The world meat market and Brazilian economy: an econometric input-out analysis

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THE WORLD MEAT MARKET AND THE BRAZILIAN ECONOMY: AN ECONOMETRIC INPUT-OUTPUT ANALYZIS

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ABSTRACT: This chapter analyzes how changes in domestic and foreign macroeconomic variables can affect Brazilian meat exports and consequently the Brazilian economy, and how changes in the production process in the animal-raising sector, and the slaughter and meat processing industries affect their share in the Brazilian economy as well as those of other economic sectors. The analysis is conducted in two stages: initially, a vector auto-regression (VAR) model is used to evaluate the impact of changes in the domestic and foreign macroeconomic variables on Brazilian meat exports. Thereafter, the results obtained in the VAR model are applied in an input-output model to evaluate the changes in the levels of importance of the different production sectors, and especially in the animal-raising sectors and slaughter and meat processing industries. The results indicate that changes in macroeconomic variables can cause significant impacts on Brazilian meat exports, that, in turn, can affect the Brazilian economy mainly in the

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following sectors, corn farming, cattle, poultry and other animal-raising sectors, other farm products, chemistry, pharmacy and veterinary, plastic goods, beef, poultry and other meat process industries, other food products, commerce and transport, public utilities and services. Finally, changes in the production processes of the animal-raising sectors and slaughter and meat preparation industries do not affect their share in the Brazilian economy.

1. INTRODUCTION

Initially, we would like to show the importance of the Brazilian meat sector to the Brazilian economy and the interconnection between this sector and the world meat market. Brazilian meat production in 1998 was estimated to be 12.6 million tons, with three main productive chains: beef (6.3 million tons or 50.1% of the total volume produced), poultry (4.6 million or 36.6% of the total volume produced) and pork (1.6 million tons or 12.9% of the total volume produced). Other meat production comprises horse, buffalo, sheep, goat and rabbit (USDA; ANUALPEC, 1996 / 1998).

Brazil is the world's second largest beef producer (12.9% of the world's total volume); third largest poultry producer (11.6% of the world's total volume); and it is still the seventh largest pork producer (2.0% of the world's total volume) (USDA; ANUALPEC, 1996 / 1998). Brazil is also the world's ninth largest beef exporter (5% of the world's total volume); second largest poultry exporter (11.2% of the world's total volume); and tenth largest pork exporter (1.8% of the world total volume). Brazil's share in the world beef and pork market might increase since some Brazilian producer areas are becoming free of Malta fever, an important sanitary beef export barrier. Moreover Brazil has the world's largest herd of commercial cattle (147 million head), and it has continually improved its production technology.

Cattle-raising's share in the Brazilian Gross Domestic Product (GDP) is above 3% and beef is sold in more than 1.8 million commercial establishments; altogether, the beef chain employs around 8 million people. Through the poultry chain, about US$ 6 billion flows yearly and it consumes a significant part of the Brazilian animal food. Pigs are raised on at least 2.7 million rural properties and through this chain flow about US$ 920 million yearly in farm production alone; the pork chain employs about 2.5 million people in the South and South-East region of

the country and consumes a significant part of Brazilian production of corn and soy oil byproducts (ANUALPEC, 1996 / 1997).

There are two primary variables that can affect Brazilian meat exports and, consequently, change the levels of importance for different production sectors in the Brazilian economy. First, the domestic economic policies of the different countries that are currently importing or might possible import Brazilian meat; these effects will be felt mainly through changes in exchange rates, subsidies and customs duties, any one of which could change the domestic meat consumption in these countries. Secondly, changes in consumer behavior, with reference mainly to quality of life, food convenience, environmental problems, meat sanitation and animal well being, have increased poultry and pork consumption, and reduced beef consumption, especially in the industrialized countries.

2. OBJECTIVE

In this chapter, we intend to analyze how the changes in domestic and foreign macroeconomic variables can affect the Brazilian economy, and in particular its beef and poultry exports. Thereafter, we will attempt to verify how changes in the production process of the beef and poultry industries can affect their share in the Brazilian economy as a whole as well as other economic sectors.

3. THEORETICAL MODEL AND ECONOMETRIC ANALYSIS

This study is conducted in two stages; initially a vector auto-regression (VAR) model is used to evaluate the impact of changes in domestic and foreign macroeconomic variables on Brazilian meat exports. The results obtained in the VAR model are applied in an input-output model to evaluate the changes in the levels of importance of the different production sectors, and especially in the slaughter and meat preparation industry.

3.1 The impacts of domestic and foreign macroeconomic variables on Brazilian meat exports.

In this work we used an approach similar to that used in LIU, *et al*. (1993) to analyze the impacts of domestic and foreign macroeconomic

variables on U.S. meat exports. These authors used a VAR approach to examine the resulting impacts on the U.S. beef, pork, turkey and chicken exports, in the context of an open economy, and they adopted the "error correction" method to account for co-integration effects that are usual in economic time series (ENGLER & GRANGER, 1987).

3.1.1 Economic Model

Following LIU, *et al*. (1993), the macro sector in the open economy is composed of the goods market, the foreign-exchange market, and the money market. The goods market includes the demand, supply, and equilibrium condition of goods and services. The demand for goods and services of the home country is specified as consisting of domestic absorption and current account. For given levels of government expenditure (G) and taxes (T), domestic absorption (da) is specified as a function of real output (y) and the interest rate (r), as they affect consumption and investment. The current account (ca) measures the country's net exports of goods and services and is specified as a function of relative price level (ep^*/p) and real outputs (y and y^*) of the domestic and foreign countries, given the tax levels (T and T^*). The exchange rate (e) is measured in terms of R$/foreign currency. Thus:

$$da = da\ (y,\ r\ /\ G,\ T) \tag{1}$$

$$ca = ca\ (ep^*/\ p,\ y,\ y^*\ /\ T,\ T^*) \tag{2}$$

The nominal price (p) is expressed as a function of real output (y) and the nominal money supply (m). Real output captures the impact on price of the real sector, while the money supply captures the impact of the monetary sector:

$$p = p\ (y,\ m) \tag{3}$$

at equilibrium, supply equals demand:

$$y = da + ca \tag{4}$$

Given the exogenous variables ($G,\ T$ and T^*) and foreign endogenous variables (p^* and y^*), equations (1) through (4) can be used to solve for the domestic price and the quantities of the variables p, da, ca, and y, if the exchange rate (e) and interest rate (r) can be also

determined. Following LIU, CHUNG & MEYERS (1993), this leads us to specification of the foreign-exchange market and money market.

The first market specification is the equilibrium in the foreign-exchange market when deposits of home and foreign currencies offer the same expected rate of return. The expected rate of return on home deposits is the sum of the foreign rate (r^*) and expected rate of home currency depreciation (as the foreign investments have to be repatriated eventually). The equilibrium condition can be written as:

$$r = r^* + (e^e - e) / e \tag{5}$$

where e is the expected exchange rate and is proxied by a trade-weighted futures rate. To account for the simultaneous determination of the spot and future rates, the expected exchange rate is treated as endogenous and specified as a function of the spot rate:

$$e^e = e^e (e) \tag{6}$$

The second market specification is the equilibrium in the money market when the money supply set by the central bank equals the aggregate money demand:

$$m / p = l (r, y) \tag{7}$$

where m/p is the real money supply and l is the real money demand expressed as a function of interest rate and real output. According to Blanchard & Watson[3] in LIU, CHUNG & MEYERS (1993), money supply is specified as a function of real output and price, as the monetary authority is assumed to target the levels of the two variables by adjusting its supply of money. Thus:

$$m = m (y, p) \tag{8}$$

Equations (1) through (8) describe the domestic macro economy. The foreign variables (except T^*) appearing in the above equations are also treated as endogenous.

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[3] BLANCHARD, O.; WATSON, M. W. Are business cycles all alike? in R. Gordon, ed., **The American Business Cycle-Continuity and Change**, Chicago: University of Chicago, 1996. pp.123-179.

3.1.2 Vector Auto-Regression (VAR) Model

The VAR approach was developed by SIMS (1980); in the current context, it has been used prominently in analyses of the dynamic relationship between macroeconomic and agricultural variables within an open economy (BARNETT *et al*., 1983; BESSLER, 1984; CHAMBERS, 1984; BRANDAO, 1985; BRADSHAW & ORDEN, 1990; BARROS & AGUIAR, 1994; PICERNO, 1996; CASTRO & CAVALCANTI, 1997). VAR analysis permits identification of the causality among more than two variables, the impact of forecasts of each variable on the other variables, and the determination of the intensity and duration of these impacts.

Usually, the parameters of a vector auto-regressive stochastic process are estimated and a moving-average representation is used to study the dynamic interrelationship among the variables in a VAR. In essence, the impulse response functions are determined by the coefficients of the moving-average representation and the forecast error variance decomposition *k*-steps ahead, provides the percentage attributed to the impacts in each process of the model (ENDERS, 1996).

In this chapter, the effects of the shocks in macroeconomic variables on the Brazilian meat exports are the elasticities used later in the input-output model to analyze the impacts of changes on Brazilian meat exports in the Brazilian economy. Therefore, all variables were transformed to natural logs before estimation so that, in the impulse analysis, the effect on each variable divided by the standard deviation of the impacted variable is a percentage variation in that variable which results from a variation of 1% in the impacted variable.

The impulse response mechanism is described next. A stationary stochastic process can be represented by a moving-average system:

$$X_t = e_t + A_1\, e_{t-1} + A_2\, e_{t-2} + \ldots \qquad (9)$$

where e_t is a stochastic process, with zero means, finite variance/covariance matrix and uncorrelated (e_t is thus white-noise disturbance).

If we designate L as a lag operator, then:

$$L_j\, Z_t = Z_{(t-j)}$$

where j is an integer and $A(L)$ is a polynomial in the L operator:

$$A(L) = A_0 + A_1 L + A_2 L^2 + ...$$

and $A(L)$ is the impulse response matrix, with A_j matrices n x n for all j and $A_0 = I$.

Equation (9) can be written as:

$$X_t = A(L)\, e_t \qquad (10)$$

and from (9), we verify that:

$$A_k = \begin{bmatrix} a_{11}^k & \cdots & a_{1n}^k \\ a_{n1}^k & \cdots & a_{nn}^k \end{bmatrix}; \qquad e_t = \begin{bmatrix} e_{1(t)} \\ e_{2(t)} \\ \vdots \\ e_{n(t)} \end{bmatrix}; \qquad X_t = \begin{bmatrix} X_{1(t)} \\ X_{2(t)} \\ \vdots \\ X_{n(t)} \end{bmatrix}$$

Unit variations in the e_t vector cause shocks in the variables. If we know (9), we can describe the dynamic behavior of these variables that result from the shocks generated in any system component. Thus, the i^{th} columns of A_k measure the effect of a unity shock in the t period.

If in a vector auto-regressive model, the $e_{(t)}$ variance/covariance matrix is not diagonal, then the shocks $e_{1(t)}$, $e_{2(t)}$, ... , $e_{n(t)}$, tend to occur simultaneously with probabilities other than zero; these shocks can be contemporaneously correlated, and the shock on $e_{k(t-n)}$ has a contemporaneous effect on the other $e_{i(t-n)}$.

The Choleski decomposition is used to turn the variance/covariance matrix into diagonal matrix. This proces permits us to determine the effects of the shocks in each variable on the whole system and we can also obtain the forecast error variance decomposition, that tells us the proportion of the movements in a sequence due to its "own" shocks versus shocks in another variable. The Choleski decomposition presents some restrictions because there is a different restriction to each variable ordering and the effects observed depend on the ordering of the variables in the analyzed vector. To reduce the effects of these restrictions, the ordering of the variables was based in the results of previous studies, such as those of LIU *et al.* (1993).

3.1.3 Co-integration

Co-integration refers to a linear combination of non-stationary variables; following ENDERS (1996), it is possible that nonlinear long-run relationships exist among a set of integrated variables. All variables must be integrated by the same order; but this does not imply that all integrated variables are co-integrated. With the variables integrated by the same order it is necessary to verify whether there is a linear combination of these variables, that is, to verify whether the series are co-integrated.

