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*O Administrador da Contemporaneidade: desafios e perspectivas*

## **Production management in the Corn Belt of the United States: implications for Brazil**

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### **Introduction**

The corn crop in America dates from about five thousand years before Christ. Its importance as a primordial element of Agricultural Policy and Food Security of almost all countries of the world, including Brazil. In 2010, world production was just over 800 million tons according to the United States Department of Agriculture (USDA, 2014), and the United States and China account for 60% of total production harvested. Corn production in Brazil reached the level of 71.1 million tons, representing an increase of 27.7% over the previous, surpassing traditional soybeans (CARISIO, 2013).

The main objective of this study was to investigate, on the basis of existing data and research and quantitative analysis, the U.S. corn competes on equal terms to the national product or involves unfair practices in international agricultural trade as well as if it is an injury or threat of injury for the agro-industrial chain of corn in Brazil. It is considered that the results can be a contribution to the knowledge of the impact of imports of U.S. corn on the level of prices of Brazilian products in the international market.

The vector operation of said objectives is established in two ways, namely: (i) promotion of investment in research, teaching, technology and extension in the levels of secondary and higher education as well as rural credit system to boost agro-industrial production; (ii) market intervention aimed at stabilizing farm prices and ensure minimum income for farmers.

For the U.S., so the corn production is a concept of internal and external security of its agricultural policy. Agricultural subsidies to corn show up thus another way of adjusting own dynamic industry of new economic agents on the world market, particularly Brazil, China and Argentina. The terms of economic policy, institutional and legal acquired by the country in recent years are making it an active and important actor in international trade both in the hemispheric sense South - North and South-South (VALLEJO, 2010).

Brazilian corn production is 71.1 million tons of corn, of which 21 metric tons are for export (USDA, 2014). The level of ending stocks of Brazilian corn is grown sustainably in recent years, despite the environmental agents to act forcefully in this productive sector. According to the BNDES (*Banco Nacional de Desenvolvimento Social*, Brazil), the growth of the Brazilian corn production can be attributed to the productivity gains achieved over the last decade (BNDES, 2014). The storage system needs adjustments and the transportation system of the Brazilian corn is one of the obstacles to improved competitiveness of the country in international agricultural scenario because estimate of subsidies (corn) and impacts on Brazilian exports and loss of revenue from exports of Brazil because only the reduction in the world price.

This is due mainly to the recent increases in the international price of this grain as well as the lack of progress in the Doha Round and the creation of a new North American agricultural law, in addition to the adverse climatic effects on corn producing region.

### **Theoretical framework**

Multivariate simultaneous equations models are widely used for microeconomic analysis when Sims (1980) called this vector auto regression model (VAR) and alternative (ENDERS, 2004) because it reduces the entropy of the data. Such macroeconomic time series models that describe the dynamic variable structure are suitable for this purpose because it allows high sphericity of the data. Generally, treatment of all variables occur endogenously because restrictions, including exogeneity of some variables can be imposed based on the statistics of the VAR models. Therefore, to represent the critical Sims, the assumptions of exogeneity for some of the variables in simultaneous equations models are ad hoc and often do not rely on fully developed theories.

The level of causality, understood as a relationship between economic variables, captures the mechanical there between so as to define the direction of this causality between variables (SUMNER, 2011). Its structure, boundary conditions, incorporation of maximum cross-entropy and generalized data as well as the application of verification and correction tests of heterogeneity in the treatment of their behavior make the vector more consistent analysis of economic trajectory for mitigation computable general dynamics of the evolution of U.S. agricultural subsidy to corn production. The pooling of the data is attenuated.

VAR models are natural tools for economic forecasting Its configuration is such that the current values of a set of variables are partly explained by past variables involved contributing to the economic analysis values because they describe the mechanism of cogeneration of variables involved (GALLEGO, 2007). Structural VAR analysis tends investigates the hypothesis of economic structure with the impulse response, the variance of the forecast error decompositions and historical projection scenarios and analyzes breakdowns are tools that have been proposed to understand the relationships between variables in a model VAR (Tokgoz et. al., 2006).

### **Research method**

In this work each time series are collected in  $K = y_t (Y_{1t}, \dots, y_{kt})'$ , given the importance of distinguishing between stochastic and deterministic components of the DGP (CLARK, 1999) of economic variables, it is convenient to separate the two components, assuming that:

$$y_t = \mu_t + x_t \quad (1)$$

where  $\mu_t$  is the deterministic part and  $x_t$  is a purely stochastic process with zero mean. It is a deterministic linear trend type  $\mu_t (\mu_t = \mu_0 + \mu_{1t})$  and can also be zero ( $\mu_t = 0$ ) or simply a constant ( $\mu_t = \mu_0$ ) for simplicity.

