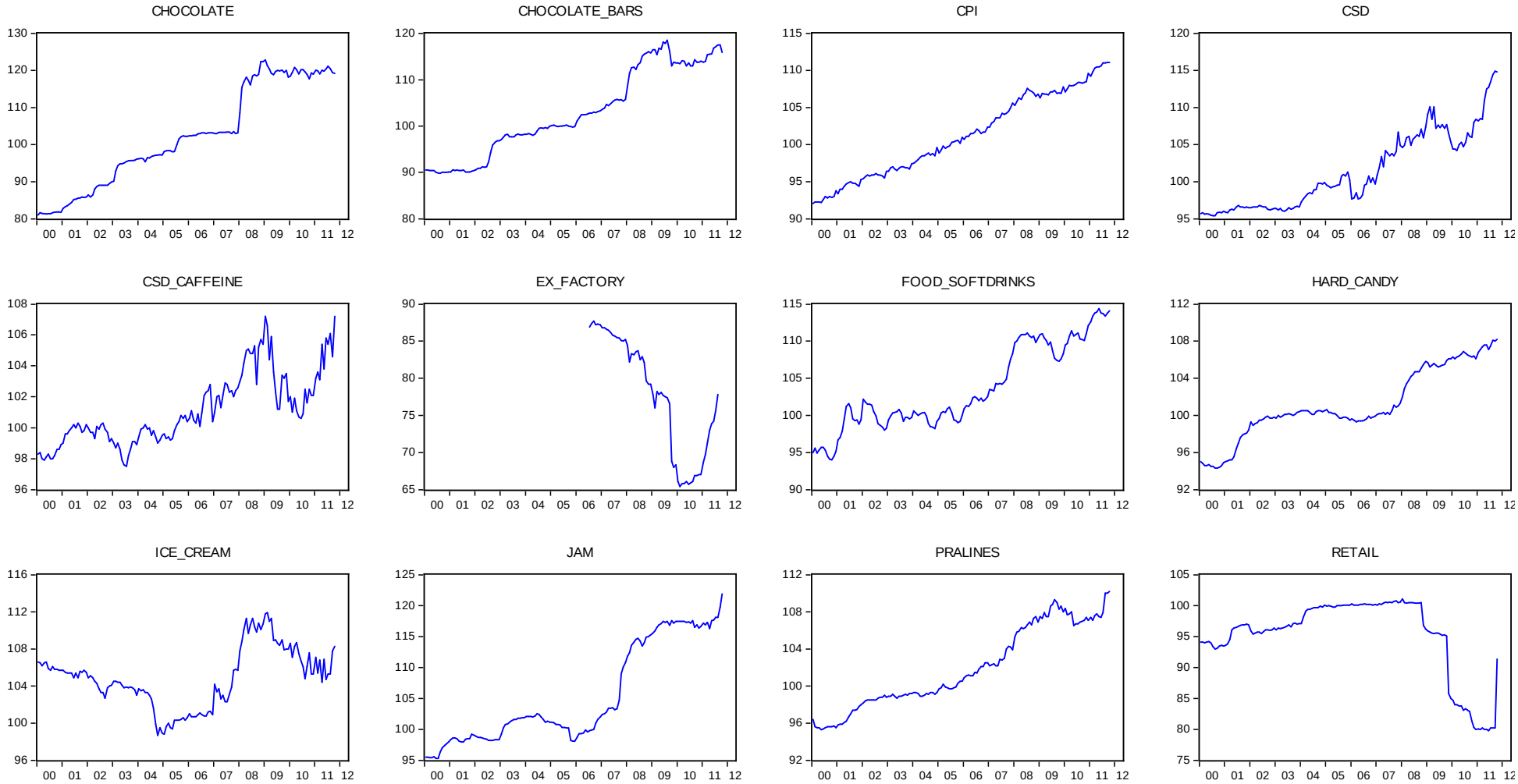
Figure 1: EU and international prices for sugar 2008-2012



Sources: European Commission (2012), USDA (2011a, 2011b), own calculations.

Figure 2. Indexed price evolution between January 2000 and October 2011



Sources: Statistisches Bundesamt Deutschland (2011).

