IMPACT OF TECHNICAL REQUIREMENTS ON BRAZILIAN MANGO EXPORTS

RESUMO

O objetivo deste trabalho é estimar uma função oferta de exportação brasileira de manga utilizando a metodologia de Auto-Regresão Vetorial e verificar os possíveis impactos sobre o preço doméstico de cortes nas exportações brasileiras de manga para os principais mercados importadores do produto. Os cortes são simulados como conseqüência da hipótese do setor exportador de manga do Brasil não cumprir as exigências técnicas impostas por esses países. Para a definição das variáveis relevantes da função de oferta de exportação foi utilizado o modelo de Barros *et al* (2002), que permite a obtenção da função de exportação a partir das definições de oferta e demanda doméstica. É estimado o VAR estrutural com identificação pelo processo de Bernanke (1986) utilizando dados do período de janeiro de 1998 a dezembro de 2005. Os resultados, no que se refere a função oferta de exportação, indicam que um aumento no preço doméstico e na renda interna têm impactos negativos no *quantum* exportado de manga pelo Brasil. Por outro lado, o efeito acumulado de um aumento no índice de atratividade (aumento do preço de exportação e/ou desvalorização cambial) é o incremento nas exportações brasileiras de manga. Os resultados indicam também que o não cumprimento de uma exigência técnica, que causaria uma redução nas exportações de manga para determinado mercado, teria um impacto negativo sobre o preço doméstico. Se o corte ocorrer nas exportações brasileiras destinadas a União Européia a queda no preço interno da manga é relativamente maior, isso devido a importância do bloco como importador da fruta brasileira.

ABSTRACT

This paper approaches potential impacts of Brazilian mango exports due to difficulties in accomplish technical requirements presented by major importing countries. An export supply model is obtained considering domestic supply and demand, based on Barros et al. (2002). The model estimated is a structural VAR model, identified through Bernanke's (1986) procedure. The results suggest that if domestic mango prices and income increase, exports decrease. The accumulated effect of an increase in an index of attractiveness, expressed by an export price increase and/or exchange rate devaluation, enhances exports. The results also suggest that a reduction in exports due to non-compliance with technical requirements has a negative impact upon domestic prices, which is proportional to the importance of the importing market where exports are banned, as simulated for the case of Brazilian exports to the EU.

1 INTRODUCTION

Despite being one of the world's greatest producers of fruits, Brazil has not assumed a leading position in the international trade markets, since great portion of its production is absorbed at the domestic market. The importance of the fruit production chain for the domestic economy is also noteworthy. In 2003, the activity was responsible for generating 6 million direct employments, which is equivalent to 27 percent of all the labor force employed in the country (IBRAF, 2005).

Mango has assumed an important position in Brazilian tropical fruits exports. Currently, Brazil is among the three major exporters of mango with its trade flux concentrated towards the European Union and the United States markets. The value of Brazilian mango exports increased significantly in the last years, from US$ 32,517,407.00 in 1998, to US$ 72,507,946.00 in 2005, which corresponds to an increase of about 122.98% (SECEX, 2006).

According to FAO data, Brazilian mango export share represented 12.25 percent of total world exports in 2004. From 2000 until 2004, Brazilian exports increased by 65.52% while world mango exports expanded by 45.9% in this period. Only Mexico and India surpassed Brazil on mango export volume through this period. Together, these two countries were responsible for 50 percent of all world exports of the fruit.

The international market for mangoes has been recognized as a very selective market, where requirements about quality, origin and sustainability of the fruit production system are important factors. Therefore, Brazilian exporters have seen their expansion plans restricted by difficulties resulting from seemingly neo-protectionist measures, such as technical barriers, as well as strict sanitary and phytosanitary issues. Technical requirements have been mostly related to safety, health and quality of human life. It leads to trade banning, unless the exporter complies with the requirements imposed by buyers. Currently, most requirements applied to mangoes are somehow related to scouting for fruit fly, hot water treatment as well as specifications of the quality pattern of mangoes.