Terms of deterministic trend have not plausible implications in the context of the prediction. Therefore, they are not recommended for use in VAR analysis. The purely stochastic part  $x_t$  can be I (1) and, therefore, may include stochastic trends and relationships of co-integration. Usually means zero and represent a VAR. Processes observable properties are determined by

$y_t$  and  $x_t$ ,  $\mu_t$ . In particular, in order that the relationships of co-integration and the integration are determined by  $x_t$ , it is assumed that the stochastic process starts at  $x_t$  is a VAR process of order  $p$  [var (p)] in the form:

$$x_t = A_1 x_{t-1} + \dots + A_p x_{t-p} + u_t \quad (2)$$

where  $A_i$  ( $i = 1, \dots, p$ ) are: ( $K \times K$ ) matrix of parametric procedural errors  $u_t = (u_{1t}, \dots, u_{Kt})'$  is a  $K$ -dimensional zero with the white noise process with covariance matrix  $E(u_t u_t') = \Sigma_u$  matrix, in the other worlds,  $u_t \sim (0, \Sigma_u)$ . Using the delay operator and the definition of the operator polynomial matrix  $A(L)$  to  $A(L) = I_K - A_1 L - \dots - A_p L^p$ , the process (1.2) can be equivalently written as:

$$A(L)x_t = u_t \quad (3)$$

The process VAR (2) / (3) is stable if and only if:

$$\det A(z) = \det (I_K - A_1 z - \dots - A_p z^p) \neq 0 \text{ para } z \in C, |z| \leq 1 \quad (4)$$

In other words,  $x_t$  is stable if all the roots of the polynomial determinant are outside the unit circle complex. In this case,  $x_t$  is  $I(0)$ . The data presented below pooling and the process is with the stationary variance and covariance.

However, if  $\det A(z) = 0$  for  $z = 1$  (that is, the process has a unit root) and all other root of the determinant polynomial are outside the unit circle of the complex, the variables are then incorporated and the process takes the non-stationary nature: the variables are  $I(0)$  or  $I(1)$  by default. Moreover,  $x_t$  is the stochastic part (usually unobserved) while  $y_t$  is the vector of observed variables. Pre-multiplying (1.1) by  $A(L)$ , that is, as  $A(L) y_t = A(L) \mu_t + u_t$ , **it is shown that  $y_t$  inherits the representative form of the VAR<sub>(p)</sub> $x_t$ .**

A VAR model of first order of integration and correlation of two variables (ENDERS, 2004) assumes the following mathematical format:

$$\begin{aligned} Y_{1t} &= m_1 + a_{11} y_{1,t-1} + a_{12} y_{2,t-1} + x_{1t} \quad (5) \\ Y_{2t} &= m_2 + a_{21} y_{1,t-1} + a_{22} y_{2,t-1} + x_{2t} \end{aligned}$$

To test the possibility of cointegration between variables of the same order of integration of the maximum likelihood test developed by Johansen (1988) is used as a mathematical tool. The proof can be seen as a generalization of the test environment for the Dickey-Fuller multivalent (ENDERS, 2004).

### Results, conclusions and implications of study

Table 1 shows the effects of the elimination of U.S. subsidies on the world price of corn. It is observed that the elimination of subsidies could have increased world prices of maize in 9% (2006) and 21% (2009) at the upper limit and the lower limit between 5% and 6% for the historical period. The average for the period was 14.3% and 4.4% higher and lower respectively. The price elasticity of U.S. demand was considered equal to world demand and its variation is negligible.

The impact on global corn prices brought about by the level of domestic prices has asymmetric Granger causality since the difference between price levels is caused by tariff barriers between nations. The levels of national and international corn prices are co-integrated and the series are not stationary.

**Table 1.** Effects of the elimination of U.S. subsidies on the world price of corn.

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
$\delta_{su}=0,1$ (Upper)	-0,12	-0,15	-0,15	-0,09	-0,10	-0,17	-0,21	-0,13	-0,16	-0,15
$\delta_{su}=0,01$ (Less)	-0,05	-0,03	-0,07	-0,05	-0,04	-0,06	-0,02	-0,04	-0,03	-0,05

Parameters used in the estimation:  $\gamma = 0.7$ ;  $\delta_{su} = 0.02$ ;  $\epsilon_u = 0.8$ ;  $\epsilon_y = 0$ ;  $\eta_u = -0.01$ ;  $\eta_y = -0.01$ .

Source: Prepared by the authors. Search results, 2014.