Traditional regression or time series analysis is applied when variables are stationary; however, few economic variables are co-integrated by an order higher than unity. Thus, most of the co-integrated literature concentrates on the case in which each variable contains a single unit root. Thus, many authors use the term "co-integration" to refer to the case in which variables are *CI*(1,1). Following ENGLER & GRANGER (1987), LIU, CHUNG & MEYERS (1993) and ENDERS (1996), when the variables are co-integrated, conventional VAR models result in either biased or inefficient estimates, because while capable of capturing the short-term dynamics of a system, the conventional VAR model ignores the long-term equilibrium relationship among variables implied by the co-integration.

If the co-integration hypothesis can be confirmed, the short-run effects should be determined by an "error correction" model (ENGLER & GRANGER, 1987; ENDERS, 1996). In the present analysis, we applied the Dickey and Fuller unit root test for each individual data series to verify their order of integration.

In the Brazilian Meat Export model, the meat export volumes and prices are endogenous variables. Based on the macroeconomic model described previously, we also introduce the following variables: domestic consumption (as a proxy for the domestic absorption), domestic and foreign output and money suppliers, and the exchange rate. The VAR model still includes the Industrialized Countries Industrial Production Index (as a foreign economic activity indicator) and world meat imports (as a proxy for the world income level).

In the unit root tests, we initially considered six lags in each model estimated for each series. Then, we performed successive adjustments and we considered as the better model the first one that presented significant coefficient lags (the rule to determine the number of lags to be included in each model can be found in ENDERS, 1996, p.90).

In the VAR model we used Likelihood Ratio tests to determine the appropriate number of lags in the systems. Following ENDERS, (1996, p.128), we estimated a system with seasonal dummies and another

one without dummies, and we also conducted the Likelihood Ratio test to verify the necessity for the inclusion of seasonal dummies.

The ordering of the variables in the systems is very important, since the innovations in the first series affect contemporaneously all other variables; innovations in the second variables have no contemporaneous effects on the first variable, but affect the others, and innovations in the last variable have no contemporaneous effects on the other variables. Moreover, there is no economic reason to justify the effects of innovations in the Brazilian meat exports on the macroeconomic variables. As a result, the Brazilian poultry and beef exports were always classified in the last positions in the system. Thus, they are contemporaneously affected by all the other variables, but they have no contemporaneous effects on the others.

3.2 Impact of Changes in the Brazilian Meat Exports on the Brazilian Economy

The results obtained in the VAR model were applied in an input-output model to analyze the changes in the levels of the importance of the different production sectors. We used the Brazilian input-output matrix of 1995 (IBGE, 1995). Some sectors of the production and input tables were disaggregated into different segments to permit the study of the cattle and poultry-raising sectors and the meat industry sector. Then we made a final balance to redistribute the internal values of these matrices into row and column totals (BACHARACH, 1970; RODRIGUES, 1997).

3.2.1 Input-Output Model

Intersectorial flows in a specific economy are determined by technological and economic factors, and these flows can be described by a system of simultaneous equations represented by:

$$X = A\,X + Y \tag{12}$$

Where X is a vector (n x 1) of total production by sector; Y (n x 1) contains the final demand values; and A is a (n x n) matrix of technical coefficients (LEONTIEF, 1951, in GUILHOTO et al., 1994; GUILHOTO, 1995; GUILHOTO & PICERNO, (1995); e MILLER & BLAIR, 1985). In the model above, the final demand vector is usually

considered exogenous to the system yielding the following system of equations:

$$X = B\,Y \tag{13}$$

and

$$B = (I - A)^{-1} \tag{14}$$

where B (n x n) is the Leontief inverse matrix.

Starting from equation (13), we can evaluate the impact of different changes in the final demand on the total production, import volumes and total salaries. Thus,

$$\Delta X = B\,\Delta Y \tag{15}$$

$$\Delta M = m\,\Delta X \tag{16}$$

$$\Delta S = s\,\Delta X \tag{17}$$

where ΔY , ΔX, ΔM and ΔS are (n x 1) vectors that show respectively the final demand increase, and the impacts on total production volume, on the import values and on the salary totals; m and s are diagonal (n x n) matrices in which the diagonal elements are the import and salary coefficients. Changes in meat exports correspond to changes in the ΔY vector; these changes are those obtained in the VAR model from the impulse analysis. The effects of changes in Brazilian meat exports on the meat production level, import values and salary totals are obtained from equations (15), (16) and (17).

Of course, VAR analysis can measure impacts in the long run, but input-output analysis should be considered as providing short-run impacts. Thus, first we assumed that the technical coefficients were fixed during the period analyzed, and then we made simulations changing some technical coefficients.

Starting from equation (14), and following Rasmussen (1956) and Hirschman (1958), we can determine which sectors present above average linkage power in a specific economy. That is, we can calculate how much a specific sector demands from the other sectors (backward linkage indices) and how much those other sectors demand of it (forward linkage indices).

3.2.2 Pure Inter-Industrial Linkages Index (GHS Approach)

The pure inter-industrial linkages index is an alternative procedure to separate the impacts of a certain sector from the other economic sectors. This index can also be used to separate the impacts of an individual region from the rest of the economy, or still to separate the impacts of certain country from the economic block in which it is inserted (GUILHOTO, HEWINGS, SONIS, 1996; GUILHOTO, HEWINGS, SONIS, 1997).

The basic idea is to isolate a certain sector *j* from the rest of the economy and to define the effect of the total linkages of the sector *j* in the economy; that is, the difference between the total production of the economy and the production in the economy if sector *j* does not buy inputs from the rest of the economy and it does not sell its production to the rest of the economy. This situation is equivalent estimating the impact on the economy that would arise should this sector disappear.

We can isolate determined sector *j* from the rest of the economy considering an input-output system with two sectors, which can be represented by the following direct Leontief coefficients (GUILHOTO, HEWINGS, SONIS, 1997):

$$A = \begin{pmatrix} A_{jj} & A_{jr} \\ A_{rj} & A_{rr} \end{pmatrix} \tag{18}$$

where A_{jj} and A_{rr} are the quadrate matrices of direct inputs within the first and second sectors and A_{jr} and A_{rj} are the rectangular matrices showing the direct inputs purchased by the second sector and vice versa.

From (18), we can generate the following expression:

$$\begin{aligned} B = \left(I - A\right)^{-1} &= \begin{pmatrix} B_{jj} & B_{jr} \\ B_{rj} & B_{rr} \end{pmatrix} = \\ &= \begin{pmatrix} \Delta_{jj} & 0 \\ 0 & \Delta_{rr} \end{pmatrix} \begin{pmatrix} \Delta_{j} & 0 \\ 0 & \Delta_{r} \end{pmatrix} \begin{pmatrix} I & A_{jr}\Delta_{r} \\ A_{rj}\Delta_{j} & I \end{pmatrix} \end{aligned} \tag{19}$$

where:

$$\Delta_j = \left(I - A_{jj}\right)^{-1} \tag{20}$$

$$\Delta_r = \left(I - A_{rr}\right)^{-1} \tag{21}$$

$$\Delta_{jj} = \left(I - \Delta_j A_{jr} \Delta_r A_{rj} \right)^{-1} \tag{22}$$

$$\Delta_{rr} = \left(I - \Delta_r A_{rj} \Delta_j A_{jr} \right)^{-1} \tag{23}$$

Through the equation (19) we can reveal the process of production in an economy as well as derive a set of multipliers/linkages. In the matrix:

$$\begin{pmatrix} I & A_{jr}\Delta_r \\ A_{rj}\Delta_j & I \end{pmatrix} \tag{26}$$

the first row separates final demand by its origin, distinguishing final demand that comes from inside the region (I) from that originating from outside the region ($A_{jr}\Delta_r$).

$$X = \left(I - A \right)^{-1} Y \tag{27}$$

and using equations (19) to (26), we can derive a set of indices, which can be used to rank the sectors in terms of their importance in the economy and to see how the production process operates in the economy.

From equations (19) to (27) we obtain:

$$\begin{pmatrix} X_j \\ X_r \end{pmatrix} = \begin{pmatrix} \Delta_{jj} & 0 \\ 0 & \Delta_{rr} \end{pmatrix} \begin{pmatrix} \Delta_j & 0 \\ 0 & \Delta_r \end{pmatrix} \begin{pmatrix} I & A_{jr}\Delta_r \\ A_{rj}\Delta_j & I \end{pmatrix} \begin{pmatrix} Y_j \\ Y_r \end{pmatrix} \tag{28}$$

which leads to:

$$\begin{pmatrix} X_j \\ X_r \end{pmatrix} = \begin{pmatrix} \Delta_{jj} & 0 \\ 0 & \Delta_{rr} \end{pmatrix} \begin{pmatrix} \Delta_j & 0 \\ 0 & \Delta_r \end{pmatrix} \begin{pmatrix} Y_j & A_{jr}\Delta_r Y_r \\ A_{rj}\Delta_j Y_j & Y_r \end{pmatrix} \tag{29}$$

where

$$A_{jr}\Delta_r Y_r \tag{30}$$

is the direct impact of the rest of the final demand of the economy on sector j and

$$A_{rj}\Delta_j Y_j \tag{31}$$

is the direct impact of sector j final demand on the rest of the economy.

Continuing from equation (29):

$$\begin{pmatrix} X_j \\ X_r \end{pmatrix} = \begin{pmatrix} \Delta_{jj} & 0 \\ 0 & \Delta_{rr} \end{pmatrix} \begin{pmatrix} \Delta_j Y_j & \Delta_j A_{jr} \Delta_r Y_r \\ \Delta_r A_{rj} \Delta_j Y_j & \Delta_r Y_r \end{pmatrix} \tag{32}$$

We have the definitions for the Pure Backward Linkage (PBL) and for the Pure Forward Linkage (PFL),

$$\begin{aligned} PBL &= \Delta_r A_{rj} \Delta_j Y_j \\ PFL &= \Delta_j A_{jr} \Delta_r Y_r \end{aligned} \tag{33}$$

where the PBL will give us the pure impact on the rest of the economy of the value of the total production in sector *j*, ($\Delta_r Y_r$). This impact is free from: a) the demand inputs that sector *j* makes from sector *j*, and b) the feedbacks from the rest of the economy to sector *j* and vice-versa. The PFL will give us the pure impact on sector *j* of the total production in the rest of the economy ($\Delta_r Y_r$).

Continuing from equation (32):

$$\begin{pmatrix} X_j \\ X_r \end{pmatrix} = \begin{pmatrix} \Delta_{jj} \Delta_j Y_j & \Delta_{jj} \Delta_j A_{jr} \Delta_r Y_r \\ \Delta_{rr} \Delta_r A_{rj} \Delta_j Y_j & \Delta_{rr} \Delta_r Y_r \end{pmatrix} = \begin{pmatrix} X_j^j & X_j^r \\ X_r^j & X_r^r \end{pmatrix} \tag{34}$$

the level of total production in the sector *j* can be broken down into two components:

$$\begin{aligned} X_j^j &= \Delta_{jj} \Delta_j Y_j \\ X_j^r &= \Delta_{jj} \Delta_j A_{jr} \Delta_r Y_j \end{aligned} \tag{35}$$

where the first component, X_j^j, indicates the level of total production in sector *j* that is due to the level of final demand in sector *j* and the second component, X_r^j, will yield the level of total production in sector *j* that results from the level of final demand in the rest of the economy. In the same way, the level of total production in rest of the economy can also be broken down into two components

$$X_j^r = \Delta_{rr}\Delta_r A_j \Delta_j Y_j$$
$$X_r^r = \Delta_{rr}\Delta_r Y_r \qquad (36)$$

where the first component, X^j_r, is the level of total production in the rest of the economy that is due to the level of final demand in the sector *j*, and the second component, X^r_r, is the level of total production in the rest of the economy that is due to the level of final demand in the rest of the economy.

3.3 The Data

In the estimations, we used annual data on the macroeconomic variables and meat variables for the period 1961 through 1995. All variables were transformed to natural logs before estimations. The annual volumes (tons) and values (US$) of Brazilian beef , poultry and pork exports (industrial and non-industrial), and of World Meat Imports were taken from the Food Agricultural Organization (FAO).The annual data for the Brazilian Gross Domestic Product (GDP) – US$, the Brazilian consumption (US$) and the exchange rate were taken from *Conjuntura Econômica*. Finally, the annual Industrialized Countries Industrial Production Index, and the USA GDP and USA M1 were taken from the International Monetary Fund (IMF, Yearbook, 1992 a 1997). The GDP variables were deflated by GDP deflator of the corresponding country and the other variables measured in US$ were deflated by USA Wholesale Price Index.