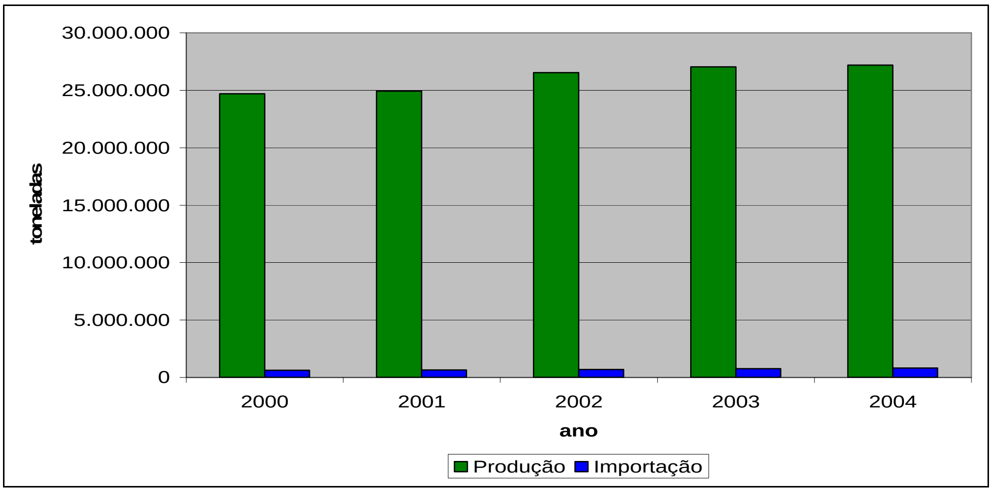
The purpose of this work is to estimate an export supply function for Brazilian mango using a vector auto-regressive model to identify possible impacts upon domestic prices due to simulated bans in exports by its major importers. The total or partial export bans are assumed to result from situations where complying with technical requirements presented by importers is difficult or represents a too heavy burden for the exporting country to accomplish.

This article is divided in five parts. The first, this introduction, presented the issue and purpose of the study; the second gives a brief characterization of the international market for mangoes. After that, the economic model is presented together with methodological procedures, followed by results and discussion. Finally conclusions are presented.

2 International markets for mango and perspectives

The international trade of mango is relatively small compared to world production. The later is higher than 20 million tones while world imports do not add up to one million ton of mango (FAO, 2006). Data presented by FAO shows that for 2004, world production reached 27.1 million tones and imports summed 818.2 thousand tones that is equivalent to 3 percent of all the production value (Figure 1).

Figure 1 – World Production and Imports of mango, 2000 to 2004, in tones



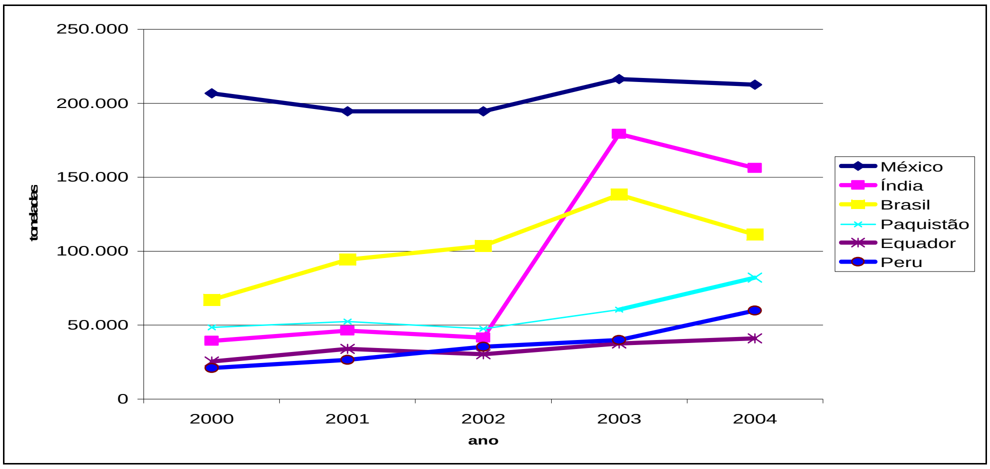
Source: FAO

In fact, this reduced weight of trade upon world production of mango is a general characteristic of tropical fruit markets. Similar to what happens in Brazil, a great portion of these fruits is consumed internally at their production regions. World production of mango is leaded by India and China, which accounted, together, for 14 million tones in 2005, which is equivalent to more than 50 percent of world production. Brazil was ranked as the seventh greatest producer with one million tones of mango produced in the country.

At the demand side, mango buyers are concentrated within a few countries, mostly in Europe, Asia, Middle East and United States. More than 90 percent of total imports were concentrated in 15 countries in 2004, such that the United States, Netherlands, Saudi Arabia and Arabs Emirates imported 60 percent of the volume traded by 2004. The highest portion is exported to the United States, an importer responsible for 33 percent of world imports in 2004. More recently, however, some other countries have been showing high and rapid increase in the demand for mangos, such as Malaysia, Saudi Arabia, Portugal, Bangladesh and United Kingdom. France and Germany have also presented an increasing mango import trend in the last years. Japan is an emerging market where quality requirements are high, but so is the remuneration for the product in relative terms.