Table 2: Bi-variate Johansen cointegration rank test

	Test statistics	Critical values ($\lambda_{0.95}$)	Test statistics	Critical values ($\lambda_{0.95}$)
Ex-Factory – Retail ('06) (k=2 ; Criteria: AIC)	**Model 2**		**Model 3**	
λ_{trace} $H_0: r = 0 \; vs \; H_1: r \geq 1$	23.92	20.26	21.32	15.50
$H_0: r \leq 1 \; vs \; H_1: r \geq 2$	4.44	9.17	2.25	3.84
λ_{max} $H_0: r = 0 \; vs \; H_1: r = 1$	19.48	15.89	19.07	14.27
$H_0: r \leq 1 \; vs \; H_1: r = 2$	4.44	9.17	2.25	3.84
Retail – Pralines (k=2; Criteria: AIC)	**Model 1**		**Model 2**	
λ_{trace} $H_0: r = 0 \; vs \; H_1: r \geq 1$	15.41	12.32	25.74	20.23
$H_0: r \leq 1 \; vs \; H_1: r \geq 2$	0.55	4.13	4.50	9.16
λ_{max} $H_0: r = 0 \; vs \; H_1: r = 1$	14.87	11.22	21.24	15.89
$H_0: r \leq 1 \; vs \; H_1: r = 2$	0.54	4.13	4.50	9.16
Retail – Jam (k=3; Criteria: AIC)	-	-		-
Retail – Ice Cream (k=2; Criteria: AIC)	-	-		-
Retail – Hard Candy (k=2; Criteria: AIC)	-	-		-
Retail – Food & Soft Drinks (k=2; Criteria: AIC)	-	-		-
Retail – CSD with caffeine (k=2; Criteria: AIC)	-	-		-
Retail – CSD (k=2; Criteria: AIC)	-	-		-
Retail – CPI (K=2; Criteria: AIC)	**Model 1**		**Model 2**	
λ_{trace} $H_0: r = 0 \; vs \; H_1: r \geq 1$	27.67	12.32	30.31	20.26
$H_0: r \leq 1 \; vs \; H_1: r \geq 2$	0.74	4.13	3.27	9.16
λ_{max} $H_0: r = 0 \; vs \; H_1: r = 1$	26.93	11.22	27.04	15.89
$H_0: r \leq 1 \; vs \; H_1: r = 2$	0.74	4.13	3.27	9.16
Retail – Chocolate Bars (k=2; Criteria: AIC)	-	-		-
Retail – Chocolate (k=2; Criteria: AIC)	-	-		-

Model 1-no intercept and no deterministic trend
Model 2-no deterministic trend (restricted constant)
Model 3-Linear deterministic trend model

Table 3: Estimates of long-run & the speed of adjustment from ECM

Model	Regressors	Parameter estimates	t-test
Ex-Factory – Retail ('06)[3]	β	-0.57	-5.01
	ECT_{t-1}	-0.15	-3.32
Retail – Pralines [2]	β	1.44	2.97
	ECT_{t-1}	0.01	1.01
Retail – Jam	β	-	-
	ECT_{t-1}	-	-
Retail – Ice Cream	β	-	-
	ECT_{t-1}	-	-
Retail – Hard Candy	β	-	-
	ECT_{t-1}	-	-
Retail – Food & Soft Drinks	β	-	-
	ECT_{t-1}	-	-
Retail – CSD with caffeine	β	-	-
	ECT_{t-1}	-	-
Retail – CSD	β	-	-
	ECT_{t-1}	-	-
Retail – CPI[2]	β	0.58	0.97
	ECT_{t-1}	-0.003	-0.66
Retail – Chocolate Bars	β	-	-
	ECT_{t-1}	-	-
Retail – Chocolate	β	-	-
	ECT_{t-1}	-	-