4. RESULTS

4.1 Unit root tests

We conducted the Dickey and Fuller unit root test for each individual series. The results are represented in tables 1 and 2. The statistical distributions used in the tests are from Dickey & Fuller (1979; 1981):

a) τ_τ : to test $\gamma = 0$ in $\Delta Y_t = \alpha + \beta_t + \gamma Y_{t\text{-}1} + \Sigma\ \theta_i \Delta Y_{t\text{-}i} + \varepsilon_t$ (stationary fluctuations around a deterministic linear trend);

b) $\tau_{\beta\tau}$: to test $(\alpha, \beta, \rho) = (0, 0, 1)$ in $Y_t = \alpha + \beta_t + \rho Y_{t\text{-}1} + \varepsilon_t$;

c) ϕ_3 : to test together the null hypothesis $\beta = 0$ and $\rho = 1$;

d) τ_{μ} : to test $\gamma = 0$ in $\Delta Y_t = \alpha + \gamma Y_{t-1} + \Sigma\theta_i \Delta Y_{t-i} + \varepsilon_t$ (fluctuations around a constant mean);

e) $\tau_{\alpha\mu}$: to test $(\alpha,\rho) = (0, 1)$ in $Y_t = \alpha + \rho Y_{t-1} + \varepsilon_t$;

f) ϕ_1 : to test together $\alpha = 0$ and $\rho = 1$;

g) τ : t o test $\rho = 1$ in $\Delta Y_t = \gamma Y_{t-1} + \Sigma\beta_i \Delta Y_{t-i} + \varepsilon_t$.

Two primary problems with relations to unit root tests are emphasized in the literature. First, the tests for roots that approach one frequently point to the existence of a unit root and are not powerful enough to distinguish between a "difference stationary" process (DS) with "drift" and a "trend stationary". Second, tests to determine the number of the lags of the models used in unit root tests can point to different values according to different criteria.

The results of the unit root tests to annual data show that:

a) The variables which can be considered stationary are: World Meat Imports (tons and US$), Industrialized Countries Industrial Production Index, the USA Gross Domestic Product (GDP), the USA Industrial Production Index, Total Brazilian Meat Exports (tons), Brazilian Poultry Exports (tons and US$) and Brazilian Beef Exports (tons and US$).

b) The variables which can be considered stationary after one differentiation are: Brazilian GDP, Total Brazilian Meat Exports (US$), Brazilian Consumption and Real Exchange Rate Index.

c) The variable which can be considered stationary after two differentiation is USA Monetary Supply.

That is, we verified that we have ten stationary variables and five not stationary variables. When there are stationary and integrated variables there is no consensus about the correct specification of a VAR model. In addition, we have the following limitation: the number of observations in the analyzed series does not permit us to include all the variables recommended for the economic model in a same VAR model. Hence, we decided not to use the differentiated VAR model (the "error correction" method). We used all the variables in their level form, but we included in each estimated model four stationary variables and one integrated variable, to avoid the long-term equilibrium relationship among variables.

Likelihood ratio tests indicated that the inclusion of seasonal dummies was not necessary and that two lags have to be included in each VAR model. We also estimated models with a trend variable and without it; we analyzed their statistical adjustments and we concluded that the trend should not be included.

Table 1. Results of the Unit Root Tests to annual variables (Dickey and Fuller Statistic) and its significance level.

Variables*	τ_τ	$\tau_{\beta\tau}$	ϕ_3	τ_μ	$\tau_{\alpha\mu}$	ϕ_1	τ
BGDP	-2,22 (0,0361)	1,99 (0,0589)	2,68 (0,0704)	-0,95 (0,3490)	1,04 (0,3090)	1,83 (0,1829)	1,6 (0,122
BDC	-2,41 (0,0243)	2,23 (0,0357)	2,91 (0,0745)	-0,85 (0,4017)	0,93 (0,3628)	1,46 (0,2514)	1,44 (0,161
BER	-1,88 (0,0724)	-0,20 (0,2081)	1,37 (0,2757)	-2,01 (0,0556)	1,99 (0,0571)	2,12 (0,1415)	-0,47 (0,637
BMET	-3,57 (0,0021)	2,81 (0,0111)	6,81 (0,0026)	–	–	–	–
BMET$	-2,94 (0,0064)	-1,53 (0,1359)	3,19 (0,0381)	-0,59 (0,5394)	0,58 (0,5647)	0,29 (0,7490)	-0,50 (0,621
BPET	-5,21 (0,0006)	9,59 (0,0037)	4,16 (0,0025)	–	–	–	–
BPE$	-3,03 (0,0190)	2,01 (0,0836)	6,68 (0,0183)	–	–	–	–
BBET	-2,77 (0,0121)	1,97 (0,0632)	4,81 (0,0117)	-2,68 (0,0144)	2,84 (0,0099)	4,60 (0,0227)	–
BBE$	-2,98 (0,0057)	-1,34 (0,1893)	2,97 (0,0479)	-2,67 (0,0134)	2,63 (0,0133)	3,47 (0,0442)	–
WMIT	-2,90 (0,0080)	2,89 (0,0082)	7,05 (0,0016)	–	–	–	–
WMI$	-2,14 (0,0432)	1,81 (0,0832)	3,09 (0,0469)	1,28 (0,2122)	1,33 (0,1939)	2,74 (0,0848)	1,89 (0,070
IPI	-2,00 (0,0572)	1,28 (0,2105)	4,33 (0,0147)	2,68 (0,0130)	2,82 (0,0095)	5,50 (0,0107)	–
USAM1	-1,35 (0,1929)	1,24 (0,2295)	1,55 (0,2323)	-1,65 (0,1139)	1,74 (0,0960)	1,53 (0,2418)	-0,54 (0,593

USAGDP	-2,10 (0,0479)	2,01 (0,0574)	2,26 (0,1113)	-1,41 (0,1679)	2,40 (0,0225)	6,56 (0,0043)	_
USAIPI	-3,72 (0,0014)	3,50 (0,0023)	9,73 (0,0004)	_	_	_	_

Critical value							
10%	-3.21	2.38	5.79	-2.61	2.19	4.04	-1.60
5%	-3.56	2.83	7.03	-2.97	2.59	5.05	-1.95
1%	-4.28	3.70	10.09	-3.68	3.36	7.55	-2.64

*Variables:

BGDP	Brazilian Gross Domestic Product	USAIPI	The USA Industrial Production Index
BDC	Brazilian Consumption (Domestic Absorption)	BMET	Brazilian Meat Exports (Tons)
BER	Brazilian Exchange Rate	BME$	Brazilian Meat Exports (US$)
WMIT	World Meat Imports (Tons)	BPET	Brazilian Poultry Exports (Tons)
WMI$	World Meat Imports (US$)	BPE$	Brazilian Poultry Exports (US$)
IPI	Industrial Production Index (Industrialized Countries)	BBET	Brazilian Beef Exports (Tons)
USAM1	The USA Monetary Supply (M1)	BBE$	Brazilian Beef Exports (US
USAGDP	The USA Gross Domestic Product		

Table 2. Results of the Unit Root Tests to annual variables (Dickey and Fuller Statistic) and its significance level after the second and the third differentiation.

Variables*	τ_τ	$\tau_{\beta\tau}$	ϕ_3	τ_μ	$\tau_{\alpha\mu}$	ϕ_1	τ

After the second differentiation							
BME$	-3,67 (0,0015)	-1,26 (0,2221)	4,63 (0,0129)	–	–	–	–
BDC	-4,04 (0,0004)	0,22 (0,8300)	5,67 (0,0036)	-4,18 (0,0002)	2,26 (0,0311)	8,77 (0,0010)	–
BER	-4,1945 (0,0003)	-0,73 (0,4709)	6,25 (0,0022)	–	–	–	–
USAM1	-1,39 (0,1747)	-1,85 (0,0763)	1,43 (0,2595)	-0,54 (0,5923)	0,32 (0,7514)	0,38 (0,6833)	-0, (0,4)
After the third differentiation							
USAM1	-3,81 (0,0014)	4,99 (0,0115)	-3,25 (0,0047)	–	–	–	–
Critical value							
10%	-3,21	2,38	5,79	-2,61	2,19	4,04	-1,
5%	-3,56	2,83	7,03	-2,97	2,59	5,05	-1,
1%	-4,28	3,70	10,09	-3,68	3,36	7,55	-2,

*Variables:

BGDP	Brazilian Gross Domestic Product
BDC	Brazilian Consumption (Domestic Absorption)
BER	Brazilian Exchange Rate
USAM1	The USA Monetary Supply (M1)
BME$	Brazilian Meat Exports (US$)

4.2 Impulse response analysis and variance decompositions

In this section we show and discuss the innovation accounting for VAR models with the best statistical adjustments estimated, that is, the impulse response analysis and the forecast error variance decomposition. We obtained the impulse responses and variance

decomposition in 15-steps in each model estimated; then, we determined the average increase of the shocks on the determined variable. Graphics 1 to 6 show the responses to those shocks in percentages which result from a variation of 1% in the impacted variable to the models with the best statistical adjustments, tables 3 to 5 show decomposition of the variance for the Brazilian beef exports impacted series and tables 6 to 8 show decomposition of the variance for the Brazilian poultry exports impacted series.

The innovation accounting shows that:

a) Shocks in the beef and poultry export variables itself explain the greater part of their variance decomposition.

b) Shocks in the exchange rate affect beef and poultry exports and these shocks are important to explain variance decompositions for meat exports, but the effects of those shocks are more significant on beef exports. Impacts in the exchange rate and the initial effects of these impacts on the meat exports have always the same direction.

c) World meat imports, as a proxy for the world income level, is very important in the variance decomposition for Brazilian meat exports, specially for beef exports, but on average the impact of a shock in the variable is more significant on poultry exports.

d) The industrial production index of the industrialized countries is also important to variance decomposition for beef and poultry exports, but on average is more significant to poultry exports.

e) Shocks in the beef exports price affect poultry exports, but shocks on the poultry exports price do not affect beef exports.

f) Shocks in the Brazilian GDP are also important to beef and poultry exports and the participation of these shocks in the variance decomposition is almost constant over time, but shocks in the domestic GDP and the initial effect of these shocks on Brazilian meat exports have contrary direction.

g) Impacts of a shock in the foreign GDP tend to be delayed, but increase over time.

h) Effects of shocks in the domestic macroeconomic variables decline to zero over time, but effects of shocks in foreign macroeconomic variable tend to stabilize in a level different of zero. In general, the foreign macroeconomic variables exert impacts on beef and poultry exports that are more significant than domestic macroeconomic variables in the first periods after the shocks, and the effects of shock in foreign variables are more persistent.

We determined the average impact to the first period after a shock in determined variable and the maximum average impact in that

variable for models with the best statistical adjustments (we obtained effects of shocks in a same variable in a different models). These impacts are the elasticities used in the input-output analyze. The elasticities obtained in the impulse response analyzes are:

a) Initial average impact of a shock in the exchange rate on Brazilian beef exports: 1,85.

b) Maximum average impact of a shock on exchange rate on Brazilian beef exports: 2,95.

c) Initial average impact of a shock in domestic GDP on Brazilian beef exports: -1,31.

d) Initial average impact of a shock in the industrial production index of industrialized countries on the Brazilian beef exports: 3,33.

e) Maximum average impact on the world meat imports on the Brazilian beef exports: 1,30.

f) Initial average impact of a shock on the exchange rate on the Brazilian poultry exports: 0,33.

g) Maximum average impact of a shock in the exchange rate on the Brazilian poultry exports: 1,63.

h) Maximum average impact of a shock on the world meat imports on the poultry exports: 1,77.

i) Initial average impact of a shock on the Brazilian GDP on the Brazilian poultry exports: -1,21.

Table 3. Decomposition of variance for Brazilian beef exports (%), model including variables industrial production index of industrialized countries (IPI), value of world meat imports (WMI$), Brazilian gross domestic product (BGDP), price of Brazilian beef exports (BBE$) and Brazilian beef exports (BBE$).