In 2004, México and India were major exporters at this market followed by Brazil that sustained a third position in the rank. India exports grew by almost 300 percent while Mexico's exports were relatively low on 3 percent. Peru, Pakistan and Ecuador emerged as important competitors for the third place in the market, currently occupied by Brazil. Export growth rate were also high in the period for these countries.

Figure 2 – Major world exporters of mango, from 2000 to 2004, in tones

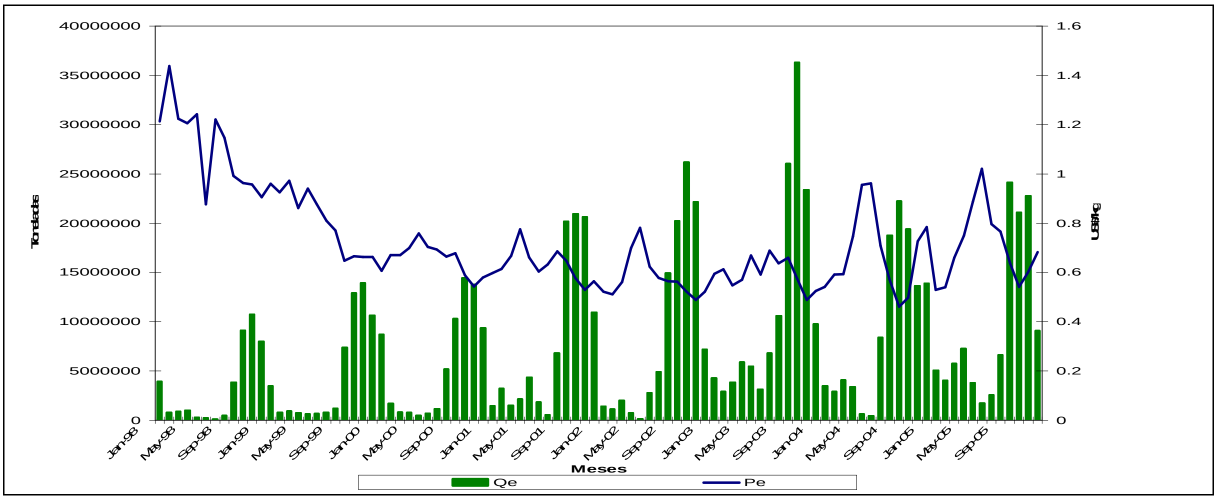


Source: FAO

FAO (2005) presented projections for the world market of tropical fruits expected for 2014. Mango imports are expected to grow at an annual rate of 1.4 percent through the period. These projections indicated that the US and European Union are expected to remain as major importers. However, import growth in the EU should be higher. Besides the traditional exporters, such as France, Netherlands and United Kingdom, some countries, such as Spain are expected to reach a higher rank in exports.

Japan is expected to show a higher and increasing demand through the period in FAO (2005) predictions, presenting an annual growth rate of 3.43 percent, which is higher than the growth rate of world demand. Currently Japan imports 10,000 tones per year, which is almost entirely provided by the Philippines and Mexico. Mango from the Philippines is similar to Indian mangoes. Mexican mangoes are mostly of Tommy Atkins varieties, which is equivalent to the Brazilian mango. Since September 2004, Japan opened its market to Brazilian mango, however only for Tommy Atkins variety. This has been considered an important opportunity for Brazil to assume a greater portion of the export market between September and March, the off-season period for Mexican mango. As stressed before, although Japan represents a relatively small market for mangoes it buys at relatively higher prices and few exporters can accomplish the Japanese technical requirements for mango, including quarantine that require investments by producers (IBRAF, 2005).

Figure 3 – Brazilian exports of mangoes (in tones) and price received for exports (US$/kg) from 1998 to 2005



Source: MDIC/SECEX (2006)

Figure 3 shows the increase in Brazilian exports between 1998 and 2005, together with exports seasonality. Currently major volumes of Brazilian mango are shipped in the second semester of each year. It is also important to note a negative relation between prices paid for exports and quantity exported at the international mango market according to FAO (2006). Data from this source shows that an increase in mango supply for international markets led to lower export prices through the last years. One of the factors that might be explaining such trend is the increasing number of countries that have been trying to export more recently.

