

# **INTERVENTION MODELS APPLIED TO MEASURE SANITARY AND TECHNICAL BARRIERS TO TRADE**

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# INTERVENTION MODELS APPLIED TO MEASURE SANITARY AND TECHNICAL BARRIERS TO TRADE

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## ABSTRACT

This research develops a methodology to evaluate quantitatively non-tariff barriers impacts (technical and sanitary) on the quantities and prices of Brazilian beef foreign sales. The preliminary analysis was implemented for the period from January/1992 through December/2000, considering two specific markets: European Union market for special beef cuts (chilled or frozen) and the United States market for *corned beef*. The basic hypothesis considered was that technical/sanitary issues influence the Brazilian beef exportation. The impact of such influences is expected either on transaction volumes, prices or both. A reduced form model was built to explain the sales of external products. Intervention models were applied to the data set to obtain impact estimates directly on prices and quantities series and establish the intervention influence pattern. Results show that a great part of foreign sales (volume and price variations) were due to market fundamental variables. In the intervention model analysis for special cuts, the 1995 March point was significant, indicating a reduction effect on those product prices, for three months. This effect can be related to the embargo of European imports to Brazil's beef exports, during that period. In general, results suggest that interventions related to sanitary events were not significant or conclusive for this period.

## INTRODUCTION

The measurement of sanitary and technical trade barriers impacts on goods and services of developing countries is a challenge, considering direct effects on their exports or even their consequences on the income and employment. Economists have applied econometric tools to quantify the trade impacts of these barriers. There are few studies evaluating quantitatively the sanitary and technical impacts of trade on developing countries, especially in Brazil.

The bovine meat sector has, by their own nature, products for which trade flow is strongly affected by effects of technical and sanitary rules and patterns. The hypothesis is that sanitary and technical events affect Brazilian beef exports, on quantity or prices, or even on both.

Meat exports ranked 6<sup>th</sup> among the main Brazilian exporting goods in 2005, when the country sold about 2.4 million tons beef on carcass-equivalent, which resulted US\$ 3.15 billion (ABIEC, 2006). Since 2004, Brazil became the major world beef exporter. Figure 1 shows the exports of the ABIEC associate companies, which were responsible for 67 percent of the whole Brazilian beef sold in 2005.

The USA, Australia, New Zealand, Argentina and the European Union are the main world Exporters. Some of them are Brazilian competitors and others potential buyers. There are great differences between the South and North Hemisphere production costs in this sector, which could encourage trade, but the meat market is highly regulated and protected (Gordon, 2000).

It is interesting to point out that Argentina is a Brazilian competitor in the European and Chilean markets, for fresh and chilled beef, and in the US, for processed products. Suppliers differently perceive differentiation in quality but they should also be associated to the consumer preferences. Countries, such as Australia, New Zealand, Canada, USA, Japan and South Korea belong to the Pacific Rim region. These countries face better prices in the international beef market, because of the high quality of the goods tradable. Moreover, these countries do not buy meat products from countries where Food and Mouth Disease (FMD) has not been eradicated. Differently from Brazil, Argentina and Uruguay have access to these markets.

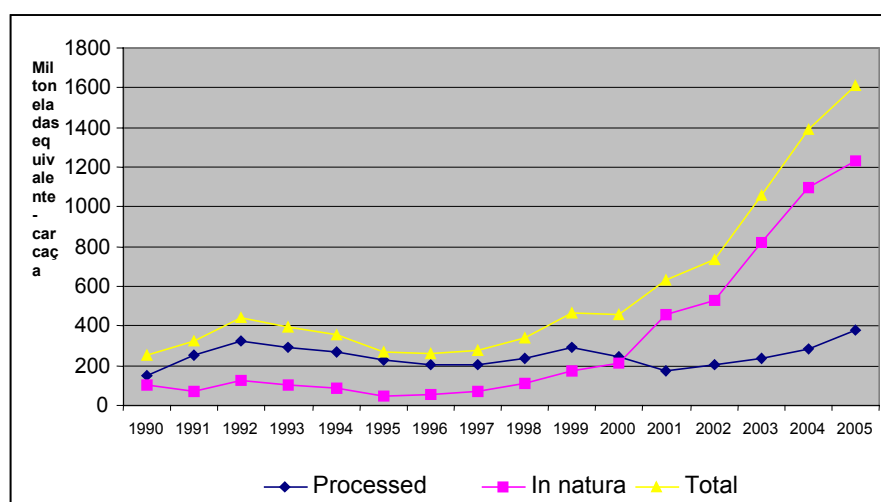


Figure 1 – Brazilian beef exports, by type (1000 thousand tons carcass-equivalent). 1990 to 2005. Source: ABIEC.

As for the processed beef, Brazil is the world-leading exporter, and its production is concentrated in a few slaughterhouses. The United Kingdom and the USA are the two largest Brazilian importers. The corned beef, which is the most important kind of processed beef traded, has a very stable world market. US market is considered a reference in quality and price.

The Beef market is heavily protected all around the world by tariff-quotes, several import licensing mechanisms, guaranteed prices, production subsidies and exports subsidies in developed countries. Over the 90's, sanitary issues became more relevant to determine trade features. Moreover, the financial damages caused by diseases outbreaks can result in great influence on changes in the behavior of the consumers, politics and commerce (Willis, 2000).