	Decomposition of the variance for Brazilian beef exports (**%**)				
Step	**IPI**	**WMI$**	**BGDP**	**BBE$**	**BBET**
1	9,34	11,45	11,87	0,31	67,03
2	6,94	18,81	19,66	5,05	49,54
3	9,09	24,86	19,86	5,53	40,67
4	8,44	28,03	18,53	6,71	38,29
5	9,43	28,33	17,04	9,97	35,22
6	10,30	28,28	16,59	10,66	34,17
7	10,57	28,20	16,54	10,59	34,10
8	10,78	28,07	16,55	10,62	33,98
9	11,22	27,81	16,76	10,53	33,67
10	11,86	27,51	16,85	10,42	33,36
11	12,42	27,31	16,79	10,34	33,14
12	12,82	27,18	16,71	10,29	32,99
13	13,14	27,10	16,65	10,25	32,87
14	13,41	27,07	16,58	10,20	32,74
15	13,65	27,06	16,50	10,16	32,62
Average	10,89	25,81	16,90	8,78	37,63

Table 4. Decomposition of variance for Brazilian beef exports (%), model including variables industrial production index of industrialized countries (IPI), value of world meat imports (WMI$), Brazilian exchange rate (BER), price of Brazilian beef exports (BBE$) and Brazilian beef exports (BBET).

	Decomposition of the variance for Brazilian beef exports (**%**)				
Step	**IPI**	**WMI$**	**BER**	**BBE$**	**BBET**
1	7,84	12,15	21,73	0,21	58,07
2	6,37	20,38	29,33	2,43	41,50
3	8,41	27,25	26,55	2,57	35,23
4	8,03	30,64	24,17	5,31	31,84
5	10,21	30,38	21,41	9,82	28,18
6	11,14	29,57	21,50	10,48	27,32
7	11,28	29,61	21,47	10,35	27,28
8	11,65	29,90	21,30	10,24	26,91

9	12,52	29,54	21,14	10,11	26,69
10	13,14	29,35	20,98	10,04	26,49
11	13,41	29,26	20,97	9,99	26,37
12	13,62	29,20	20,92	9,99	26,26
13	13,86	29,18	20,83	10,04	26,10
14	14,03	29,19	20,78	10,08	25,93
15	14,12	29,19	20,78	10,09	25,81
Average	11,31	27,65	22,26	8,12	30,66

Table 5. Decomposition of variance for Brazilian beef exports (%), model including variables USA gross domestic product (USAGDP), volume of world meat imports (WMIT), Brazilian gross domestic product (BGDP), price of Brazilian beef exports (BBE$) and Brazilian beef exports (BBET).

	Decomposition of the variance for Brazilian beef exports (%)				
Step	**USAGDP**	**WMIT**	**BGDP**	**BBE$**	**BBET**
1	0,01	0,21	15,54	0,55	83,68
2	7,80	2,39	16,98	1,47	71,37
3	11,90	2,56	15,80	1,33	68,40
4	11,69	2,70	16,17	2,87	66,58
5	11,65	2,65	16,63	3,40	65,67
6	11,71	3,34	16,48	3,53	64,94
7	11,73	3,75	16,28	3,91	64,32
8	11,90	3,74	16,25	3,96	64,16
9	11,99	3,79	16,18	3,94	64,10
10	12,00	3,83	16,11	3,94	64,13
11	12,03	3,89	16,10	3,96	64,02
12	12,13	4,00	16,13	3,97	63,77
13	12,26	4,12	16,16	3,97	63,49
14	12,39	4,22	16,16	3,99	63,24
15	12,51	4,31	16,15	4,01	63,02
Average	10,91	3,30	16,21	3,25	66,33

Table 6. Decomposition of variance for Brazilian poultry exports (%), model including variables industrial production index of industrialized countries (IPI), Brazilian exchange rate (BER), price of Brazilian beef exports (BBE$), price of Brazilian poultry exports (BPE$) and Brazilian poultry exports (BBET).

	Decomposition of the variance for Brazilian poultry exports (%)				
Step	**IPI**	**BER**	**BBE$**	**BPE$**	**BPET**
1	30,64	0,78	0,43	9,57	58,58
2	29,68	2,75	11,95	15,20	40,42
3	14,98	22,04	23,99	18,45	20,54
4	14,63	39,65	20,28	12,24	13,20
5	28,71	37,49	16,00	8,41	9,39
6	39,30	32,61	14,11	6,69	7,29
7	45,05	29,72	12,56	6,41	6,26
8	49,39	27,17	11,41	6,33	5,70
9	52,12	25,48	10,89	6,19	5,33

10	52,84	25,20	10,64	6,20	5,12
11	52,16	25,80	10,73	6,33	4,98
12	50,79	26,84	11,19	6,34	4,84
13	49,38	28,05	11,62	6,25	4,71
14	48,43	29,03	11,76	6,17	4,61
15	47,98	29,57	11,80	6,11	4,54
Average	40,41	25,48	12,62	8,46	13,03

Table 7. Decomposition of variance for Brazilian poultry exports (%), model including variables value of world meat imports (WMI$), Brazilian gross domestic product (BGDP), price of Brazilian beef exports (BBE$), price of Brazilian poultry exports (BPE$) and Brazilian poultry exports (BBET).

	Decomposition of the variance for Brazilian poultry exports (%)				
Step	**WMI$**	**BGDP**	**BBE$**	**BPE$**	**BPET**
1	9,57	30,46	10,86	0,00	49,11
2	7,63	37,49	22,26	3,37	29,24
3	5,15	41,48	25,86	8,24	19,28
4	9,51	39,06	24,98	8,53	17,92
5	15,24	34,96	25,15	8,37	16,28
6	16,54	30,74	30,25	8,18	14,29
7	14,93	29,29	36,47	7,08	12,22
8	12,61	28,84	42,33	5,97	10,26
9	10,76	28,75	46,57	5,21	8,72
10	9,84	29,37	48,41	4,71	7,67
11	9,75	30,12	48,73	4,36	7,04
12	10,06	30,49	48,55	4,17	6,73
13	10,42	30,60	48,27	4,11	6,61
14	10,67	30,59	48,08	4,09	6,58
15	10,74	30,53	48,09	4,08	6,57
Average	10,89	32,18	36,99	5,36	14,57

Table 8. Decomposition of variance for Brazilian poultry exports (%), model including variables value of world meat imports (WMI$), Brazilian exchange rate (BER), price of Brazilian beef exports (BBE$), price of Brazilian poultry exports (BPE$) and Brazilian poultry exports (BBET).

	Decomposition of the variance for Brazilian poultry exports (%)				
Step	**WMI$**	**BER**	**BBE$**	**BPE$**	**BPET**
1	8,83	21,17	5,07	2,73	62,21
2	5,25	20,88	20,68	11,73	41,47
3	7,99	17,79	25,80	21,48	26,95
4	18,06	15,08	24,96	19,61	22,28
5	26,25	15,44	21,32	17,48	19,51
6	29,82	14,52	20,05	17,14	18,47
7	29,69	14,43	21,42	16,67	17,80
8	27,26	14,75	26,30	15,44	16,25
9	25,57	15,98	30,97	13,60	13,89

10	25,86	18,77	32,22	11,52	11,63
11	27,29	21,45	31,57	9,80	9,89
12	29,07	22,91	30,62	8,67	8,73
13	30,65	23,68	29,61	8,02	8,04
14	31,70	24,20	28,67	7,74	7,69
15	32,17	24,42	28,15	7,71	7,55
Average	23,70	19,03	25,16	12,62	19,49

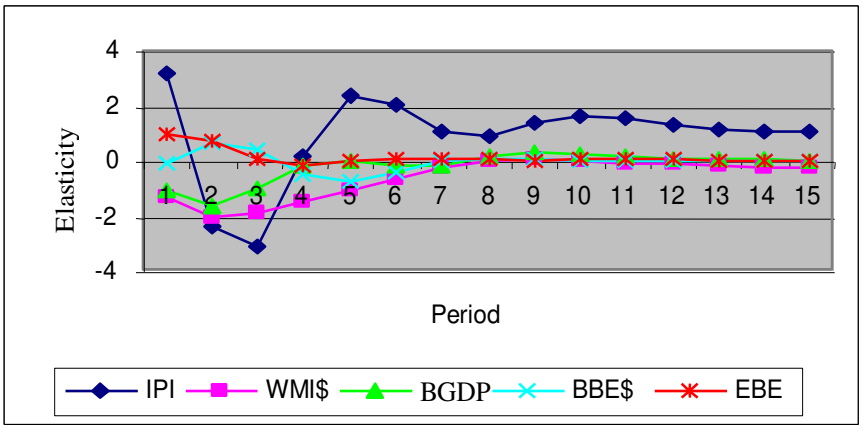

Figure 1. Effects of shocks in the variables industrial production index of the industrialized countries (IPI), world meat imports (WMI$), gross domestic product (BGDP), Brazilian beef price exports (BBE$) and Brazilian beef exports (BBET) on the Brazilian beef exports (BBET).

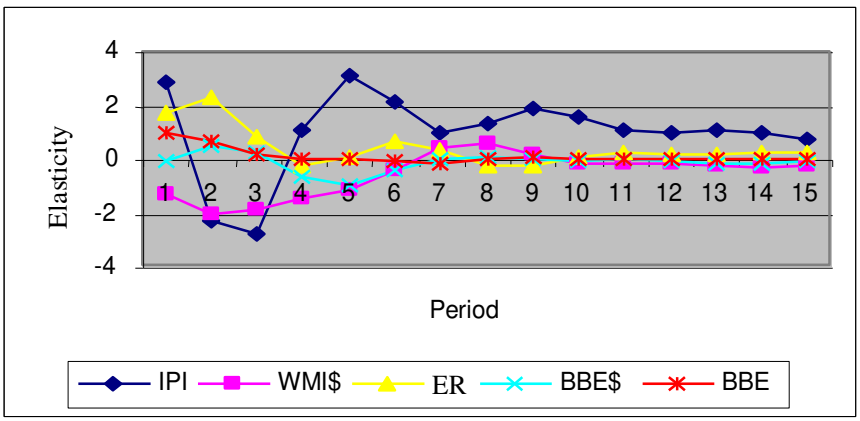

Figure 2. Effects of shocks in the variables industrial production index of the industrialized countries (IPI), world meat imports (WMI$), exchange rate (ER), Brazilian beef price exports (BBE$) and Brazilian beef exports (BBE$) on the Brazilian beef exports.

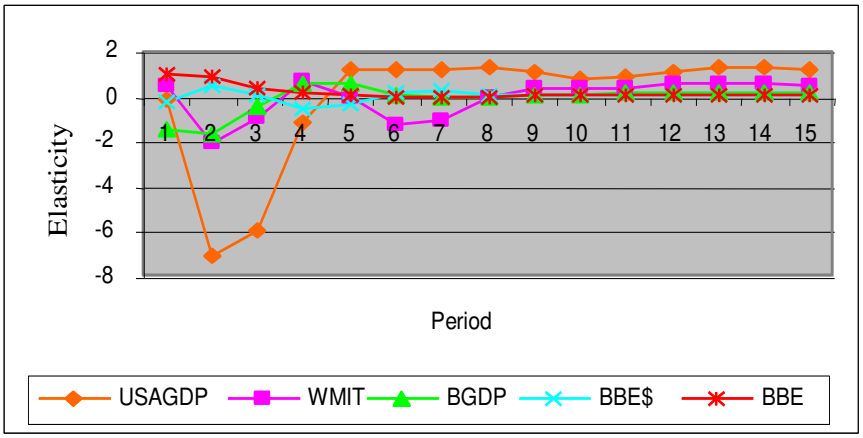

Figure 3. Effects of shocks in the variables USA foreign gross domestic product (USAGDP), world meat imports (WMI), Brazilian gross domestic product (BGDP), Brazilian beef price exports (BBE$) and Brazilian beef exports (BBET) on the Brazilian beef export.

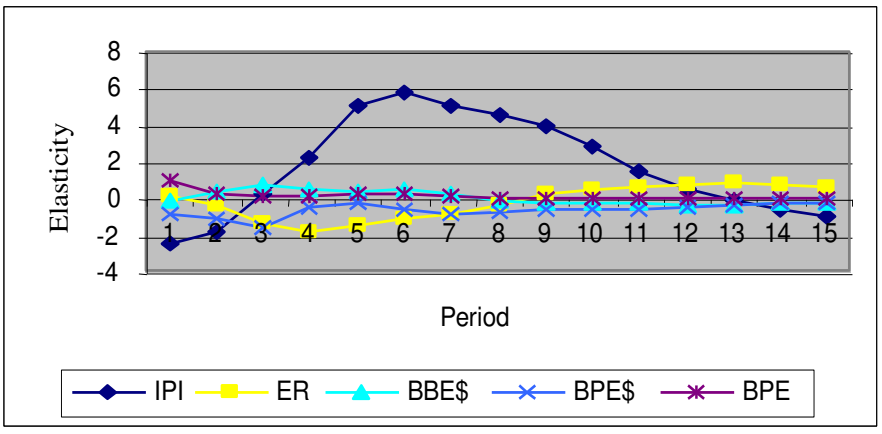

Figura 4. Effects of shocks in the variables industrial production index of the industrialized countries (IPI), exchange rates (ER), Brazilian beef price exports (BBE$), Brazilian poultry price exports (BPE$), and Brazilian poultry exports (BPET) on the Brazilian poultry exports (BPET).