3 Methodology and Data

The impacts of technical requirements upon domestic market prices and upon export prices were simulated according to procedure also used by Bacchi (2006). The effects of technical requirements upon exports were simulated through estimation of an export supply function using vector auto-regression models (VAR). The export supply function is specified according to a theoretical model presented and applied by Barros *et al* (2002). This model specifies an export function based on definitions of domestic supply and demand functions, along with a price margin relationship. A detailed presentation of this model is presented in the following section together with the scenarios proposed for the analysis.

3.1 Theoretical model

Barros *et al* (2002) presented a model considering that exported quantity is a function of surplus function for the domestic market. Quantities demanded and supplied domestically, defined in logarithmic form, can be represented as:

$$q^s = F + \gamma p_d + \mu f \qquad \gamma > 0, \; \mu < 0 \qquad (1)$$
$$q^d = O + \eta p_d + \theta y \qquad \eta < 0, \; \theta > 0 \qquad (2)$$

where q^s and q^d are the quantities supplied and demanded, respectively, p_d is domestic price, f represents a supply shift factor and y is per capita income, with all variable expressed in logarithm form.

Assuming that in equilibrium, quantity demanded and supplied are equal such that:

$$F + \gamma p_d + \mu f = O + \eta p_d + \theta y$$

Then, domestic price can be determined based on this equality. It represents domestic equilibrium and also the prevailing price level in the absence of trade.

$$p_d^* = [(O - F) + \theta y - \mu f] / (\gamma - \eta) \qquad (3)$$

It is assumed that domestic mangoes can be exported at p_x (expressed in foreign country currency). A relationship of external (P_x) and domestic market prices (P_d) is used to define a marketing margin ($M = P_x / P_d$), which is also assumed sustained at a level that covers costs of these operations. It can be represented in a logarithmic form as:

$$m = a p_d \qquad (4)$$

where a is the elasticity that relates m and p_d. According to this definition, international prices must equal the sum of export margin and domestic prices, such that the following relation can be expressed:

$$p_x = p_d + m$$

or

$$p_d = p_x - a p_d \qquad (5)$$

Substitution equation (5) into equations (1) and (2), these can be rewritten as:

$$q^s = F + \gamma\, p_x - \gamma a\, p_d + \mu\, f \qquad (1')$$
$$q^d = O + \eta\, p_x - \eta a\, p_d + \theta\, y \qquad (2')$$

Based on these definitions, the model specifies the export supply as an excess supply upon domestic demand function, given domestic and international prices. The reduced form of these equations can be expressed in logarithmic form as:

$$q^x = f\,(p_x, p_d, f, y) \qquad (6)$$

It must be remembered that $q^x = ln\ Q^x$, and that $Q^x = Q^s - Q^d$, such that all capital letters represent quantities that are not expressed in a logarithmic form. However, the equality *px=pe*e*, where *pe* stands for export prices in foreign currency and e is an exchange rate can be used to transform expression (6) into:

$$q^x = f\,(p_{e},,e\ p_d, f, y) \qquad (6')$$

Barros *et al* (2002) specified exports as a function of its prices in foreign currency, of domestic price multiplied by and exchange rate, domestic per capita income and a supply-shifting factor. Based on this relationship, positive signs are expected for the estimated coefficients obtained for the exchange rate and negative estimated coefficients are expected for domestic price and income. The expected negative relation between domestic price and exports is based on the consideration that: an increase in domestic prices is related to an increase in domestic demand relative to supply, indicating potential export reduction. Since the model is expressed with its variables in logarithmic form the estimated coefficients can be interpreted as its elasticities. In addition, variables in logarithms reduce problems related to a non-constant variance of the error terms.

3.2 Methodology[1]

Vector auto-regressive models (VAR) can be used to obtain the response to a shock at a specified *k* number of periods after it occurs. When expressed as elasticities, these provide insights with respect to the behavior of individual variables as response to individual shocks

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[1] This section is bsed in Alves e Bacchi (2004).

in any variables of the system. Through simulations, these can be used to evaluate the effects of events that have a given positive probability to occur. The VAR allows for variance decomposition of the forecast error *k* future periods. This decomposition indicates the proportion of a variable change that is due to a shock upon the same variable and the proportion explained by shocks and other variables included in the equation. It is commonly considered that in the short run, a greater portion of the variance of error prediction is explained by the own variable while this proportion is also expected to be reduced as the period of forecast increases (ALVES; BACCHI, 2004).