This study measures the impacts of sanitary or technical events, in particular on the Brazilian beef exports. The econometric model was applied to the Brazilian beef export

sales, for the period of 1992 through 2000 and its residues were analyzed using a time series intervention model.

## REVIEW OF TRADE BARRIERS

The discussion of sanitary and technical barriers applied to agribusiness tradable products is basically carried out on the background of the Sanitary and Phytosanitary (SPS) and the Technical Barriers to Trade (TBT) multilateral Agreements (WTO). The SPS provisions deal with some of the most important principles to protect human, animal and plant health and food safety. Moreover, SPS establishes the regionalization and the equivalence provisions, which are useful tools to facilitate world trade. The TBT goal is to prevent technical requirements of creating unnecessary barriers to trade and handle also with origin certification, environment protection, residues, conformity assessment procedures, traceability, among other issues.

These two references encourage countries to adopt international patterns developed by international scientific organizations, such as the *Codex Alimentarius* Commission, the Office International for Epizootics and the International Protection Plant Convention (IPPC).

Brazilian products (including beef) face a large diversity of requirements imposed by importers due to the difficulties in harmonization, as well as the resistance to accept international references on sanitary and technical aspects. This situation boosts the costs of products adjustment, resulting in more bureaucracy, difficulties in identifying regulation requirements in different countries and so on. It also contributes to a misapplication of technical and sanitary measures that would go far from the justified objectives of human and animal health and thus shaping a non-tariff kind of trade barrier.

Taking in consideration the technical requirements by Brazilian importers, the slaughter sector was one of the most directly affected (Ferraz Filho, 1997). The sampled firms<sup>1</sup> considered sanitary rules a very important obstacle to their exporting growth rates. Procópio Filho (1994) carried out a survey on Brazilian private sector and revealed that sanitary and environmental requirements are perceived as a way to decrease prices in negotiation. Lima, Miranda & Galli (2005) showed that Brazil has been out of a beef market amounted to US\$ 7.5 billion in 2004, which includes the Pacific Rim countries, because of its the FMD status.

There are some tools proposed by economic literature to deal with non-tariff barriers impacts on trade. Partial equilibrium models, General Equilibrium models, frequency indices, case studies are reviewed. Some economists such as Laird (1996) and Beghin and Bureau (2001) presented a survey of these mathematical models.

Occurrences which effects are non-directly quantified (e.g. a sanitary new rule) can be handled in econometric models using dummy variables. As alternative, it is also possible to evaluate this kind of event applying time series methods, through intervention models and using intervention variables to explain specific occurrences identified in a time series

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<sup>1</sup> All state capital owned and with foreign background.

data behavior. This paper studies new approaches to evaluate the effects of technical barriers on trade. However, one must note that a detailed knowledge of the selected market, about the relation among determinants of the time series and even about the specific occurrence (or barrier) is a previous condition to be successful using this kind of methodology.

## ECONOMETRIC MODEL

The model for Brazilian beef exports is presented in Miranda (2001). The basic structural model, which generated the estimated forms, is described above. Moreover, two assumptions were made: the imported good is not a perfect substitute considering the domestic market and there is no perfect substitution in the international market between beef from other countries and the Brazilian one.

Related to the foreign market, a structural model for the supply and demand for Brazilian exports is outlined as follows:

$$S_I = f(P_I, P_B, W_I) \quad (1)$$

$$D_I = g(P_I, Y_I) \quad (2)$$

Where:

Eq. 1 shows the domestic beef supply;

Eq. 2 shows the domestic demand for beef;

$S_I$  = volume of beef supplied by domestic market;

$P_I$  = domestic price for Brazilian beef (in Real currency - R\$);

$P_B$  = Brazilian beef exporting price (R\$);

$W_I$  = domestic supply shifts;

$D_I$  = quantity of Brazilian beef demanded in the domestic market;

$Y_I$  = shifts of domestic demand of Brazilian beef;

Concerning the international market, the supply and demand for Brazilian beef exports is outlined as follows:

$$X_S = S_I - D_I = f(P_I, P_B, W_I) - g(P_I, Y_I) = h(P_I, P_B, W_I, Y_I), \quad X_S \geq 0 \quad (3)$$

$$X_D = m(P_B/TC, P_W, Z_D) \quad (4)$$

In which:

$X_S$  = volume of Brazilian beef supplied to the international market;

$X_D$  = volume of Brazilian beef demanded by the international market;

$TC$  = exchange rate (R\$/US\$);

$P_W$  = beef price of competitors in the international market (US\$); and,

$Z_D$  = shift of the foreign demand of Brazilian beef.

If  $P_X = P_B/TC$ , then  $P_X$  is expressed in US\$ price of the exported Brazilian beef.

In a balanced international market, the Brazilian exports follow eq. 5:

$$X^* = X_S = X_D \quad (5)$$

In which  $X^*$  is the equilibrium quantity negotiated in the international market, or the Brazilian foreign sells.

Hence, substituting expressions (3) and (4) into (5), then:

$$X^* = h(P_I, P_B, W_I, Y_I) = m(P_B/TC, P_W, Z_D) \quad (6)$$

Therefore, the equilibrium price for foreign sells  $X^*$  is a function that can be expressed by:

$$P_B = p(P_I, W_I, Y_I, TC, P_W, Z_D) \quad (7)$$

And the equation for exports volume is a function of:

$$X^* = H(P_B, P_I, TC, W_I, Y_I, P_W, Z_D) \quad (6')$$

If the demand for Brazilian beef in the international market ( $X_D$ ) is perfectly elastic, the quantity supplied by Brazil in the international market is given by eq. 3.