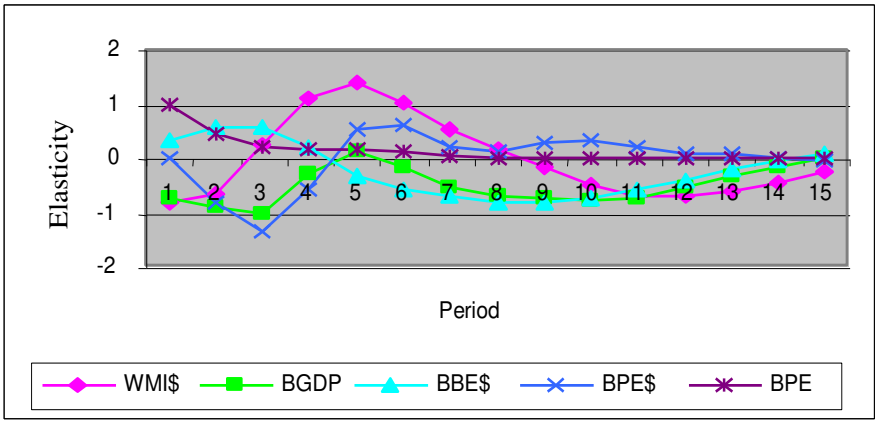

Figura 5. Effects of shocks in the world meat imports (WMI$), Brazilian gross domestic product (BGDP), Brazilian beef price exports (BBE$), Brazilian poultry price exports (BPE$) and Brazilian poultry exports (BPET) on the Brazilian poultry exports (BPET).

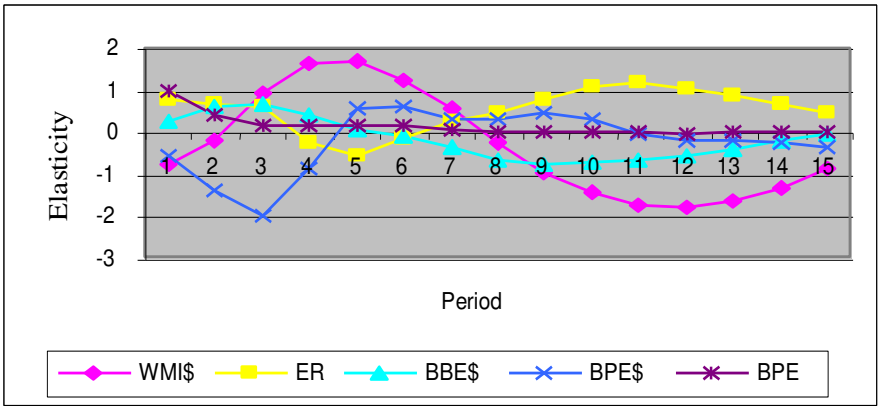

Figure 6. Responses to a 1% shock on the variables world meat imports (WMI$), exchange rate (ER), Brazilian beef price exports (BBE$), Brazilian poultry price exports (BPE$) and Brazilian poultry exports (BPET) on the Brazilian poultry exports (BPET).

4.3 Impact of changes in the Brazilian meat exports on the Brazilian economy.

Some of the highlights from the input-output analysis will be presented here. Using the traditional Rasmussen-Hirschman indices, we can consider that the beef, poultry and other animal-raising sectors, and the cattle, poultry and other animal slaughter and industrial sectors are key-sectors in the Brazilian economy. (see table 9). The cattle and poultry slaughter and industrial sectors present the highest and the third highest backward linkages and they present small forward linkages index, indicating that those sectors demand products from the other several sectors, but they are not demanded by other sectors since most of their sales are to final demand.

As may be revealed in table 11, changes in Brazilian beef and poultry exports generate impacts that are concentrated in other agricultural sectors as well as chemicals, services and food products. Changes in the exchange rate that initially affect the Brazilian beef and poultry exports will also indirectly affect these same sectors more prominently than other sectors of the economy. The affects of simultaneous changes in these two sectors extend the reach of the industry into a few more sectors of the economy but there is still a strong concentration in agriculture and food production. Changes in the production processes of the beef and poultry industries, estimated five years ahead, do not affect their share in the Brazilian economy.

We analyzed: a) type 1 multipliers (Table 9); b) Rasmussen/Hirschman backward and forward linkage indices (Table 9); and c) pure backward, forward and total linkage indices (Table 10). Then, we simulate changes in the technical coefficients (Table 16) and calculate those multipliers and those indices again. Tables 17 and 18 show the Rasmussen/Hirschman and pure inter-industrial indices after the forth simulation, respectively. Then, we compare the order of those multipliers and of those indices before and after the changes in the production process.

Table 9. Type 1 Multipliers and Rasmussen/Hirschman backward and forward linkage indices.

	Rasmussen/Hirschman linkage indic

Sectors	Multipliers	Order	Backward		Forward	
			Index	Order	Index	O
1-Corn	1,6238	25	1,0060	11	0,8109	
2-Cattle-raising	1,5625	29	0,9009	13	0,7803	
3-Poultry-raising	2,0746	15	0,8188	14	1,0360	
4-Other animals-raising	2,1585	12	0,6333	25	1,0779	
5-Other farm products	1,5695	28	2,7366	2	0,7837	
6-Mining	1,9552	19	1,1166	7	0,9764	
7-Steel industry	2,3387	7	1,6713	5	1,1679	
8-Machinery / vehicles	2,0361	16	1,0927	8	1,0167	
9-Electric / electronic	1,9342	21	0,6608	22	0,9659	
10-Wood / furnishings	2,0022	17	0,6536	23	0,9998	
11-Paper / graphics	2,1552	13	0,9779	12	1,0763	
12-Rubber industry	2,1526	14	0,8022	15	1,0749	
13-Chemistry	1,9209	22	2,7639	1	0,9592	
14-Pharmacy / veterinary	1,8384	23	0,5429	31	0,9181	
15-Plastic goods	1,9584	18	0,7502	17	0,9780	
16-Textile industry / clothing	2,2227	9	1,0318	10	1,1099	
17-Shoes industry	2,2038	10	0,6123	27	1,1005	
18-Coffee industry	2,3726	6	0,6762	20	1,1848	
19-Vegetable products processing	2,1967	11	0,6906	19	1,0970	
20-Cattle slaughter / industry	2,5524	1	0,6920	18	1,2746	
21-Poultry slaughter / industry	2,4566	3	0,5045	32	1,2268	
22-Other animals slaughter	1,5165	31	0,5474	30	0,7573	
23-Milk industry	2,4154	5	0,6372	24	1,2062	
24-Sugar industry	2,4421	4	0,6731	21	1,2195	
25-Vegetable oils industry	2,5043	2	0,7758	16	1,2505	
26-Other food products	2,3070	8	1,0375	9	1,1520	
27-Other industries	1,9432	20	0,6016	28	0,9704	
28-Public usefulness	1,5990	27	1,1328	6	0,7985	
29-Building	1,6257	24	0,5939	29	0,8118	
30-Commerce / transport	1,6171	26	2,0746	3	0,8076	
31-Communication	1,2533	32	0,6230	26	0,6258	
32-Services	1,5718	30	1,9680	4	0,7849	

Table 10. Pure inter-industrial linkage indices (R$ - billions): Pure Forward Linkage - (PFL), Pure Backward Linkage (PBL) and Pure Total Linkage (PTL).

Sectors	PFL		PBL		PTL	
	Index	Order	Index	Order	Index	Ord
1-Corn grain	3,564	22	0,058	32	3,620	30
2-Cattle-raising	5,173	16	1,720	25	6,890	22
3-Poultry-raising	2,633	23	1,474	27	4,110	29
4-Other animals-raising	1,976	25	1,646	26	3,620	31
5-Other farm products	34,655	4	9,846	9	44,500	5
6-Mining	19,730	6	2,882	22	22,610	9
7-Steel industry	34,785	3	6,128	13	40,910	7
8-Machinery / vehicles	15,752	8	27,376	4	43,130	6
9-Electric / electronic	5,317	15	15,462	6	20,780	10
10-Wood / furnishings	4,023	19	5,700	15	9,720	17
11-Paper / graphics	13,231	9	3,635	20	16,870	13
12-Rubber industry	5,463	14	0,589	31	6,050	24
13-Chemistry	49,544	2	5,595	16	55,140	3
14-Pharmacy / veterinary	0,980	28	7,337	11	8,320	18
15-Plastic goods	6,482	11	1,094	29	7,580	19
16-Textile industry / clothing	4,968	17	8,154	10	13,120	14
17-Shoes industry	0,383	31	4,230	18	4,610	27
18-Coffee industry	0,603	30	3,651	19	4,250	28
19-Vegetable products processing	4,245	18	14,702	7	18,950	11
20-Cattle slaughter / industry	1,947	26	9,984	8	11,930	15
21-Poultry slaughter / industry	0,296	32	5,522	17	5,820	25
22-Other animal slaughter	0,657	29	0,852	30	1,510	32
23-Milk industry	1,082	27	6,056	14	7,140	20
24-Sugar industry	1,985	24	3,156	21	5,140	26
25-Vegetable oils industry	3,764	20	7,232	12	11,000	16
26-Other food products	7,058	10	19,564	5	26,620	8
27-Other industries	3,586	21	2,526	23	6,110	23
28-Public usefulness	15,856	7	2,322	24	18,180	12
29-Building	5,521	13	48,012	2	53,530	4
30-Commerce / transport	44,232	1	35,540	3	79,770	2
31-Communication	5,832	12	1,195	28	7,030	21
32-Services	34,082	5	78,002	1	112,080	1

Table 11. Changes in the production level of the Brazilian economic sectors resulting from shocks in the Brazilian meat exports (R$).

Sectors	Changes in the production level (R$ - million)								
	DX1*	DX2*	DX3*	DX4*	DX5*	DX6*	DX7*	DX8*	DX
1-Corn grain	3,44	5,48	-2,43	6,19	-2,42	8,93	9,70	-6,63	7,2
2-Cattle-raising	44,27	70,59	-31,35	79,68	-31,20	0,13	0,14	-0,10	-31
3-Poultry-raising	0,06	0,10	-0,05	0,12	-0,05	48,91	53,11	-36,31	53,
4-Other animals-raising	12,50	19,93	-8,85	22,50	-8,81	0,20	0,22	-0,15	-8,
5-Other farm products	7,44	11,87	-5,27	13,40	-5,25	8,72	9,47	-6,47	4,2
6-Mining	1,22	1,94	-0,86	2,19	-0,86	1,78	1,93	-1,32	1,0
7-Steel industry	2,10	3,35	-1,49	3,78	-1,48	2,91	3,16	-2,16	1,6
8-Machinery / vehicles	1,47	2,34	-1,04	2,65	-1,04	1,97	2,13	-1,46	1,1
9-Electric / electronic	0,16	0,25	-0,11	0,29	-0,11	0,28	0,30	-0,21	0,1
10-Wood / furnishings	0,16	0,25	-0,11	0,28	-0,11	0,29	0,31	-0,22	0,2
11-Paper / graphics	0,68	1,08	-0,48	1,22	-0,48	1,32	1,43	-0,98	0,9
12-Rubber industry	0,25	0,41	-0,18	0,46	-0,18	0,34	0,37	-0,25	0,1
13-Chemistry	6,94	11,07	-4,91	12,49	-4,89	10,00	10,86	-7,43	5,9
14-Pharmacy / veterinary	0,95	1,51	-0,67	1,70	-0,67	0,37	0,40	-0,27	-0,
15-Plastic goods	0,38	0,61	-0,27	0,69	-0,27	4,16	4,51	-3,09	4,2
16-Textile industry / clothing	0,37	0,60	-0,27	0,67	-0,26	0,85	0,92	-0,63	0,6
17-Shoes industry	0,18	0,29	-0,13	0,33	-0,13	0,07	0,07	-0,05	-0,
18-Coffee industry	0,01	0,02	-0,01	0,03	-0,01	0,03	0,03	-0,02	0,0
19-Vegetable products processing	0,78	1,25	-0,55	1,41	-0,55	3,04	3,31	-2,26	2,7
20-Cattle slaughter / industry	87,82	140,03	-62,19	158,07	-61,90	0,23	0,25	-0,17	-61
21-Poultry slaughter / industry	0,02	0,04	-0,02	0,04	-0,02	93,97	102,04	-69,76	102
22-Other animal slaughter	2,47	3,94	-1,75	4,44	-1,74	0,06	0,06	-0,04	-1,
23-Milk industry	0,11	0,17	-0,08	0,19	-0,08	0,15	0,16	-0,11	0,0
24-Sugar industry	0,25	0,40	-0,18	0,46	-0,18	0,64	0,69	-0,47	0,5
25-Vegetable oils industry	0,61	0,97	-0,43	1,10	-0,43	1,36	1,47	-1,01	1,0
26-Other food products	5,33	8,50	-3,77	9,59	-3,76	15,53	16,87	-11,53	13,
27-Other industries	0,14	0,22	-0,10	0,24	-0,10	0,45	0,49	-0,34	0,4
28-Public usefulness	2,00	3,19	-1,42	3,60	-1,41	2,64	2,87	-1,96	1,4
29-Building	0,31	0,50	-0,22	0,56	-0,22	0,40	0,44	-0,30	0,2
30-Commerce / transport	10,19	16,25	-7,22	18,35	-7,18	12,39	13,46	-9,20	6,2
31-Communication	0,54	0,87	-0,38	0,98	-0,38	0,73	0,79	-0,54	0,4
32-Services	5,73	9,13	-4,06	10,31	-4,04	7,40	8,03	-5,49	3,9
Total impact	198,89	317,15	-140,84	358,01	-140,20	230,22	249,99	-170,90	109