The VAR methodology can be used to express the impacts upon domestic prices of a simulated export reduction, as a proxy for non attainment of technical requirements imposed by importing countries, based on the relationships expressed by the theoretical model.

A VAR methodology that applies Cholesky decomposition has limitations due to its implicit recursive structure for contemporaneous relationships between the variables included in the model. This identification process has been indicated as a limitation since its results will be highly based on the endogeneity degree of a variable which will result only due to the order used to include these in the recursive system (BORGES; SILVA, 2006). A structural VAR proposed by Sims (1986) and Bernanke (1986) allows for expressing contemporaneous relations between the variables according to economic theory (ENDERS, 2004).

A structural VAR model can be represented as:

$$B_0 y_0 = B_1 y_{t-1} + B_2 y_{t-1} + ... + B_p y_{t-p} + e_t \qquad (7)$$

Where B_j are (*n* x *n*) matrices for any *j>0,* B_0 is the matrix of contemporaneous relationships; e_t is an *n* x 1 vector of orthogonal shocks and y_t is a vector including variables focused by the analysis. In the present analysis these may be represented as: export quantity of mango, domestic price, per capita income and an index of attractiveness[2]

It must be stressed that the e_t are assumed to be not serially correlated and also that these are mutually not correlated such that $E(e_t e_t^{'}) = D$. Equation (7) can be represented as:

$$B(L) y_t = e_t \qquad (8)$$

2

Where L is the lag operator and $B(L)$ is a polynomial function expressed as $L\ (B_0 + B_1 L + B_2 L^2 + ... + B_P L^P)$. Equation (8) can be pre-multiplied by B_0^{-1} to obtain the VAR in a reduced form, such as:

$$A(L) y_t = u_t \tag{9}$$

Where $A(L) = B_0^{-1} B(L)$, $A_0 = I_n$ and $u_t = B_0^{-1} e_t$. A matrix of variance and covariance of the residual can be expressed as:

$$\Omega = B_0^{-1} D B_0^{-1}{}' \tag{10}$$

Bernanke (1986) presents a procedure that estimates coefficients related to B_0 and D. Based on the logarithmic form of the maximum function conditioned upon $\hat{\Omega}$. If the process is stationary, equation (9) can be rewritten as a moving average:

$$y_t = C(L) u_t \tag{11}$$

Where C(L), is an infinite order polynomial of the B_j matrices that is estimated based on knowledge of $A(L)$. Substituting $u_t = B_0^{-1} e_t$ into equation 11 allows it to be written as a function of e_t:

$$y_t = C(L) B_0^{-1} e_t \tag{12}$$

A representation of moving averages is used to examine the effects of shocks upon variables through its variance decomposition of the error prediction. The model can be expressed as a moving average if the series are stationary or if they become stationary after differentiation in order to avoid spurious relationship among the variables.

There are several procedures to test for unit roots. Among these, Fuller (1976) and Dickey & Fuller (1979 e 1981) have been most used. The general equation of Augmented Dickey & Fuller is represented as:

$$\Delta y_t = a_0 + \gamma y_{t-1} + a_2 t + \sum_{i=2}^{p} \beta_i \Delta y_{t-i+1} + \varepsilon_t \tag{13}$$

Where *p* indicates the order of the AR model used to describe the time series.

Statistics τ_τ, τ_μ e τ are defined by Fuller (1976) and correspond to a *t* test for the coefficient of the y_{t-1} variable indicated by equation 13 for: (a) including a constant and trend, (b) including a constant e (c) without constant and trend, respectively. In addition, statistics defined by Dickey and Fuller (1981) such as $\tau_{\beta\tau}$, $\tau_{\alpha\mu}$ e $\tau_{\alpha\tau}$ can be used to test the deterministic terms of each model. Enders (2004) has defined a procedure to be followed in order to define the model and which is presented in a detailed form at Annex 1 to this article.

The partial autocorrelation function and the AIC (AKAIKE Information Criterion) and SC (SCHWARZ Criterion) tests can be used in an one equation version to determine the value of *p* (maximum number of lags such that residuals are not auto-correlated due to misspecification). The *Q* test of Ljung Box can be used to check for the existence of autocorrelation and help in the determination of the *p* value.

If all variables are integrated of a same order, it becomes necessary to test for the existence of co-integration between them. Co-integration is a concept associated with a long run equilibrium relation between the variables. The methodology applies for models with more than two explanatory variables or for those where regression endogeneity is a potential problem, as proposed by Johansen (1988).