The international demand for the national product can be expressed by:

$$P_X = P_B/TC = h(P_W, Z_D) \quad (4')$$

Hence, in the case of an international demand perfectly elastic for the Brazilian beef, the expression (4') indicates a price function, in which the Brazilian beef volumes exported is expressed by eq. 6''.

$$X_S = G(P_I, P_W, TC, W_I, Y_I, Z_D) \quad (6'')$$

Ordinary least square estimation method was used to estimate the functional model forms given by the reduced equations of the structural model presented above (eq. 4' and 6'').

The residuals were observed in order to identify the effects of selected interventions (events that can be associated to non-tariff barriers). A possible situation of a non-perfectly elastic international demand will be appraised. For this purpose, variables related to beef domestic demand and supply will be considered in the model above (eq. 7).

The time series approach seek to elucidate the intervention effects directly by the own data generating process. Basically, considering some stochastic process  $Z_t$  then (Jenkins, 1979; Vandaele, 1983):

$$Z_t = U_t + N_t \quad (8)$$

where,  $U_t$  is  $Z_t$ 's share explained in terms of  $X_t$  (the explanatory variable responsible for part of the changes occurred in  $Z_t$ ) and  $N_t$  is the error term (residue), representing all the variables not included in the model. Regarding the relation between  $U_t$  and  $X_t$ , the lag  $\mathbf{b}$ , which is the moment the explanatory variable starts to influence  $U_t$ , yields the following transfer function:

$$U_t = c + \frac{w_0 - w_1 B - \dots - w_l B^l}{1 - \delta_1 B - \dots - \delta_m B^m} X_{t-b} = c + \frac{\omega(B)}{\delta(B)} X_{t-b} = c + V(B) X_t \quad (9)$$

The transfer function  $V(B)$  comprises a moving average operator  $\omega(B)$  with  $l$  terms; an autoregressive operator  $\delta(B)$ , with  $m$  terms; and a lag parameter  $b$ , describing the whole number of delays necessary so that  $X_t$  has any effects on  $Z_t$ . Additionally,  $V(B)$  must be convergent, that is,  $\delta(B) = 0$  and  $\omega(B) = 0$  roots must be out of the unit circle.

The residual term can also be represented by an ARIMA model (p,d,q):

$$Nt = \frac{\theta(B)}{\phi(B)} a_t \quad (10)$$

Replacing eq. 9 and 10 into eq. 8, gives the transfer function:

$$Z_t = c + \frac{w(B)}{\delta(B)} X_{t-b} + \frac{\theta(B)}{\phi(B)} a_t \quad (11)$$

In order to evaluate the impact of an intervention variable  $\varepsilon_t$  on the variable modeled, the following term should be added to eq. 11:

$$\frac{\omega(B)}{\delta(B)} \varepsilon_{t-b} \quad (12)$$

which defines one or more intervention variables. It is worth mentioning that the identification process for the model structure consists simply of determining the values for (p,d,q), the polinoms  $\omega(B)$  and  $\delta(B)$  orders and the lag constant of the transfers functions models, given by eq. 11.

The first step is checking if it shifts the level of series, smoothly or drastically, or if it shifts trend. After that the intervention analyzes is applied. Shifts in series  $Z_t$ , promoted by an exogenous event, may be immediate or lagged, temporary or permanent. So, the representation of these intervention variables can be classified in two types: pulse (effect occurs only in a single moment T) and step (from the moment T and so on, continuously). There is also an intermediary case when the intervention occurs during a time break causing level or inclination moves on  $Z_t$  series.

Santiago et al. (1997) and Margarido (2000) analyzed the possible ways to introduce intervention variables in time series models. Two basic types are proposed: the additive *outlier* (AO) and the innovative *outlier* (IO). The former is described by:

$$x_t = \varepsilon_t + \omega I_t T \quad (13)$$

$I_t T$  shows the shock at the moment T (exactly moment when the intervention happens),  $\omega$  denotes the extension of the level change and  $\varepsilon_t$  is the noise model. This kind of *outlier* can be introduced through a pulse intervention variable. Regarding the IO case:

$$x_t = \varepsilon_t + \frac{\theta(B)}{\phi(B)} \omega I_t^T \quad (14)$$

The study comprised data for 1992 January through 2000 December. All the econometric models were implemented in 4.0 Regression Analysis Time Series (RATS) program (Doan, 1994).

Moreover, visits to 10 slaughterhouses were conducted to interview people involved in the beef exporting business. This sample represented about 70.1% and 66.5% of the total value and volume exported of beef *in natura* in 2000. Data for special fresh and chilled cuts exported to the EU were obtained with ABIEC<sup>2</sup>.

Brazilian cattle and beef wholesale prices were obtained from the Instituto de Economia Agrícola (IEA) and from the Boletim Intercarnes<sup>3</sup>, they were corrected by an index of general prices (IGP-DI)/FGV, basis 2001 January. Monthly data on Argentinean prices and exported volumes for beef *in natura* were from the Secretaria de Agricultura Ganaderia y Pesca – SAGYP (<http://siiap.sagyp.mecon.ar/http-hsi/bases/expmes.htm>).