*: DX1 = results from changes minimum of 18,5% in the Brazilian beef exports caused by a shock of 10% in the exchange rate.

DX2 = results from changes maximum of 29,5% in the Brazilian beef exports caused by a shock of 10% in the exchange rate.

DX3 = results from changes of 13,1% in the Brazilian beef exports caused by a shock of 10,0% in the Brazilian GDP.

DX4 = results from changes of 33,3% in the Brazilian beef exports caused by a shock of 10,0% in the industrial production index of the industrialized countries.

DX5 = results from changes of 13,0% in the Brazilian beef exports caused by a shock of 10,0% in the world income level.

DX6 = results from changes of 16,3% in the Brazilian poultry exports caused by a shock of 10% in the exchange rate.

DX7 = results from changes of 17,7% in the Brazilian poultry exports caused by a shock of 10% in the world income level.

DX8 = results from changes of de 12,1% in the Brazilian poultry exports caused by a shock of 10,0% in the Brazilian GDP.

DX9 = results from changes of 13,0% in the Brazilian poultry exports caused by a shock of 10,0% in the world income level.

DX10 = results from changes of 18,5% in the Brazilian beef exports and 3,3% in the Brazilian poultry exports caused by a shock of 10,0% in the exchange rate.

Table 12. Changes in the production level of the Brazilian economic sectors resulting from shocks in the Brazilian meat exports (%).

Sectors	Changes in the production level (%)								
	DX1*	**DX2***	**DX3***	**DX4***	**DX5***	**DX6***	**DX7***	**DX8***	**DX**
1-Corn grain	0,090	0,144	-0,064	0,163	-0,064	0,235	0,255	-0,174	0,19
2-Cattle-raising	0,508	0,810	-0,360	0,915	-0,358	0,001	0,002	-0,001	-0,3
3-Poultry-raising	0,002	0,002	-0,001	0,003	-0,001	1,150	1,249	-0,854	1,24
4-Other animals-raising	0,364	0,581	-0,258	0,655	-0,257	0,006	0,006	-0,004	-0,2
5-Other farm products	0,012	0,019	-0,008	0,021	-0,008	0,014	0,015	-0,010	0,0
6-Mining	0,005	0,008	-0,003	0,009	-0,003	0,007	0,008	-0,005	0,0
7-Steel industry	0,004	0,007	-0,003	0,007	-0,003	0,006	0,006	-0,004	0,0
8-Machinery / vehicles	0,002	0,004	-0,002	0,005	-0,002	0,003	0,004	-0,002	0,0
9-Electric / electronic	0,001	0,001	-0,000	0,001	0,000	0,001	0,001	-0,001	0,0
10-Wood / furnishings	0,001	0,002	-0,001	0,002	-0,001	0,002	0,003	-0,002	0,0
11-Paper / graphics	0,004	0,006	-0,003	0,006	-0,003	0,007	0,007	-0,005	0,0
12-Rubber industry	0,004	0,006	-0,003	0,007	-0,003	0,005	0,006	-0,004	0,0
13-Chemistry	0,011	0,017	-0,008	0,019	-0,008	0,015	0,017	-0,011	0,0
14-Pharmacy / veterinary	0,010	0,015	-0,007	0,017	-0,007	0,004	0,004	-0,003	-0,0
15-Plastic goods	0,005	0,008	-0,003	0,009	-0,003	0,053	0,058	-0,040	0,0
16-Textile industry/clothing	0,001	0,002	-0,001	0,003	-0,001	0,003	0,004	-0,002	0,0
17-Shoes industry	0,003	0,005	-0,002	0,006	-0,002	0,001	0,001	-0,001	-0,0
18-Coffee industry	0,000	0,000	-0,000	0,001	0,000	0,000	0,001	0,000	0,0
19-Vegetable products processing	0,004	0,007	-0,003	0,008	-0,003	0,017	0,019	-0,013	0,0
20-Cattle slaughter / industry	0,888	1,417	-0,629	1,599	-0,626	0,002	0,003	-0,002	-0,6
21-Poultry slaughter / industry	0,001	0,001	-0,000	0,001	0,000	2,289	2,485	-1,699	2,48
22-Other animal slaughter	0,100	0,160	-0,071	0,180	-0,071	0,002	0,002	-0,002	-0,0
23-Milk industry	0,001	0,002	-0,001	0,003	-0,001	0,002	0,002	-0,001	0,0
24-Sugar industry	0,005	0,008	-0,004	0,009	-0,004	0,013	0,014	-0,009	0,0
25-Vegetable oils industry	0,006	0,009	-0,004	0,010	-0,004	0,013	0,014	-0,009	0,0
26-Other food products	0,022	0,036	-0,016	0,040	-0,016	0,065	0,071	-0,048	0,0
27-Other industries	0,002	0,003	-0,001	0,004	-0,001	0,007	0,007	-0,005	0,0
28-Public usefulness	0,007	0,011	-0,005	0,013	-0,005	0,009	0,010	-0,007	0,0
29-Building	0,000	0,001	-0,000	0,001	0,000	0,000	0,000	0,000	0,0
30-Commerce / transport	0,008	0,013	-0,006	0,015	-0,006	0,010	0,011	-0,008	0,0
31-Communication	0,005	0,008	-0,004	0,009	-0,004	0,007	0,007	-0,005	0,0
32-Services	0,002	0,002	-0,001	0,003	-0,001	0,002	0,002	-0,001	0,0
Total impact	0,018	0,028	-0,013	0,032	-0,013	0,021	0,022	-0,015	0,0

*: DX1 = results from changes minimum of 18,5% in the Brazilian beef exports caused by a shock of 10% in the exchange rate.

DX2 = results from changes maximum of 29,5% in the Brazilian beef exports caused by a shock of 10% in the exchange rate.

DX3 = results from changes of 13,1% in the Brazilian beef exports caused by a shock of 10,0% in the Brazilian GDP.

DX4 = results from changes of 33,3% in the Brazilian beef exports caused by a shock of 10,0% in the industrial production index of the industrialized countries.

DX5 = results from changes of 13,0% in the Brazilian beef exports caused by a shock of 10,0% in the world income level.

DX6 = results from changes of 16,3% in the Brazilian poultry exports caused by a shock of 10% in the exchange rate.

DX7 = results from changes of 17,7% in the Brazilian poultry exports caused by a shock of 10% in the world income level.

DX8 = results from changes of de 12,1% in the Brazilian poultry exports caused by a shock of 10,0% in the Brazilian GDP.

DX9 = results from changes of 13,0% in the Brazilian poultry exports caused by a shock of 10,0% in the world income level.

DX10 = results from changes of 18,5% in the Brazilian beef exports and 3,3% in the Brazilian poultry exports caused by a shock of 10,0% in the exchange rate.

Table 13. Changes in the imports level of the Brazilian economic sectors resulting from shocks in the Brazilian meat exports (R$).

Sectors	Changes in the total imports (R$ - thousand)							
	DM1*	**DM2***	**DM3***	**DM4***	**DM5***	**DM6***	**DM7***	**DM8***
1-Corn grain	19,00	30,30	-13,50	34,20	-13,40	49,40	53,60	-36,60
2-Cattle-raising	20,30	32,40	-14,40	36,60	-14,30	0,10	0,10	0,00
3-Poultry-raising	0,00	0,10	-0,00	0,10	0,00	34,50	37,50	-25,60
4-Other animals-raising	14,60	23,20	-10,30	26,20	-10,30	0,20	0,30	-0,20
5-Other farm products	106,30	169,50	-75,30	191,30	-74,90	124,50	135,20	-92,40
6-Mining	22,20	35,30	-15,70	39,90	-15,60	32,50	35,20	-24,10
7-Steel industry	114,20	182,10	-80,90	205,50	-80,50	158,20	171,70	-117,40
8-Machinery / vehicles	101,40	161,70	-71,80	182,60	-71,50	135,70	147,30	-100,70
9-Electric / electronic	21,30	33,90	-15,10	38,30	-15,00	37,20	40,40	-27,60
10-Wood / furnishings	2,20	3,50	-1,60	4,00	-1,60	4,00	4,40	-3,00
11-Paper / graphics	40,10	64,00	-28,40	72,20	-28,30	77,70	84,40	-57,70
12-Rubber industry	20,10	32,10	-14,20	36,20	-14,20	26,60	28,90	-19,70
13-Chemistry	758,60	1209,70	-537,20	1365,50	-534,70	1093,40	1187,30	-811,70
14-Pharmacy / veterinary	95,80	152,80	-67,80	172,50	-67,50	37,10	40,30	-27,60
15-Plastic goods	21,30	33,90	-15,10	38,30	-15,00	231,80	251,80	-172,10
16-Textile industry / clothing	26,70	42,50	-18,90	48,00	-18,80	60,70	65,90	-45,00
17-Shoes industry	9,40	14,90	-6,60	16,80	-6,60	3,40	3,70	-2,50
18-Coffee industry	0,00	0,00	-0,00	0,00	0,00	0,00	0,00	0,00
19-Vegetable product processing	32,50	51,80	-23,00	58,40	-22,90	126,20	137,00	-93,70
20-Cattle slaughter / industry	492,20	784,80	-348,50	885,90	-346,90	1,30	1,40	-1,00
21-Poultry slaughter / industry	0,10	0,20	-0,10	0,30	-0,10	576,80	626,30	-428,10
22-Other animal slaughter	13,00	20,80	-9,20	23,40	-9,20	0,30	0,30	-0,20
23-Milk industry	1,70	2,80	-1,20	3,10	-1,20	2,40	2,60	-1,80
24-Sugar industry	4,10	6,50	-2,90	7,40	-2,90	10,30	11,20	-7,70
25-Vegetable oils industry	43,80	69,90	-31,00	78,90	-30,90	97,20	105,60	-72,20
26-Other food products	492,80	785,90	-349,00	887,10	-347,40	1436,60	1560,00	-1066,50
27-Other industries	1,20	1,80	-0,80	2,10	-0,80	3,90	4,20	-2,90
28-Public usefulness	318,00	507,10	-225,20	572,50	-224,20	419,60	455,70	-311,50
29-Building	12,50	19,90	-8,80	22,40	-8,80	16,10	17,40	-11,90
30-Commerce / transport	469,30	748,30	-332,30	844,70	-330,80	570,60	619,60	-423,60
31-Communication	0,90	1,40	-0,60	1,50	-0,60	1,10	1,20	-0,80
32-Services	2150,70	3429,50	-1522,90	3871,30	-1516,00	2777,00	3015,50	-2061,50
Total impact	5426,30	8652,60	-3842,30	9767,20	-3824,90	8146,40	8846,00	-6047,30

*: DX1 = results from changes minimum of 18,5% in the Brazilian beef exports caused by a shock of 10% in the exchange rate.