[2, 3, 4] indicates that the results are derived from model 2, 3, 4 respectively

Table 4: Bi-variate Johansen cointegration rank test

		Test statistics	Critical values ($\lambda_{0.95}$)	Test statistics	Critical values ($\lambda_{0.95}$)
Food & Soft Drinks - Pralines (k=2 ; Criteria: AIC)		**Model 3**		**Model 5**	
λ_{trace}	$H_0: r = 0 \ vs \ H_1: r \geq 1$	18.63	15.49	22.78	18.40
	$H_0: r \leq 1 \ vs \ H_1: r \geq 2$	0.03	3.84	2.90	3.84
λ_{max}	$H_0: r = 0 \ vs \ H_1: r = 1$	18.60	14.26	19.88	17.15
	$H_0: r \leq 1 \ vs \ H_1: r = 2$	0.03	3.84	2.90	3.84
Food & Soft Drinks - Jam (k=2 ; Criteria: AIC)		-	-	-	-
Food & Soft Drinks – Ice Cream (k=2 ; Criteria: AIC)		-	-	-	-
Food & Soft Drinks – Hard Candy (k=2 ; Criteria: AIC)		**Model 2**		**Model 3**	
λ_{trace}	$H_0: r = 0 \ vs \ H_1: r \geq 1$	30.96	20.26	22.13	15.49
	$H_0: r \leq 1 \ vs \ H_1: r \geq 2$	3.51	9.16	0.42	3.84
λ_{max}	$H_0: r = 0 \ vs \ H_1: r = 1$	27.45	15.89	21.70	14.26
	$H_0: r \leq 1 \ vs \ H_1: r = 2$	3.51	9.16	0.42	3.84
Food & Soft Drinks – CSD with caffeine (k=2 ; Criteria: AIC)		-	-	-	-
Food & Soft Drinks - CSD (k=2 ; Criteria: AIC)		**Model 1**		**Model 2**	
λ_{trace}	$H_0: r = 0 \ vs \ H_1: r \geq 1$	20.87	12.32	21.42	20.26
	$H_0: r \leq 1 \ vs \ H_1: r \geq 2$	7.13	4.13	7.44	9.16
λ_{max}	$H_0: r = 0 \ vs \ H_1: r = 1$	13.75	11.22	13.98	15.98
	$H_0: r \leq 1 \ vs \ H_1: r = 2$	7.12	4.13	7.43	9.16
Food & Soft Drinks - CPI (k=2 ; Criteria: AIC)		**Model 1**		**Model 2**	
λ_{trace}	$H_0: r = 0 \ vs \ H_1: r \geq 1$	40.31	12.32	40.78	20.26
	$H_0: r \leq 1 \ vs \ H_1: r \geq 2$	6.62	4.13	6.86	9.16
λ_{max}	$H_0: r = 0 \ vs \ H_1: r = 1$	33.69	11.22	33.92	15.89
	$H_0: r \leq 1 \ vs \ H_1: r = 2$	6.62	4.13	6.86	9.16
Food & Soft Drinks – Chocolate Bars (k=2 ; Criteria: AIC)		-	-	-	-
Food & Soft Drinks - Chocolate (k=2 ; Criteria: AIC)		-	-	-	-

Model 1-no intercept and no deterministic trend
Model 2-no deterministic trend (restricted constant)
Model 3-Linear deterministic trend model
Model 5-allows linear trend in the cointegrating space and intercept in VAR

Table 5: Estimates of long-run & the speed of adjustment from ECM

Model	Regressors	Parameter estimates	t-test
Food & Soft Drinks – Pralines[3]	β	-1.20	-13.86
	ECT_{t-1}	0.06	3.27
Food & Soft Drinks - Jam	β	-	-
	ECT_{t-1}	-	-
Food & Soft Drinks – Ice Cream	β	-	-
	ECT_{t-1}	-	-
Food & Soft Drinks – Hard Candy[3]	β	-1.41	-13.85
	ECT_{t-1}	0.05	4.37
Food & Soft Drinks – CSD with caffeine	β	-	-
	ECT_{t-1}	-	-
Food & Soft Drinks – CSD[2]	β	-0.98	-8.86
	ECT_{t-1}	0.09	2.79
Food & Soft Drinks – CPI[2]	B	-0.97	-8.63
	ECT_{t-1}	-0.01	-0.91
Food & Soft Drinks – Chocolate Bars	β	-	-
	ECT_{t-1}	-	-
Food & Soft Drinks – Chocolate	β	-	-
	ECT_{t-1}	-	-

[2, 3, 4] indicates that the results are derived from model 2, 3, 4 respectively

Table 6: Test of no cointegration versus threshold cointegration (Antonio *et al.*, 2009; Seo, 2006) - *1000 bootstrap*