The source for nominal exchange rate series (R\$/US\$) was supplied by IPEA (2001). Such series were converted to real values using the IGP-DI and the IPP (Bureau of Labor Statistics, from the USA, available in <http://stats.bls.gov/datahome.htm>). The domestic income proxy was the nominal average revenue for people employed, with more than 15 years old (Pesquisa Mensal de Preços – IBGE, 2001), also converted to real values.

It was necessary to choose some dummies to be analyzed through the models residues and the intervention model. These dummies were selected based on the interviews and the main occurrences in the domestic and international market, which could affect the beef exports, particularly in a protectionism context.

- 1995 March: temporary restriction by the European Community on importing fresh beef from São Paulo and Minas Gerais states, for three months;
- 1996 March: EU bans beef imports from United Kingdom;
- 1996 June: go into force the government rule n° 304 (Portaria) to set up the compulsoriness of the bovine meat commercialization in quarters and standard, classified, identified and packaged cuts;
- 1998 March: FMD outbreaks in Porto Murtinho/Mato Grosso do Sul (MS) - Brazil;
- 1998 May: Rio Grande do Sul (RS) and Santa Catarina (SC) states were declared free from FMD with vaccination;
- 1998 June: partial interruption of the ban on the British beef exports;
- 1998 October: FMD outbreak in Naviraí County/MS;
- 1999 July: the *Calf Processing Aid Scheme* (CPAS) is ended;
- 1999 December: advertisements on the Common Agricultural Policy reforms – Agenda 2000, implemented in 2000;

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<sup>2</sup> The companies associated to ABIEC, between 1990 to 1998, were responsible for at least 90% of the Brazilian beef exports, regarding volumes (Miranda, 2001).

<sup>3</sup> INTERCARNES. Boletim Informativo. São Paulo. Several numbers (1992-2000). Published daily through fax.

- 2000 May: Argentina, RS and SC were recognized as FMD free zones without vaccination; Centre-West Circuit, recognized as FMD free with vaccination, both by the Office International des Epizooties (OIE);
- 2000 August: FMD outbreaks in J6ia County/RS;
- 2000 September: FTAA lifted bans on Argentinean *in natura* beef exports because of FMD problems.

Moreover, two other *dummies* were tested for 1995 January (WTO beginning, as well as the SPS and AA) and for 2000 July (implementation of the tariff reductions agreed at the Uruguay Round).

## RESULTS AND DISCUSSION

Regarding the objectives of checking up the sanitary and technical events impacts on the Brazilian exports performance, the results presented in this paper are focused on the estimated models in level. The differentiation of series makes it difficult to identify the exactly moment when the intervention occurs (Vandaele, 1983). In spite of this fact, models with differentiated variables were estimated, and unit roots and cointegration tests were carried out. The first case presented treats of the special fresh and chilled cuts exports to the EU and the first model was fitted for the exported volume series (**vdue**), showed in Figure 2. All the series were transformed to logarithms. Cattle and domestic beef prices (front cuts) and the real exchange data can be observed in Figures 3 and 4.

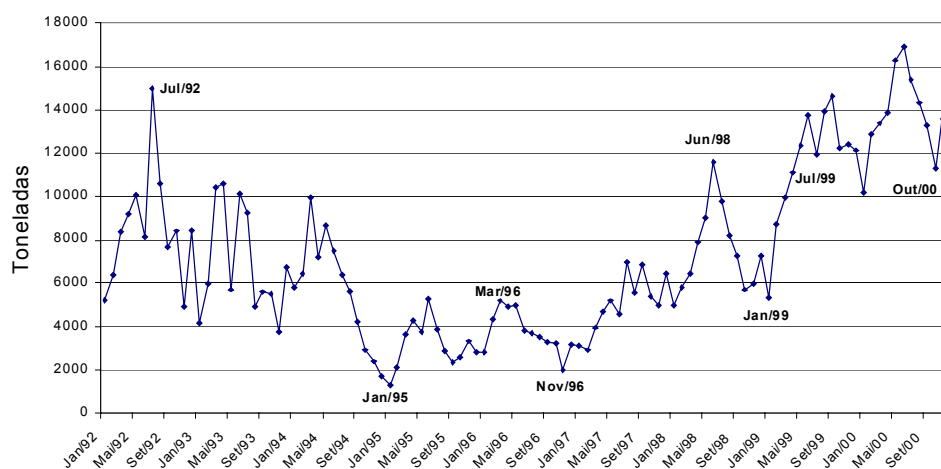


Figure 2 – Quantity of special cuts exported to the EU by Brazil (Tons). 1992 January-2000 December. Source: ABIEC.

Results of the reduced form estimation (eq. 6'') are described in Table 1. The model shows the determination coefficient and the variable coefficients with its respective statistical significant values and expected signs.

The domestic real price for cattle (**pbreal**) showed a negative and significant coefficient, interpreted as the elasticity between this price and the exported quantity. The value  $-1.06$

means that for each 1 percent increase in **pbreal** comes up an expected reduction of 1,06% in exported volume for EU (**vdTue**).