DX2 = results from changes maximum of 29,5% in the Brazilian beef exports caused by a shock of 10% in the exchange rate.

DX3 = results from changes of 13,1% in the Brazilian beef exports caused by a shock of 10,0% in the Brazilian GDP.

DX4 = results from changes of 33,3% in the Brazilian beef exports caused by a shock of 10,0% in the industrial production index of the industrialized countries.

DX5 = results from changes of 13,0% in the Brazilian beef exports caused by a shock of 10,0% in the world income level.

DX6 = results from changes of 16,3% in the Brazilian poultry exports caused by a shock of 10% in the exchange rate.

DX7 = results from changes of 17,7% in the Brazilian poultry exports caused by a shock of 10% in the world income level.

DX8 = results from changes of de 12,1% in the Brazilian poultry exports caused by a shock of 10,0% in the Brazilian GDP.

DX9 = results from changes of 13,0% in the Brazilian poultry exports caused by a shock of 10,0% in the world income level.

DX10 = results from changes of 18,5% in the Brazilian beef exports and 3,3% in the Brazilian poultry exports caused by a shock of 10,0% in the exchange rate.

Table 14. Changes in the salary level of the Brazilian economic sectors resulting from shocks in the Brazilian meat exports.

Sectors	Changes in the total salary (R$ - thousand)							
	DS1*	**DS2***	**DS3***	**DS4***	**DS5***	**DS6***	**DS7***	**DS8***
1-Corn grain	580,90	926,00	-411,30	1046,00	-409,50	1.509,00	1.638,60	-1.120,20
2-Cattle-raising	7098,40	11319,00	-5026,40	12777,00	-5003,40	20,80	22,60	-15,50
3-Poultry-raising	7,10	11,00	-5,00	13,00	-5,00	5.429,80	5.896,10	-4.030,80
4-Other animals-raising	1267,30	2021,00	-897,40	2281,00	-893,30	20,60	22,40	-15,30
5-Other farm products	427,60	682,00	-302,80	770,00	-301,40	500,80	543,80	-371,70
6-Mining	114,30	182,00	-80,90	206,00	-80,60	167,50	181,90	-124,30
7-Steel industry	168,30	268,00	-119,20	303,00	-118,60	233,10	253,10	-173,00
8-Machinery / vehicles	167,20	267,00	-118,40	301,00	-117,80	223,60	242,80	-166,00
9-Electric / electronic	12,80	20,00	-9,10	23,00	-9,10	22,50	24,40	-16,70
10-Wood / furnishings	22,30	36,00	-15,80	40,00	-15,70	40,90	44,40	-30,30
11-Paper / graphics	82,30	131,00	-58,30	148,00	-58,00	159,40	173,10	-118,40
12-Rubber industry	16,80	27,00	-11,90	30,00	-11,80	22,20	24,10	-16,50
13-Chemistry	323,30	516,00	-228,90	582,00	-227,90	466,00	506,00	-345,90
14-Pharmacy / veterinary	106,50	170,00	-75,40	192,00	-75,10	41,30	44,80	-30,60
15-Plastic goods	43,50	69,00	-30,80	78,00	-30,70	474,30	515,10	-352,10
16-Textile industry / clothing	34,50	55,00	-24,40	62,00	-24,30	78,50	85,30	-58,30
17-Shoes industry	27,20	43,00	-19,30	49,00	-19,20	9,90	10,70	-7,30
18-Coffee industry	0,60	1,00	-0,40	1,00	-0,40	1,10	1,20	-0,90
19-Vegetable product processing	44,10	70,00	-31,20	79,00	-31,10	171,40	186,10	-127,20
20-Cattle slaughter / industry	4569,10	7286,00	-3235,40	8224,00	-3220,60	12,00	13,00	-8,90
21-Poultry slaughter / industry	1,40	2,00	-1,00	2,00	-1,00	5.339,60	5.798,10	-3.963,80
22-Other animal slaughter	121,10	193,00	-85,80	218,00	-85,40	2,80	3,10	-2,10
23-Milk industry	4,10	7,00	-2,90	7,00	-2,90	5,60	6,10	-4,20
24-Sugar industry	19,90	32,00	-14,10	36,00	-14,00	50,10	54,40	-37,20
25-Vegetable oils industry	12,20	20,00	-8,70	22,00	-8,60	27,10	29,50	-20,10
26-Other food products	459,60	733,00	-325,50	827,00	-324,00	1.339,80	1.454,90	-994,60
27-Other industries	18,70	30,00	-13,30	34,00	-13,20	62,70	68,10	-46,50
28-Public usefulness	441,50	704,00	-312,60	795,00	-311,20	582,50	632,50	-432,40
29-Building	20,10	32,00	-14,30	36,00	-14,20	25,90	28,20	-19,30
30-Commerce / transport	2031,50	3239,00	-1438,50	3657,00	-1431,90	2.470,20	2.682,30	-1.833,70
31-Communication	121,00	193,00	-85,70	218,00	-85,30	162,20	176,10	-120,40
32-Services	1728,00	2756,00	-1223,60	3110,00	-1218,00	2.231,20	2.422,90	-1.656,30
Total impact	20093,20	32041,00	-14228,30	36167,00	-14163,20	21.904,40	23.785,70	-16.260,50

*: DX1 = results from changes minimum of 18,5% in the Brazilian beef exports caused by a shock of 10% in the exchange rate.

DX2 = results from changes maximum of 29,5% in the Brazilian beef exports caused by a shock of 10% in the exchange rate.

DX3 = results from changes of 13,1% in the Brazilian beef exports caused by a shock of 10,0% in the Brazilian GDP.

DX4 = results from changes of 33,3% in the Brazilian beef exports caused by a shock of 10,0% in the industrial production index of the industrialized countries.

DX5 = results from changes of 13,0% in the Brazilian beef exports caused by a shock of 10,0% in the world income level.

DX6 = results from changes of 16,3% in the Brazilian poultry exports caused by a shock of 10% in the exchange rate.

DX7 = results from changes of 17,7% in the Brazilian poultry exports caused by a shock of 10% in the world income level.

DX8 = results from changes of de 12,1% in the Brazilian poultry exports caused by a shock of 10,0% in the Brazilian GDP.

DX9 = results from changes of 13,0% in the Brazilian poultry exports caused by a shock of 10,0% in the world income level.

DX10 = results from changes of 18,5% in the Brazilian beef exports and 3,3% in the Brazilian poultry exports caused by a shock of 10,0% in the exchange rate.

Table 15. Total impacts of the changes in the Brazilian beef and poultry exports on the Brazilian production, import and salary totals (R$ - millions).

Changes in the Brazilian exports	Production level (R$-millions)	Total imports (R$-millions)	Total salary (R$-millions)
DY1*	198,89	5,43	20,09
DY2*	317,15	8,65	32,04
DY3*	-140,84	-3,84	-14,23
DY4*	358,01	9,77	36,17
DY5*	-140,20	-3,82	-14,16
DY6*	230,22	8,15	21,90
DY7*	249,99	8,85	23,79
DY8*	-170,90	-6,05	-16,26
DY9*	109,79	5,02	9,62
DY10*	245,51	7,08	24,53

*: DX1 = results from changes minimum of 18,5% in the Brazilian beef exports caused by a shock of 10% in the exchange rate.
DX2 = results from changes maximum of 29,5% in the Brazilian beef exports caused by a shock of 10% in the exchange rate.
DX3 = results from changes of 13,1% in the Brazilian beef exports caused by a shock of 10,0% in the Brazilian GDP.
DX4 = results from changes of 33,3% in the Brazilian beef exports caused by a shock of 10,0% in the industrial production index of the industrialized countries.
DX5 = results from changes of 13,0% in the Brazilian beef exports caused by a shock of 10,0% in the world income level.
DX6 = results from changes of 16,3% in the Brazilian poultry exports caused by a shock of 10% in the exchange rate.
DX7 = results from changes of 17,7% in the Brazilian poultry exports caused by a shock of 10% in the world income level.
DX8 = results from changes of de 12,1% in the Brazilian poultry exports caused by a shock of 10,0% in the Brazilian GDP.
DX9 = results from changes of 13,0% in the Brazilian poultry exports caused by a shock of 10,0% in the world income level.
DX10 = results from changes of 18,5% in the Brazilian beef exports and 3,3% in the Brazilian poultry exports caused by a shock of 10,0% in the exchange rate.

Table 16. Changes in the production processes of the beef and poultry industries, estimated to five years ahead.

	Coefficient	% of changes in the coefficients of Matr
		Simulations

Sectors	changed in the Matrix A	1º-	2º-	3º-	
2-Cattle-raising	a_{22}	5	5	10	
3-Poultry-raising	a_{33}	2	2	5	
4-Other animals-raising	a_{44}	2	11	11	
20-Cattle slaughter / industry	a_{2020}	5	10	10	
21-Poultry slaughter / industry.	a_{2121}	5	5	10	
22-Other animal. slaughter	a_{2222}	5	10	15	

Table 17. Type 1 Multipliers and Rasmussen/Hirschman backward and forward linkage indices after simulation changes in the production process of beef and poultry industries.

Sectors	Multipliers	Order	Rasmussen/Hirschman linkage indic			
			Backward		Forward	
			Index	Order	Index	O
1-Corn grain	1,6238	25	1,0060	11	0,8109	
2-Cattle-raising	1,5625	29	0,9009	13	0,7803	
3-Poultry-raising	2,0746	15	0,8188	14	1,0360	
4-Other animals-raising	2,1585	12	0,6333	25	1,0779	
5-Other farm products	1,5695	28	2,7366	2	0,7837	
6-Mining	1,9552	19	1,1166	7	0,9764	
7-Steel industry	2,3387	7	1,6713	5	1,1679	
8-Machinery / vehicles	2,0361	16	1,0927	8	1,0167	
9-Electric / electronic	1,9342	21	0,6608	22	0,9659	
10-Wood / furnishings	2,0022	17	0,6536	23	0,9998	
11-Paper / graphics	2,1552	13	0,9779	12	1,0763	
12-Rubber industry	2,1526	14	0,8022	15	1,0749	
13-Chemistry	1,9209	22	2,7639	1	0,9592	
14-Pharmacy / veterinary	1,8384	23	0,5429	31	0,9181	
15-Plastic goods	1,9584	18	0,7502	17	0,9780	
16-Textile industry/clothing	2,2227	9	1,0318	10	1,1099	
17-Shoes industry	2,2038	10	0,6123	27	1,1005	
18-Coffee industry	2,3726	6	0,6762	20	1,1848	
19-Vegetable prod. processing	2,1967	11	0,6906	19	1,0970	
20-Cattle slaughter / industry	2,5524	1	0,6920	18	1,2746	
21-Poultry slaughter / industry	2,4566	3	0,5045	32	1,2268	
22-Other animal slaughter	1,5165	31	0,5474	30	0,7573	
23-Milk industry	2,4154	5	0,6372	24	1,2062	
24-Sugar industry	2,4421	4	0,6731	21	1,2195	
25-Vegetable oils industry	2,5043	2	0,7758	16	1,2505	
26-Other food products	2,3070	8	1,0375	9	1,1520	
27-Other industries	1,9432	20	0,6016	28	0,9704	
28-Public usefulness	1,5990	27	1,1328	6	0,7985	
29-Building	1,6257	24	0,5939	29	0,8118	
30-Commerce / transport	1,6171	26	2,0746	3	0,8076	
31-Communication	1,2533	32	0,6230	26	0,6258	
32-Services	1,5718	30	1,9680	4	0,7849	

Table 18. Pure inter-industrial linkage indices (R$ - billions) after the forth simulation changes in the production process of beef and poultry industries: Pure Forward Linkage (PBL), Pure Backward Linkage (PBL) and Pure Total Linkage (PTL).