Retail -	Test Statistic	P-value	Threshold parameter (L)	Threshold parameter (H)
Jam	15.37 (75.65)	0.98	-	-
Ice Cream	7.46 (41.41)	0.69	-	-
Hard Candy	15.62 (49.36)	0.46	-	-
Food & Soft Drinks	14.27 (58.93)	0.59	-	-
CSD with caffeine	18.38 (51.00)	0.45	-	-
CSD	28.29 (77.60)	0.37	-	-
Chocolate Bars	20.36 (60.70)	0.66	-	-
Chocolate	17.05 (71.46)	0.80	-	-
Food & Soft Drinks-				
Jam	16.20 (18.31)	0.17	-	-
Ice Cream	13.00 (22.39)	0.97	-	-
CSD with caffeine	14.99 (24.40)	0.88	-	-
Chocolate Bars	27.36 (41.10)	0.82	-	-
Chocolate	11.50 (20.48)	0.55	-	-

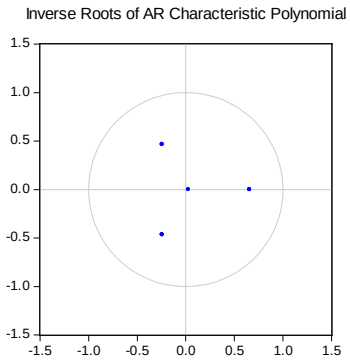
Critical values (95%) are shown in parentheses next to the respective test statistic

Appendix 1: Unit Root tests using the Augmented Dickey-Fuller & Phillips-Perron

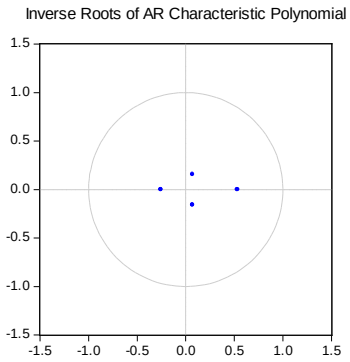
	Augmented Dickey-Fuller		Phillips-Perron	
Variable (price)	Drift	Trend	Drift	Trend
Ex-Factory ('06)	-1.18	0.39	-1.26	-0.29
Δ Ex-Factory ('06)	-6.03®		-6.23®	
Retail ('06)	0.07	-2.00	0.03	-2.03
Δ Retail ('06)	-6.78®		-6.78®	
Retail	-1.16	-1.56	-1.31	-1.66
Δ Retail	-7.02®		-7.02®	
Jam	0.60	-1.22	0.42	-1.37
Δ Jam	-7.43®		-7.77®	
Chocolate	-0.95	-2.58	-0.93	-1.95
Δ Chocolate	-7.92®		-7.81®	
Chocolate Bars	-0.63	-2.32	-0.44	-1.84
Δ Chocolate Bars	-8.21®		-8.23®	
Pralines	0.48	-2.25	0.49	-2.26
Δ Pralines	-12.89®		-12.05®	
Hard Candy	-0.29	-1.38	-0.21	-1.51
Δ Hard Candy	-8.07®		-8.41®	
Ice Cream	-1.11	-1.55	-1.44	-1.83
Δ Ice Cream	-15.18®		-14.85®	
Carbonized Soft Drinks w/ caffeine	-0.81	-2.33	-1.01	-3.12
Δ Carbonized Soft Drinks w/ caffeine	-15.92®		-15.87®	
Carbonized Soft Drinks w/o caffeine	0.66	-1.85	0.91	-1.93
Δ Carbonized Soft Drinks w/o caffeine	-13.09®		-13.03®	
CPI	0.29	-3.05	0.22	-3.10
Δ CPI	-17.47®		-14.32®	
Food & Soft Drinks	-0.56	-2.58	-0.58	-2.33
Δ Food & Soft Drinks	-7.91®		-7.97®	

Lag length for ADF tests are based on SIC.
Maximum Bandwidth for PP tests are decided based on Newey-West (1994)
Critical values are -2.89 (5%), -3.49 (1%) with drift only and; -3.45 (5%), and –3.49 (1%) for a model with constant and trend; -1.94 (5%) and –2.58 (1%) for a pure random walk model (Mackinnon, 1996)
® indicates the pure random walk model

