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Transaction Costs Between Dry Bean Producer Markets in Brazil

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Introduction

Beans are grown throughout the year in most Brazilian states, providing the market with a constant supply (IBGE, 2012).

Transaction costs restrict the price transmission between bean markets. Transmission only begins to occur when the gains from arbitrage outweigh the transaction costs. If they do not, isolated shocks are not transmitted between markets, determining a situation in which prices are not related (GOODWIN AND PIGOTT, 2001). As the price adjustments that are induced by deviations from the long-term equilibrium can be considered as a linear function of such a deviation, the same very small deviations would lead to an adjustment process in each market (MATTOS et al., 2011).

In determining the cointegration models with a threshold that can be used in the analysis of the integration k market, a traditional relation of cointegration, representing an economic balance, is considered (equation 1).

$$Pit - \beta 2P2t - \beta 3P3t - \cdots - \beta kPkt = Zt \qquad (1)$$

where Pit (i = 1, 2, ..., k) is the price observed in the i-th market at time t, βi are parameters that determine the relation between prices and $Zt = pZ_{t-1}+\varepsilon_t$, representing the derivation from equilibrium in period t. Starting from BALKE AND FOMBY (1997), MATTOS et al. (2010) extended the basic structure of cointegration between variables for the case in which Zt follows an autoregressive process with a threshold (equation 2).

$$p = \begin{cases} p(1), if\ [Zt-1] \leq \gamma \\ p(2), if\ [Zt-1] > \gamma \end{cases} \qquad (2)$$

where γ represents the threshold that limits the alternative similarly and e p (j), (j = 1,2) indicates that p varies according to the treatment applied.

The cointegrating non-linear process specified in equation 2 is, as the co-linear integration, broadly stable. The range $[Zt-1] \leq \gamma$ becomes a locally unstable process.

Thus, this study aimed to broach an application of the threshold cointegration models to analyse the integration process of the national bean market.

Material and Methods

The TAR models are applied to the major regional markets for beans in Brazil. The TAR models used in the present study follow the specification presented and used by GOODWIN AND PIGOTT (2001) and MATTOS et al. (2010) (equation 3):

$$\Delta Zt = \begin{cases} \lambda(\text{internal})Zt - 1 + V1t, \text{if } [Zt-1] \leq \gamma \\ \lambda(\text{external})Zt - 1 + V2t, \text{if } [Zt-1] > \gamma \end{cases} \qquad (3)$$

where *Zt* is the residue of the cointegration relationship between the prices that are estimated between pairs of markets. The TAR models defined (3) have two regimes.
For the econometric estimation of the model presented previously (3), the study follows the model proposed by HANSEN (1999). The first step consists of the analysis of integration among the markets studied.
The determination of the parameter γ (2nd step) follows that proposed by BALKE AND FOMBY (1997). The parameter consists of initially sorting the data according to the value of the variable threshold and *Zt-1*, as highlighted by MATTOS et al. (2010), rather than arranging them over time, giving rise to what is known in the literature as ordinary autoregression.
The third and final step in estimating the TAR model is equivalent to a test of statistical significance of the presence of a threshold effect. This entire process can be performed through the statistical Sup-Wald F12, proposed by HANSEN (1999) (equation 4).

$$F12 = T[\frac{S1-S2}{S2}] \quad (4)$$

where T is the sample size and S1 and S2 are respectively the sum of markets of the residuals of the AR and TAR models.
This study also aims to estimate the half-life, which is the time required for half of the deviation of the ratio of cointegration to be eliminated. This calculation is performed using equation 5.

$$mv = ln(0{,}5)/ln(1 + \tau) \quad (5)$$

In the equation 5, *ln* is the natural logarithm and τ is the autoregressive coefficient of the first order in (3) (GOODWIN AND PIGOTT, 2001; MATTOS et al., 2010).
The analyses are bivariate. We analysed pairs of markets, so it is necessary to establish a functioning market as the central market. This market acts as the central price setter.
In markets in which a space is considered with *n* markets to test whether a number *i* price is weakly exogenously influenced, the study tests the null hypothesis that all the coefficients of the line corresponding to the i-th price are statistically equal to zero, as in equation 6.

$$H0 = \propto i1 = \propto 12 = \propto 13 = \cdots = \propto in = 0 \quad (6)$$

for all *i*, where *i* = 1,2, ..., n. The *i* price series is weakly exogenous if the hypothesis is not rejected.
We used bean price series in the wholesale market, in which the spatial arbitrage, which is the factor leading to regional markets' integration, occurs at this stage of the marketing process. The trading activities of beans in the wholesale market are more concentrated in specific localities, while producer markets are generally in the producing areas.
Eight production markets are considered in this study: Unaí (MG), Cristalina (GO), Castro (PR), Paracatu (MG), Euclides da Cunha (BA), Prudentópolis (PR), Brasília (DF) and Luziânia (GO). They represent the largest bean-producing municipalities of Brazil (IBGE, 2012). The data used are considered in their natural logarithms and are of daily frequency; we consider the period 2003-2011.

Results and Discussion

We determined the variable integration test by Dickey-Fuller GLS (DF-GLS) (ELLIOTT et al. (1996). The results show that all the series are, at a significance level of 1%, integrated of first order, i.e. I (1).
After identifying the central market, the test of cointegration between bean prices is performed. The test is performed for the seven pairs of markets, formed by the combination of the central market and each of the other markets considered in the analysis. The results indicate that the prices in all the markets are cointegrated with the price in Paraná. This result suggests an inverse relationship between the physical distance between the markets of Paraná and the degree of interdependence of prices in the long run. Markets that are at a greater distance from Paraná have fewer market-related prices than that state.
After obtaining the cointegrating relationships and their residuals, the estimation of threshold autoregressive (TAR) models is carried out, as specified in equation (4), as well as models (linear)

that do not consider the effects of transaction costs. We adopt the hypothesis that the transaction costs are higher in some markets than in others, depending mainly on the freight component, because it is directly related to the distance between the areas analysed. The results are shown in Table 1.