Sectors	PFL		PBL		PTL	
	Index	Order	Index	Order	Index	Ord
1-Corn grain	3,564	22	0,058	32	3,620	30
2-Cattle-raising	5,173	16	1,720	25	6,890	22
3-Poultry-raising	2,633	23	1,474	27	4,110	29
4-Other animals-raising	1,976	25	1,646	26	3,620	31
5-Other farm products	34,655	4	9,846	9	44,500	5
6-Mining	19,730	6	2,882	22	22,610	9
7-Steel industry	34,785	3	6,128	13	40,910	7
8-Machinery / vehicles	15,752	8	27,376	4	43,130	6
9-Electric / electronic	5,317	15	15,462	6	20,780	10
10-Wood / furnishings	4,023	19	5,700	15	9,720	17
11-Paper / graphics	13,231	9	3,635	20	16,870	13
12-Rubber industry	5,463	14	0,589	31	6,050	24
13-Chemistry	49,544	2	5,595	16	55,140	3
14-Pharmacy / veterinary	0,980	28	7,337	11	8,320	18
15-Plastic goods	6,482	11	1,094	29	7,580	19
16-Textile industry/clothing	4,968	17	8,154	10	13,120	14
17-Shoes industry	0,383	31	4,230	18	4,610	27
18-Coffee industry	0,603	30	3,651	19	4,250	28
19-Vegetable product processing	4,245	18	14,702	7	18,950	11
20-Cattle slaughter / industry	1,947	26	9,984	8	11,930	15
21-Poultry slaughter / industry	0,296	32	5,522	17	5,820	25
22-Other animal slaughter	0,657	29	0,852	30	1,510	32
23-Milk industry	1,082	27	6,056	14	7,140	20
24-Sugar industry	1,985	24	3,156	21	5,140	26
25-Vegetable oils industry	3,764	20	7,232	12	11,000	16
26-Other food products	7,058	10	19,564	5	26,620	8
27-Other industries	3,586	21	2,526	23	6,110	23
28-Public usefulness	15,856	7	2,322	24	18,180	12
29-Building	5,521	13	48,012	2	53,530	4
30-Commerce / transport	44,232	1	35,540	3	79,770	2
31-Communication	5,832	12	1,195	28	7,030	21
32-Services	34,082	5	78,002	1	112,080	1

5. CONCLUSIONS

This chapter has analyzed how changes in domestic and foreign macroeconomic variables can affect Brazilian meat exports and consequently the Brazilian economy and how changes in the production process of the beef and poultry industries affect their share in the Brazilian economy. The main results indicate that changes in macroeconomic variables can cause significant impacts on Brazilian meat exports, that, in turn, affect a large number of other agriculture sectors together with a few other sectors such as services, chemicals and food production that are strongly with agriculture in general.

While the forward linkage affects do vary, the strong backward linkages exhibited by the meat sectors suggest that they are clearly key sectors in the Brazilian economy. Forecasted changes in the production processes in these sectors do not affect either their impacts on the rest of the economy of their share of Brazilian GDP.

6. REFERENCES

ANUALPEC 96/98. Anuário da Pecuária Paulista. São Paulo: FNP Consultoria & Comércio, 1996/98.

BACHARACH, M. **Biproportional matrices & input-output change**. Cambridge: University Press, 1970. 170p.

BAER, W.; GUILHOTO, J. J. M.; FONSECA, M. A. R. Mudanças estruturais na economia industrial brasileira: 1960-1980. **Conjuntura Econômica**, v.40, n.7, p.95-103, jul. 1986.

BARROS, G. S. C. Impacts of monetary and real factors on the US dollar in identifiable VAR models. **Revista Brasileira de Economia**, v.45, p.519-541, out./dez. 1991.

BARROS, G. S. C.; AGUIAR, D. R. D. **Análise dos efeitos da liberação comercial sobre a competitividade da agricultura**. Piracicaba: Escola Superior de Agricultura "Luiz de Queiroz", Universidade de São Paulo, fev. 1994. (Relatório Final, projeto financiado pelo Banco Mundial).

BESSLER, D. A. Relative price and money: a vector autorregression on Brazilian data. **American Journal of Agricultural Economics**. v.66, n.1, p.25-30, 1984.

BLISKA, F. M. M. Tendências no mercado da carne de aves. **Coletânea ITA**L, v.27, n.1/2, p.119-128, Jan./dez. 1997a.

BLISKA, F. M. M. Industrialização da carne suína e bovina: análise e perspectiva. **Revista Nacional da Carne**, v.21, n.248, p.97-112, out.1997b.

BLISKA, F. M. M. Perspectivas de demanda para o mercado de carnes embaladas. In: GONÇALVES,J. R. (Ed.) **Preservação e acondicionamento de carne bovina "in natura"**, Campinas: CTC/ITAL, 1998. p.1-8: Perspectivas de demanda para o mercado de carnes embaladas.

BLISKA, F. M. M.; BARROS, G. S. C. Formação de preços de carne bovina : uma aplicação do modelo de auto-regressão vetorial. **Agricultura em São Paulo**, v.37, n.3, p.41-59, 1990.

BLISKA, F. M. M. (Coord.) Prospecção de demandas tecnológicas na cadeia produtiva de carne bovina em São Paulo. **Boletim Técnico do Instituto de Zootecnia**, n.42, 1998. 73p.

BLISKA, F. M. M.; GUILHOTO, J. J. M. Abate de animais e preparação de carnes no Brasil: importância e comportamento do setor - 1970/75/80. **Coletânea ITAL**, v.26, n.1, p. 55-70, jan./jun. 1996.

BLISKA, F. M. M.; VIEIRA, M. C. Tendência nas exportações brasileiras de carnes. **Coletânea ITAL**, v.26, n.1, jan./jun. 1996.

BULMER-THOMAS, V. **Input-output analysis in developing countries: source, methods and applications**. New York: Wiley, 1982. 197p.

COUTINHO, L. G.; FERRAZ, J. C. Competitividade na indústria de abate e preparação de carnes: estudo da competitividade da indústria brasileira. **Nota Técnica Setorial do Complexo Agroindustrial**, Campinas, IE/ UNICAMP - IE/UFRJ, 1993, 63p.

DBO Rural. Sistema bovino lidera faturamento na economia rural, v.13, n.174-A, p.22, fev.1995.

DICKEY, D. A.; FULLER, W. A. Distribution of the estimator for auto-regressive time series with a unit root. **Journal of the American Statistical Association**, v.74, p.427-31, 1979.

DICKEY, D. A.; FULLER, W. A. Likelihood ratio statistics for autorregressive time series with a unit root. **Econometrica**, v.49, n.4, p.1057-1072, jul. 1981.

ENDERS, W. **RATS Handbook For Econometric Time Series**. Iowa State University, 1996. 204p.

ENGLE, R. F.; GRANGER, C. W. J. Co-integration and error correction: representation, estimation, and testing. **Econometrica**, v.55, n.2, p.251-276, mar. 1987.

FAO. **FAOSTAT** – Statistics data base: agricultural trade data.

FAVERET FILHO, P.; CÔRTES, L. Cadeia da carne bovina: os desafios da coordenação vertical. **Agroindústria: informe setorial**. Rio de Janeiro: BNDES, n.14, jul. 1998. 4p.

FERREIRA, A. H. B. Teste de cointegração e um modelo de correção de erros para a balança comercial brasileira. **Estudos Econômicos**, v.23, n.1, p.35-65, jan./abr.1993.

FMI - **International Financial Statistics Yearbook**. International Monetary Fund. 1992/1997.

FULLER, W. A. **Introduction to statistical time series**. New York: John Wiley, 1976. 352p.

GUILHOTO, J. J. M. Um modelo computável de equilíbrio geral para planejamento e análise de políticos agrícolas (PAPA) na economia brasileira. Piracicaba: 1995. 258p. Tese (Livre Docência) - Escola Superior de Agricultura "Luiz de Queiroz", Universidade de São Paulo.

GUILHOTO, J.J.M. Mudanças estruturais e setores chaves na economia brasileira, 1960-1990. *In*: ENCONTRO Brasileiro de Econometria, 14. Campos do Jordão. **Anais...**., v.1, p.293-310, 1992.

GUILHOTO, J. J. M.; CONCEIÇÃO, P. H. Z.; CROCOMO, F. C. Estruturas de produção, consumo e distribuição de renda na economia brasileira: 1975 e 1980 comparados. **Economia & Empresa**. v.3, n.3, p.33-64, jul./set.1996.

GUILHOTO, J. J. M.; HEWINGS, G. J. D.; SONIS, M.; GUO, J. Economic structural change over time: Brazil and United States compared. **Economia Aplicada**, v.1, n.1, p.35-57, jan./mar.1997.

GUILHOTO, J. J. M.; SONIS, M.; HEWINGS, G. J. D. Linkages and multipliers in a multiregional framework: integration of alternative approaches. **Discussion Paper**. Urbana-Champaign: Regional Economics Applications Laboratory. 1996. 20p.

GUILHOTO, J. J. M.; HEWINGS, G. J. D.; SONIS, M. Interdependence, linkages and multipliers in Asia: an international input-output analysis. **Discussion Paper**. Urbana-Champaign: Regional Economics Applications Laboratory. 1997. 33p.

GUILHOTO, J.J.M.; SONIS, M.; HEWINGS, G.I.D.; MARTINS, E.B. Índices de ligações e setores-chave na economia brasileira: 1959/90. **Pesquisa e Planejamento Econômico**, v.24, n.2, p.287-314, agosto 1994.

GUILHOTO, J.J.M.; PICERNO, A. E. Estrutura produtiva, setores-chave e multilplicadores setoriais: Brasil e Uruguai comparados. **Revista Brasileira de Economia**, v.49, n.1, p.35-61, jan./mar.1995.

HEWINGS, G. J. D.; FONSECA, M. A. R.; GUILHOTO, J. J. M.; SONIS, M. Key sectors and structural change in the Brazilian economy: a comparison of alternative approaches and their policy implications. **Journal of Policy Modeling**. v.11, n.1, p.67-90, 1989.

HIRSCHMAN, A.O. **The strategy of economic development**. New Haven: Yale University Press, 1958.

IBGE. **Matriz de insumo produto - Brasil - 1995**. Rio de Janeiro: IBGE, 1997, 217p.

IBGE. **Produção da Pecuária Municipal - Brasil**; Rio de Janeiro: IBGE, v.23, n.1, 1995, 10p.

LIU, J. D.; CHUNG, P. J.; MEYERS, W. H. The impact of domestic and foreign macroeconomic variables on U.S. meat exports. **Agricultural and Resource Economics Review**, v.22, n.2, p.210-224, Oct. 1993.

MARTINS, S. S. Cadeias produtivas do frango e do ovo: avanços tecnológicos e sua apropriação. São Paulo: 1996. 113p. Tese (Doutorado) - Escola de Administração de Empresas de São Paulo da Fundação Getúlio Vargas.

MILLER, R. E.; BLAIR, P. D. **Input-output analysis: foundations and extensions**. Englewood Cliffs: Prentice-Hall, 1985. 464p.

NÚMEROS e metas para a pecuária bovina de corte. **Revista Nacional da Carne**, v.19, n.213, p.113, nov. 1994.

PICERNO PONGIBOVE, A. E. Políticas macroeconômicas, agricultura e comércio de produtos agrícolas: o caso do Brasil e Uruguai. Piracicaba: 1996. 181p. Tese (Doutorado) Escola Superior de Agricultura "Luiz de Queiroz", Universidade de São Paulo.

RASMUSSEN, P. **Studies in inter-sectoral relations**. Amsterdam: North Holland, 1956.

RODRIGUES, M. T. Eficiência alocativa do fundo constitucional de financiamento do Nordeste (FNE) - uma visão de insumo-produto. Piracicaba: 1997. 217p. Dissertação (MS) Escola Superior de Agricultura "Luiz de Queiroz", Universidade de São Paulo.

ROTHENBERG, T. J.; STOCK, J. H. Inference in a nearly integrated autoregressive model with nonnormal innovations. **Journal of Econometrics**, v. 80, n.2, p.269-286, oct. 1997.

SATO, G. S. A produção e o consumo de proteína animal no Brasil. **Revista Nacional da Carne**, v.20, n.224, p.20-28, out.1995.

SIMS, C. Money, income and causality. **American Economic Review**, v.62, n.4, p.540-552, 1972.

SIMS, C. Macroeconomics and reality. **Econometrica**, v.48, n.1, p.1-48, 1980.

STOCK, J.; WATSON, M. Testing for common trends. **Journal of the American Statistical Association**, v.83, p.1097-1107, Dec.1988.

VASCONCELOS, C. R. F. Impactos setoriais de mudanças na demanda final da agricultura. Viçosa: 1992. 77p. Dissertação (MS) – Universidade Federal de Viçosa.