The Table 2 shows the effects of the elimination of U.S. subsidies on world production. It is observed that the elimination of domestic support programs in the U.S. could have reduced global production from 11% (2006) and 28% (2009) with upper and 12% and 30% at the lower limit. The average for the period 2003-2012 was 18.9% and 17.8%, respectively, to the two limits. Some simulations varying the value of the coefficient were performed, but the results did not vary significantly, demonstrating the model fit to the level of 88% ( $R^2 = 0.88$ ).

The demand varies on the scenario used. This variable could have been reduced from 3% to 4% and the upper limit from 0.02% to 0.04% in the lower, depending on the years considered. As the upper limit results in a greater impact on the world price of corn, this entails a further reduction in U.S. consumption. Exports were 12% (2004) to 28% (2009) with upper and 12% (2004) to 30% (2009), the lower limit. The lapse of time was chosen because of its relevance.

**Table 2.** Effects of the elimination of U.S. subsidies on world corn production

Year:	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
<b>Levelofdomesticproduction</b>										
$\delta_{su}=0,1$ (Upper)	-0,17	-0,12	-0,15	-0,24	-0,27	-0,29	-0,21	-0,27	-0,18	-0,13
$\delta_{su}=0,01$ (Less)	-0,16	-0,09	-0,12	-0,24	-0,27	-0,29	-0,02	-0,27	-0,18	-0,13
<b>Levelofdomesticdemand</b>										
$\delta_{su}=0,1$ (Upper)	-0,03	-0,03	-0,03	-0,03	-0,04	-0,04	-0,04	-0,04	-0,03	-0,03
$\delta_{su}=0,01$ (Less)	-0,004	-0,002	-0,003	-0,003	-0,002	-0,004	-0,004	-0,004	-0,002	-0,002
<b>Levelofexports</b>										
$\delta_{su}=0,1$ (Upper)	-0,24	-0,12	-0,12	-0,11	-0,22	-0,26	-0,28	-0,26	-0,16	-0,12
$\delta_{su}=0,01$ (Less)	-0,24	-0,12	-0,12	-0,12	-0,24	-0,28	-0,30	-0,04	-0,18	-0,14

Parameters used in the estimation:  $\gamma = 0.7$ ;  $\delta_{su} = 0.02$ ;  $\epsilon_u = 0.8$ ;  $\epsilon_y = 0$ ;  $\eta_u = -0.01$ ;  $\eta_y = -0.01$ . Source: Prepared by the authors. Search results, 2014.

The lower level of corn exports presents a generalized entropy and distortion of the data displayed in the period considered by the small difference between the average ranges (1.1%). This demonstrates causality between subsidies and high level of exports of U.S. corn justified by the simultaneous estimation of equations with auto-correlation through a test with  $\chi^2$  distribution with probability of 84% near until de top that is 100% (GUJARATI, 2010).

The results of the economic analysis presented in this study indicate that there may have been significant impact of U.S. subsidies on the world price of corn in the last decade. Assuming that the U.S. representing 35% of the world market with the potential to influence prices, the average annual effect of subsidies in 2003-2012 was depressed international prices by about 9% (ranging from 12% in 2003 and 21% in 2009). The U.S. represent the largest worldwide production, the average annual effect on the same period was price suppression in 14.3%.



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However, one should also take into account the fact that the U.S. share of world corn exports declined in the last 05 years.

Given the low prices of corn in the U.S. market and relatively stable international prices, the dumping margins remain the same over time and cannot demonstrate that there is an unfair international trade practices through prices for corn, since the subsidies are diluted and uniformly distributed to farmers and indistinct manner. Regarding perspectives on progress in reducing U.S. subsidies to corn is unlikely a concrete and reasonable prediction on this political aspect.

In the case of a lowered for corn and kept the current level of U.S. subsidies for this crop international price scenario the gains from this trade to Brazil suffer considerable reduction in both the price level as the profit level by transmitting effects of economic integration in the international market model .

At current levels of corn prices in the international market, Brazil suffer considerable reduction in both the price level as the profit level by transmitting the economic effects of market integration. Brazil is directly affected by these effects because it is a competitive agent in this trade, directly reflected in increased production area.

As for net spending of the U.S. government the trend is that there is a rise in subsidies and insurance in corn as the costs of storage and commercial utility parameters are considered in U.S. agricultural policy. Payment for Production affects the product offering, increasing it. This countercyclical policy tends to raise levels of agricultural subsidies (crop insurance, disaster, direct payments to producers, etc.) - causing the domestic price level decays while the international price suffers this causality since the U.S. is the world's largest product of this grain.

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