Table 1: Estimates of autoregressive models (AR) and threshold autoregressive (TAR) models for residuals of the relations of cointegration between Paraná and the other markets, for the period 2003–2011.

Market	AR Models		Threshold γ	TAR Models (Internal System)			TAR Models (External System)			Hansen Test
	λ	Half-Life (Days)		$\lambda^{internal}$	Obs.	Half-Life (Days)	$\lambda^{external}$	Obs.	Half-Life (Days)	Hansen Test (F_{12})
Unaí	-0.03267* (0.003543	11	0.1573	-0.55578* (0.437890)	256	16.7	-0.01576* (0.004067)	142	11.5	47.67* (0.0007)
Cristalina	-0.06800* (0.034658	24	0.0097	-0.46902* (0.218790)	1279	13.8	-0.16780* (0.042350)	786	17.8	2.56* (0.5643)
Castro	-0.04789* (0.038562	19	0.1265	-0.04678* 0.010019	345	-	-0.20898* (0.052198)	120	12	33.45* (0.0005)
Paracatu	-0.05326* (0.003516)	18	0.1738	-0.44537* (0.178060)	167	-	-0.03428* (0.007694)	144	15.3	30.80* (0.0005)
Prudentópolis	-0.01345* (0.005487)	20.5	0.1487	-0.02987* (0.043786)	888	20	-0.06765* (0.004567)	144	15	6.76* (0.5309)
Euclides da Cunha	-0.06349* (0.054390)	19.1	0.1768	-0.02764* (0.014768)	809	29.4	-0.05564* (0.004534)	564	17.4	34.05* (0.0005)
Brasília	-0.01480* (0.005462)	21	0.0043	-0.47040* (0.543200)	134	17	-0.02393* (0.005760)	376	17.5	7.08* (0.0392)

(1) The internal (external) regime is defined by the observations of which the deviations from equilibrium relationships, lagged in one period, in absolute values ([Zt-1]), are smaller (larger) than the value of the *threshold* parameter (γ);
(2) Test of the null hypothesis that the appropriate model is an AR (linear) model against the alternative hypothesis of a TAR with two regimes, from the Sup-Wald statistic F_{12}; the figures in brackets refer to the standard errors of the statistical estimated parameters;
The values in brackets refer to the statistical *p*-value of F_{12} obtained from the *bootstrap* to waste, 2,000 simulations, according to the procedure proposed by Hansen (1999);
* Significant at 1%.

The first results presented are related to the estimation of linear AR models. The specification presents the autoregressive coefficients of the first order (λ). The tests of the autoregressive coefficients of the estimated AR models are all significant at the 1% level.
The largest half-lives are associated with the more distant markets from Paraná, Bahia (38.8) and Goiás (26.3). The large amount of time required is consistent with the results of the tests showing the absence of cointegration between the prices of Bahia and those of Paraná. As for the markets that are present in Goiás, 24 days are required, so the value can be considered high, although for the markets of Goiás there is no cointegration with the markets of Paraná.
In relation to the inverse greater half-lives, which are considered the most distant from the lower half-lives, they are associated with the closest markets. As Paracatu (MG) has a half-life of 18 days and Unaí (MG) has 11 days, a shock in respect to cointegration is eliminated. The exception of a significant positive relationship between the distance to the central market and the half-life is Cristalina (GO), which has a high half-life in relation to the other markets in the central market. One can attribute this effect to the fact that Cristalina (GO) is a city with large bean production; therefore, the region may have the greatest potential supply of beans.
Regarding the autoregressive coefficients of the internal regime, they are not statistically significant for the more distant squares from Paraná, such as Cristalina and Euclides da Cunha. However, when the deviations are relatively small, there is no cointegration between the prices of Paraná and those of each of these markets.
Regarding the calculated half-lives, it is clear that they are positively related to the distances between the markets and the city of Castro. Under the internal system, for the markets closest to Paraná, such as Unaí and Paracatu, the time required for half of a shock in respect of cointegration to be eliminated is about 17 days less than the time required for distant markets such as Euclides da Cunha, with 30 days. In the external system, the largest half-lives refer to Cristalina, Euclides

da Cunha and Brasília, which are markets located at greater distances from the central market. Those with smaller half-lives are Unaí and Castro, with an average of 12 days. These results are consistent, therefore, with the hypothesis of positive transaction costs related to the distance between markets.

These findings point out that, like the results obtained by GOODWIN AND PIGOTT (2001), CAMPENHOUT (2007) and MATTOS et al. (2010), the adjustments for possible deviations from equilibrium relationships not occurring with long-term external arrangements are significantly faster than those that occur in the internal system. Another point also highlighted by the authors is that the model with a threshold (TAR) presents adjustments faster than the AR model, which ignores the presence of the threshold.

The last column listed in Table 1 shows the linearity Hansen test, used to test the statistical significance of threshold effect, i.e. the significance for the model of the non-linear model imposed by the TAR. The threshold model, with the results being significant at the 1% level, is the most suitable.

Conclusions and Outlook

The results of the application of TAR models and the analysis of price transmission between regional bean markets suggest the presence of market transaction costs. These costs may occur mainly in the freight component, and may be positively associated with the distance to markets.

Actions like improvements in the transportation and communication infrastructure and reductions of fees and cash expenses as well as removing the technical trade barriers may contribute to increasing the market integration, thereby allowing the transaction costs to be reduced and markets to become more competitive.

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