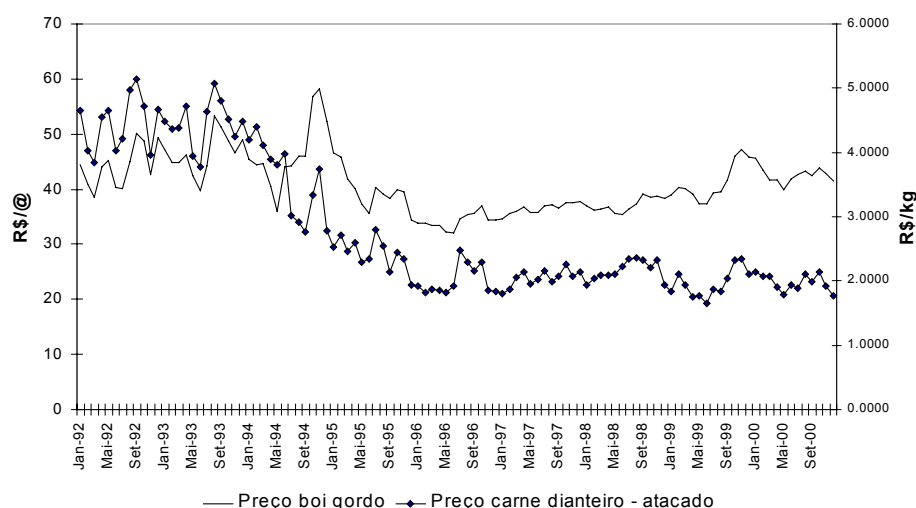


Figure 3 – Real price of beef cattle and wholesale price for front beef parts (R\$). 1992 January-2000 December. Source: CEPEA/IEA; Boletim Intercarnes.

The lag of the real exchange rate was adopted as an expectation for exporters, and the coefficient was estimated in 0.72 (significant). That is, for each 1 percent variation in the variable **txreal**, at moment **t**, it is expected an increase of 0.72% in the exported volumes to EU (**vdTue**). Positive changes in the real exchange rate benefit the growing export sales, holding the *coeterus paribus* conditions, and supposing that the exchange devaluation are not completely transmitted to the dollar prices of the Brazilian exporting goods. It is interesting to note that the effect of **txreal** is particularly important after the devaluation in 1999 (Figure 2).

Seasonal effects on exports were also analyzed through a Seasonal Index for harvest time production related to beef supply in Brazil, calculated by geometric moving average. Its positive effect suggests that during months of harvest time to livestock in the country (February to July) there is a trend to enlarge the exports to the EU.

The coefficient of the explanatory variable for quantity of chilled/fresh beef, exported by Argentina (**vxarg**), lagged by one period, was significant. For one percent increase in Argentinean exports, a 0.46% decrease is expected in the Brazilian cuts exports in the next month. The coefficient of the domestic real income (**rbras**) was also negative (-0.90), that means when real income raises nationally, there is an increase in food consumption. The evolution of **rbras** series shows that there was a real gain with the implementation of the government Real Plan, in July 1994, and consequently a reduction of the export level (Figure 2).

Fitting this model to Brazilian exports, the following step was taken in order to analyze the residues and identifying shocks or events not related to the explanatory variables. The

Box-Jenkins methodology was accomplished, taking the residues from the regression presented in Table 1 as the dependent variable.

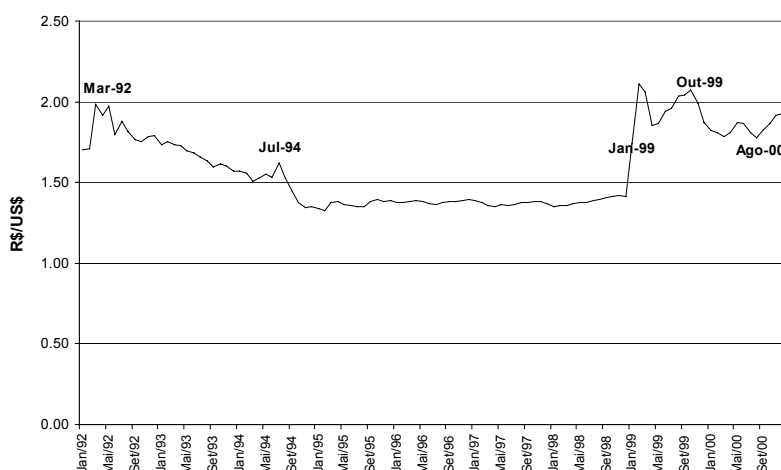


Figure 4 – Real exchange rate. Brazil. 1992 January – 2000 December. Source: IPEA.

Table 1. Results of Brazilian exports model.. Beef special cuts to the European Union (**lvd tue**). 1992 January - 2000 December. Series in level

Variable	Coefficient	Test “t”
Model: $F(9,97) = 79,05^*$	$\overline{R^2} = 0,88$	Dependent variable = <b>LVD TUE</b>
Constant	18,04*	4,62
$ltxreal_{t-1}$	0,72*	2,51
$lvd tue_{t-1}$	0,44*	6,92
$lrpbrarg$	-0,10	-0,47
$lrbras_{t-1}$	-0,90**	-2,20
$lprdiand_{t-1}$	-0,23	-0,99
$lpbreal$	-1,06*	-3,09
$lvxarg_{t-1}$	-0,46*	-3,04
Seasonality	0,23*	4,23
Trend	0,0075*	3,77

\* Significant at 1%      \*\* Significant at 5%      \*\*\* Significant at 10%

<sup>1</sup> Data in logarithms:  $ltxreal$  = real exchange rate,  $lvd tue$  = quantity of front/back special cuts exported by Brazil to the EU,  $rpbrarg$  = ratio between Brazilian exports price (to the EU) and Argentinean average prices of fresh/chilled cuts exports,  $lrbras$  = real average revenue of workers (older than 15 years),  $lpbreal$  = cattle real price,  $lprdiand$  = real beef price of front quarter,  $lvxarg$  = quantity of fresh/chilled beef exported by Argentina, Seasonality = domestic supply shifter, built up regarding production period.