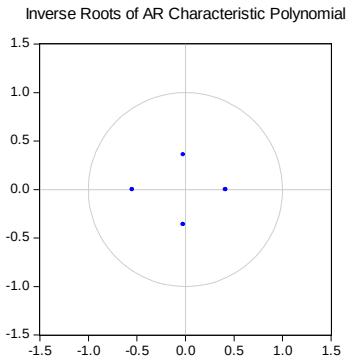
Appendix 2: Inverse Root of AR Characteristic Polynomial



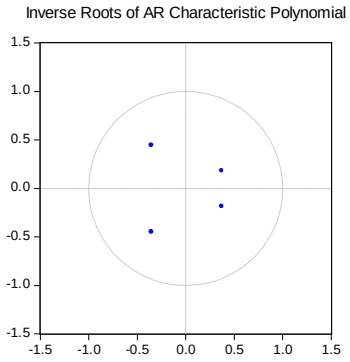
Retail '06 – Ex-Factory



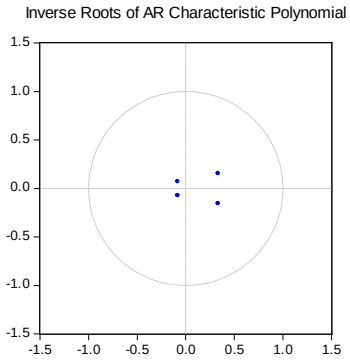
Retail – Hard Candy



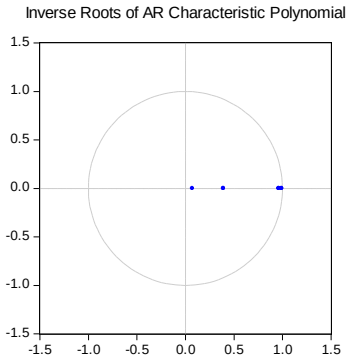
Retail - CPI



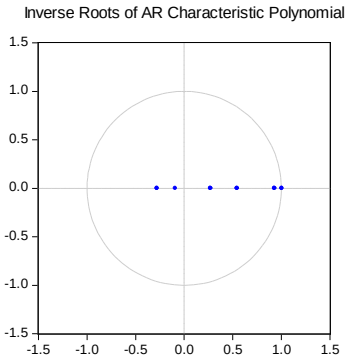
Retail – pralines



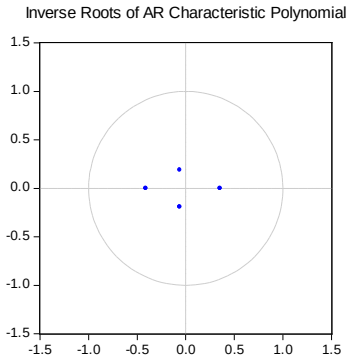
Retail – Food & Soft Drinks



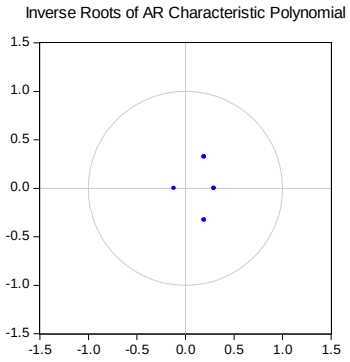
Retail – chocolate bars



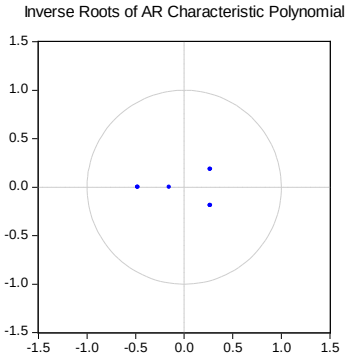
Retail – Jam



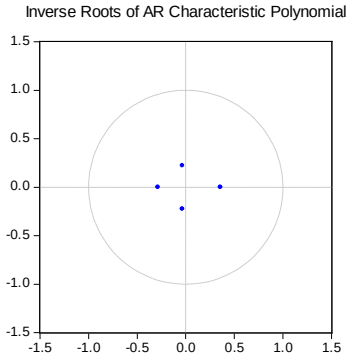
Retail - CSD with caffeine



Retail - Chocolate

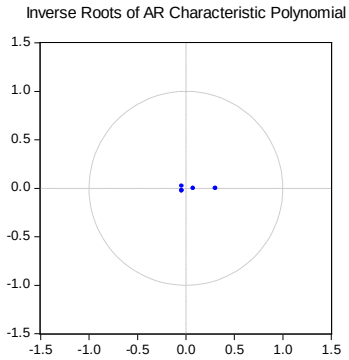


Retail – Ice Cream