The only significant interventions were related to the following variables: January and July 1995, March 1996 and July 2000. In order to provide a better understanding of these

intervention effects and patterns, the fitted model using linear regression (Table 1) was also estimated using alternatively the Box-Jenkins methodology, with a transfer function and intervention variables (Table 2).

Table 2. Results of Box-Jenkins model for Brazilian beef exports, special cuts to the EU (**vdTue**). January 1992 to December 2000.

Modelo: Q(24,1) = 24,89*	$\overline{R^2} = 0,92$	Variável dependente = LVDTUE <sup>1</sup>
Variável	Coefficiente	Teste "t"
Constante	25.62*	4.41
AR(1)	0.28**	2.16
N_SAZ{0} <sup>2</sup>	0.13	1.28
N_SAZ{1}	0.008	0.05
N_SAZ{2}	0.12	0.89
N_SAZ{3}	0.46*	3.15
N_SAZ{4}	0.62*	3.92
N_SAZ{5}	0.60*	3.10
N_SAZ{6}	0.70*	3.57
N_SAZ{7}	0.43*	2.24
N_SAZ{8}	0.19	1.26
N_SAZ{9}	0.15	1.19
N_SAZ{10}	0.08	0.73
N_LTXREAL{1}	0.59	1.27
N_LVXARG{1}	-0.48**	-2.47
N_LPBREAL{1}	-0.80	-1.46
N_LRPBRARG{0}	-0.23	-0.77
N_LPRDIANT{1}	-0.47	-1.50
N_LRBRAS{1}	-1.62**	-2.17
N_TREND	0.002	0.12
N_D0195{0}	-0.76*	-2.90
N_D0195{1}	0.52**	2.13
N_D0396{1}	-0.01	-0.06
N_D0396{2}	-0.35	-1.27
N_D0396{3}	0.03	0.12
N_D07{0}	0.32***	1.75
N_D07{1}	1.42*	4.41
N_D07{2}	-0.44	-1.39

\* Significant to 1% \*\* Significant to 5% \*\*\* Significant to 10%

<sup>1</sup> Data in logarithms: saz is the seasonal variable from RATS program

<sup>2</sup> "N" in front of the intervention variable means that the coefficient is related to a numerator term from the function established to represent the intervention variable itself. The number behind the name of the intervention variable indicates the order of this term in the numerator. So, the index zero means that the coefficient express the effect of the own intervention when it occurs. When number 1 follows the first term of the numerator, the correspondent coefficient represents the intervention effect that is felt only in the following moment, that is, the lag is equal to one. Letter D denotes the denominator.

The results of the intervention model were similar to those showed in Table 1. The intervention for January 1995 was statistically significant. This variable (shock) was defined as  $(m, l, d) = (0, 1, 0)$ , where **m** is the auto-regressive component, **l** is the moving average component and **d** is the lag. This pattern determines the way this intervention/event acts on the dependent variable.

The result shows an immediate intervention impact, valued in a decrease of 0.76% on **vdTue**. On the other side, in the following moment this intervention has a positive effect on exports, decreasing it in 0.52%. This kind of intervention pattern is illustrated in Figure 5, based on the mathematical developments proposed by Vandaele (1983).

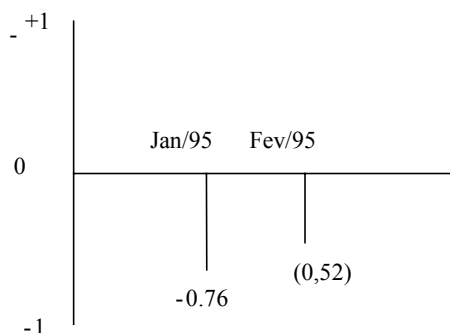


Figure 5 – Sketch on the pattern of the intervention variable effects on exports (**vdTue**) for January 1995.

This is called a “step” intervention variable, and it is assumed that since January 1995 it started having permanent impacts on the exports performance. These results must be carefully interpreted because even when the impacts of the intervention variable are identified, there are other events in the market that could decrease or increase the previous effects.

Analyzing the intervention explanatory variables (July 1995 and 2000), one can note a positive effect on **vdTue**, according to the coefficients presented in Table 2. Three parameters were identified in the numerator of the intervention variable in the mathematical expression. The first parameter is the coefficient for the intervention ( $N\_D07 \{0\}$ ) and for its first lagged ( $N\_D07 \{1\}$ ), both positive and significant.

\*\*Analyzing the series of residues generated using the model in Table 2, one can notice that although several interventions verified and the statistical significance of the explanatory variables, there are some significant residues correspondents to May 1993, December 1994 and November 1996, and it was not possible to associate them to relevant occurrences in this market.

The reduced forms related to the equation (4') were also estimated. The best fit for Brazilian exports prices practiced in the UE market (**pdtuen**) is the model detailed at Table 3. The output for the real exchange rate (as explanatory variable), lagged by one period, suggests that the devaluation expectation induces the reduction of the exports price in dollar. The strong competition through prices present in the international beef market can bring some lights on this result.

The lagged **Itxreal** coefficient was  $-0.20$ , meaning that a devaluation of real exchange rate of one percent would decrease 0.20% the effective exports prices for the European

market. This result and that for the effects of exchange rate movements on **vdTue** imply that an increase in the exports due to exchange devaluation causes a cut in the transactions prices, suggesting the Brazilian influence on this market. The concluding remark, taking these facts into account is that EU demand for this product is not perfectly elastic.

The **pbreal** coefficient shows that an increase in cattle prices of one percent results, in the following moment, a rising in the beef export unit values of 0.16%. Both, the exchange rate and **pbreal** coefficients point out that the domestic Brazilian variables also affect beef prices negotiated with importers. Based on these coefficients it is certainly impossible to assure that Brazil is a “price maker”. This fact is confirmed by the literature and also by the interviews, showing that Brazil does not determine prices in this market. However, based on the results some differentiation related to the quality may exist.

Table 3. Models Results for nominal price dependent variable (**pdTuen**). Brazilian export prices for beef special cuts to EU (US\$). January 1992 – December 2000. Series in level

Variable	Coefficient	Test “t”
Constant	1,91**	2,14
ltxreal t-1	-0,20*	-3,20
lpdtuen t-1	0,53*	5,76
lpdtuen t-2	0,25*	2,71
lpbreal t-1	0,16*	2,66
lpnarg t-1	0,18**	2,14
lpnarg t-2	-0,25*	-2,93
Seasonality	-0,004	-0,27
Trend	-0,0003	-0,97

\* Significant to 1%      \*\* Significant to 5%      \*\*\* Significant to 10%

1 pdtuen is the nominal average price for special cuts exported to the EU, in dollar; pnarg is the average export price for fresh/chilled beef from Argentina.

The nominal average prices for Brazilian and Argentinean beef cuts (chilled and fresh) exports are illustrated in Figure 6. A similar behavior is observed in the temporal movements of prices.

Taking the residues of the model presented in Table 3, and applying the Box-Jenkins time series model, the statistical significance was tested for intervention points. Only two shocks were remarkable regarding their impacts on **pdTuen**: March 1995 and May 1998.

On March 1995, the European Union suspended beef imports from the states of São Paulo and Minas Gerais, because of sanitary reasons. This break lasted three months and

it might be the responsible for the significant and negative effects identified by that model.

On May 1998, the OIE declared Brazilian South-Circle as FMD free area, with vaccination. At that time, the expectation was that this fact could favor Brazilian market opportunities.

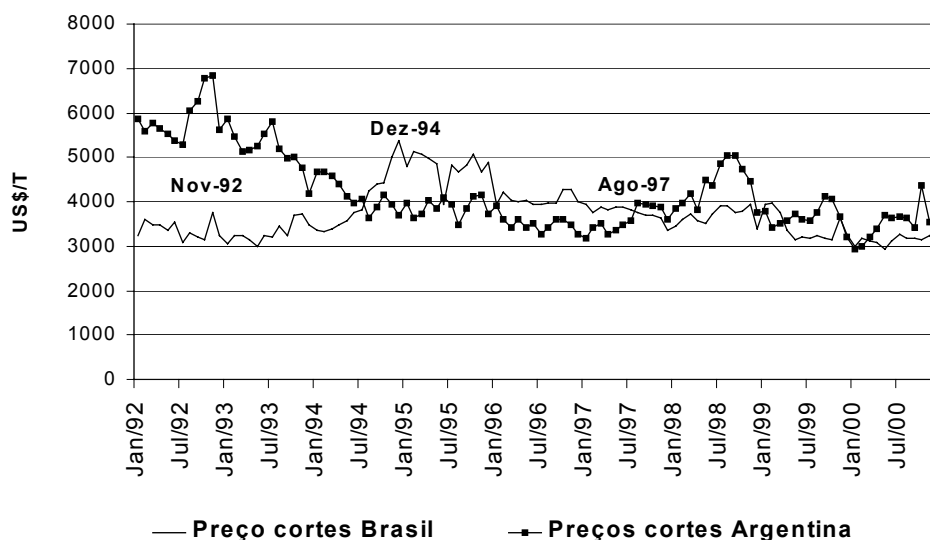


Figure 6 – Nominal average prices for beef exports, special cuts (front and back) from Brazil and frozen/fresh cuts from Argentina. January 1992 – December 2000.

In order to sustain these results and facilitate interpretation, this issue was also adjusted to the intervention model (Table 4), employing the same variable of Table 3 model's. The coefficient estimated for the intervention on March 1995 indicates a 0.06% fall in the export prices in the following three months, starting on March 1995.

For the May 1998 coefficient it was assumed a step intervention variable, for all the subsequent period. Observing coefficients presented in Table 4, only the denominator coefficient was significant. This result has no significant answer to the intervention analysis. Real impacts of intervention (event) might be assigned to the numerator coefficients.

All the models adjusted assumed that the foreign demand for Brazilian beef is non-perfectly elastic. Notwithstanding the significant coefficient for the real cattle price in the estimated regression, fitted models to address the European demand showed that variables related to this demand function answer almost the total effect of determination coefficient, show in Table 3.