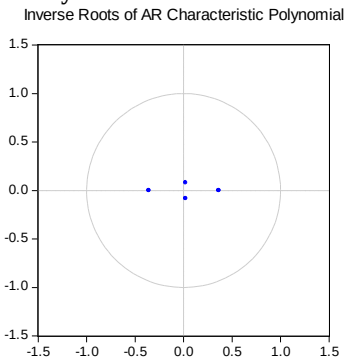


Retail – CSD

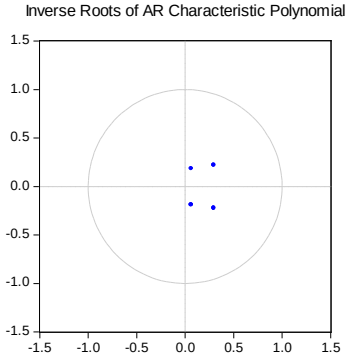
Appendix 3: Inverse Root of AR Characteristic Polynomial



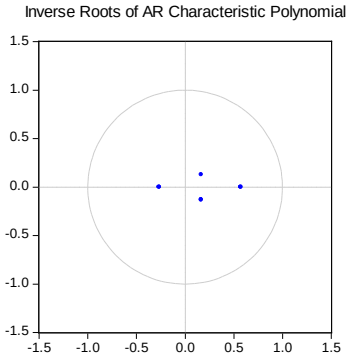
Food & Soft Drinks – Pralines



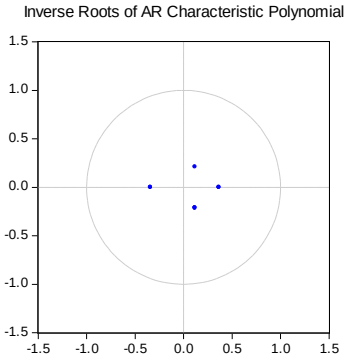
Food & Soft Drinks - CSD with caffeine



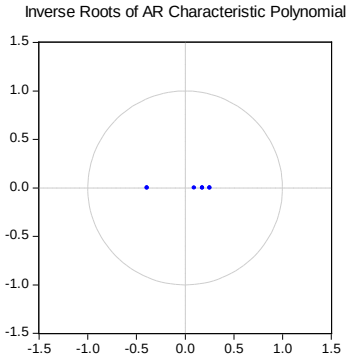
Food & Soft Drinks – Chocolate



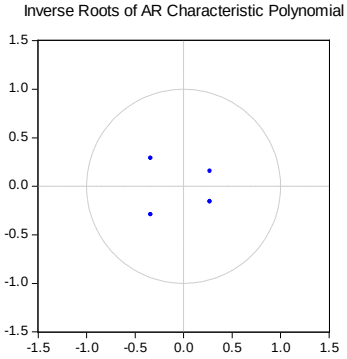
Food & Soft Drinks – Jam



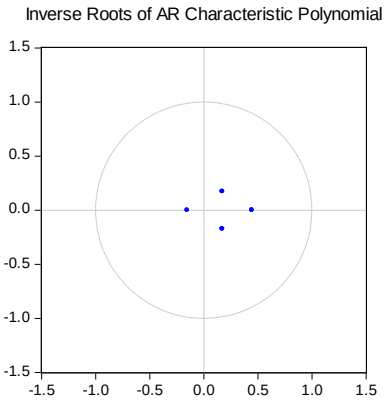
Food & Soft Drinks – CSD



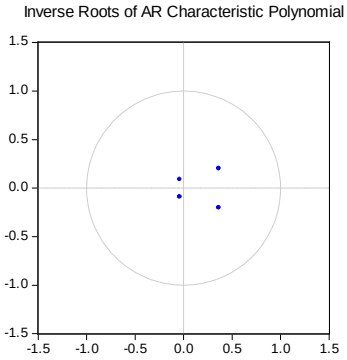
Food & Soft Drinks – Ice Cream



Food & Soft Drinks – CPI



Food & Soft Drinks – Hard Candy



Food & Soft Drinks – Chocolate Bars