The second case studied concerns to the corned beef exported by Brazilian companies to the US. Applying the theoretical model proposed, regressions for quantities exported were estimated (**vcb**). The coefficient of the independent variable (real exchange rate) was significant at 1%. In each one percent of devaluation on exchange rate, the exports

raise, in volume, about 1.29%. This impact is larger than that measured for the case of fresh/frozen beef sold to the EU.

Table 4. Box-Jenkins model results for nominal average prices of Brazilian beef exports as dependent variable. Special cuts to EU. In dollar. January 1992 to December 2000. Series in level

Q(26,2) = 27,74		Dependent variable = LPDTUE	
Variable	Coefficient	Test "t"	
Constant	6,88*	6,39	
AR(1)	0,61*	5,91	
AR(2)	0,32*	3,08	
N_SAZON{0}	0,002	0,15	
N_TREND{0}	0,001	0,24	
N_LPBREAL{1}	0,25*	2,55	
N_LPNARG{1}	0,20**	2,28	
N_LPNARG{2}	-0,15	-1,62	
N_LTXREAL{1}	0,08	0,53	
N_D0395{0}	-0,07***	-1,71	
N_D0598{1}	0,08	1,22	
N_D0598{2}	-0,10	-1,56	
D_D0598{1}	0,94*	11,36	

\* Significant to 1%

\*\* Significant to 5% \*\*\* Significant to 10%

From January 1999, Brazilian corned beef export prices decreased, while the quantities increased. The performance of the nominal average prices of corned beef exported by Argentina followed the movements of Brazilian prices. Tests for Granger causality indicated a bi-causality relation between these two variables. Rising one percent in the average prices practiced by Argentinean corned beef exports (pcbarg), there is an increase of 1.96% in Brazilian exports to the US (in volume). Hence, it is evident the substitution between products of these two countries in the US corned beef importing market.

Another expected result was the one obtained with the introduction of the nominal average price of Brazilian corned beef exported to the EU (pcbuen). Once the price is a key-variable for these products trade, increasing prices of products sold in the European market will lead to a reduction of exports to the US. The coefficient for this explanatory variable was  $-2.36$  for the contemporary effects.

The residues of the regression in the selected model were tested considering the significance of the dummy variables. When the intervention variables were all included in

the model (adopting the “step” behavior pattern), May 1998 (positive effect), May 2000 (positive) and August 2000 (negative) showed some effects on the residues of corned beef exports series. Thus, it seems that sanitary events associated to these periods may have had some impact on the exports performance. All these months are important as references of changes in sanitary status in the OIE context for Brazil. Even though these results could not be corroborated by the estimation of intervention models, the May 2000 shock had almost a positive statistically significant coefficient. At this particular month, Brazil’s Middle West and South Circles were recognized by OIE as FMD free regions, with vaccination.

It is worth observing that, graphically, a decreasing trend is noticed for these products exports, which began in August 2000, at the same time as an FMD outbreak blew up in Rio Grande do Sul state. Later, news showed the focus of the disease in Argentina as well, which was also a beef exporting to the US. However, in the model, this intervention did not present significant results.

Average prices of corned beef exported to the US (**pcb**) were also modeled as dependent variable. However, the hypothesis of a not perfectly elastic foreign demand for processed beef was not corroborated by the results. A foreign demand for Brazilian products totally elastic had a better fit in all the situations analyzed.

Box-Jenkins models for these residues showed significant effects for interventions examined for events on March 1996 and May 1998. The former is probably related to worsen of mad-cow disease crises in Europe, causing the ban of United Kingdom beef trade. The latter had some effects connected with the national government announcement of South Circle in Brazil as a FMD free zone.

## **CONCLUDING REMARKS**

The main goal of this work consists on proposing a method to measure effects of non-tariff barriers, particularly technical and sanitary, on trade (volume and price negotiated) and evaluate its convenience to study the exports of Brazilian beef.

The first challenge to propose a suitable methodology to achieve the measurement of sanitary and technical effects on trade is organize a complete survey about the issue investigated. A second task is to join enough information and data to provide the necessary inputs to the quantitative models.

Applying transfer functions and intervention models for the residues generated by the econometric model on trade assumes that a detailed knowledge about the issue and the determinants of trade, protectionism, sanitary, and other relevant events to the studied sector are available.

Results suggest that exports of Brazilian beef to EU (fresh/chilled) are influenced not only by the European demand conditions but also by the Brazilian domestic markets of cattle and beef wholesale. The real exchange rate is definitively a very important variable to understand the exporting performance. Concerning the sanitary events examined and their impacts on trade, the intervention model showed significant coefficients only for a few cases. The most important is the intervention variable estimated for March 1995,

when the exports of Brazilian beef were suspended by the European countries for a couple of months. This paper models the data set considering the effects of this occurrence and taking into account its statistical significance. Export prices were also affected downwards for all that period.

Three reasons can be pointed out to explain the difficult to quantify this kind of impacts: first, the limitations to establish the exactly pattern to draw the intervention function; second, the regionalized effects of the events on the exportations; and finally, the occurrences coming just after a specific event analyzed can reduce the observation of its original impacts.

An update of this research for 2001 to 2005 is being developed, adopting the same econometric and time series procedures, but different data sets. Many sanitary outbreaks have hit this sector for the last years and so it seems interesting to apply the model considering this context.

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