Regression Analysis of Time Series (RATS) program was used for model estimation and testing for unit roots.

3.3 Analytical model and data

The model proposed to evaluate mango export demand equation for this study is:

$$Qe_t = \alpha + \beta Pi_t + \phi AT_t + \theta Y_t + \sum_{i=1}^{11} \omega_i D_{it} + \sum_{j=1}^{n-1} \varphi_j Z_{jt} + u_t \tag{14}$$

Where Qe_t is the volume of mango exports, Pi_t is internal price, AT_t is the attractiveness index for mango exports, Y_t represents domestic per capita income, D_{it} are *dummy* variables introduced to represent different months of the year, and Z_{jt} represents dummy variables for each of the *n* years included in the sample.

The denominated index of attractiveness[3] (AT_t) represents the product of mango external prices and real effective exchange rate for this study. Therefore, an increase in this variable can result either from a mango price increase, in dollars, or from devaluation of Brazilian real with respect to other currency, or both of these factors. Therefore, considering the theoretical model specification, this variable is expected to show a positive relation with mango exports.

The matrix of contemporaneous relations was specified to express the theoretical model in terms of the contemporaneous effects, which means that exported quantity is considered to be contemporaneously related with (AT_t) and with domestic price. Income per capita was considered to impact exported quantities only at lagged periods. In addition, a contemporaneous positive effect is expected between the attractiveness index (AT_t) and domestic mango price. The underlying rational for this assumption is that an increase in the per unit value received for exported mango will make domestic prices higher, since part of the production would be directed to exports.

Data about quantity of mango exports were obtained from the Brazilian International Trade Secretary (SECEX) as presented by the System of Information Evaluation of International Trade (ALICE). An average price (Reals/kilos) was used for Tommy Atkins varieties of mangoes which are presented by CEAGESP/SP. Average price received for exports were obtained by dividing export values of the exported quantity. The real effective exchange rate was obtained from data provided by IPEADATA. Income per capita was represented by a *proxy*, calculated as the ratio of monthly estimates for Brazilian GDP, published by the Central Bank and population data was obtained from IBGE. The values expressed in Reals (R$) were deflated using the General Price Index- domestic availability (IGP – DI) published by the Getulio Vargas Foundation and the prices received for exports (in dollar per kilogram) was deflated using the Consumer Price Index of the United States which is also available at IPEADATA. The period of the analysis is January 1998 through December, 2005 and the data were transformed in logarithms for econometric analysis.

3.4 Scenarios

Once the VAR model is adjusted, it is used to simulate impulse response functions. In fact, any VAR that presents dynamic stability can be used to identify an innovation with a particular variable. This is equivalent to a conceptual experiment of disturbing a system at

[3] A concept adopted by CEPEA (2006) to evaluate Brazilian agribusiness exports (www.cepea.esalq.usp.br).

equilibrium (GREENE, 2000). For a given shock injected in the system, the endogenous variable will move away from, then return to, it's equilibrium. An impulse response of the VAR is the path whereby these variables return to their equilibrium values (GREENE;2000).

This characteristic was explored in the present analysis by injecting a shock in the form of export reductions, in different proportions. The effect of a change in the export variable accumulated through 12 months after the shock was used to calculate the impact of restricting mango exports upon domestic price (a concept that is also called flexibilities).

These flexibilities can be used to define scenarios considering that bans imposed by major importing countries – such as the United States and European Union - reduce BRAZILIAN MANGO exports by 80%, 60%, 40% e 20%, successively.

For that purpose the quantity traded and prices for 2005 were considered as a basic reference. It must be stressed that bans and cuts in mango exports are simulated separate for each importing country. The effects are accumulated when these measures are used by more than one importing country.

4 RESULTS AND DISCUSSION

4.1 Export supply function ESTIMATE for Brazilian mango exports

The procedure presented by Enders (2004) was applied to identify a model form considering its stationary properties. The results of unit root tests for the variables were first considered and are presented at Table 1. These suggest that export quantity (QE) and the attractiveness index (AT) are stationary, varying in turn of a deterministic trend until converging for equilibrium levels. Domestic price (PD) seems to be stationary with respect to its average trend. The time series used for Brazilian income per capita seems to be integrated of order one I(1). Considering that three series were I(0), however, the model specified with all the variables as I(0) was selected, since it presented the best adjustment.

Table 1 – Results of unit root tests: variables of the export supply equation of Brazilian mango

		Model 1*					**Model 2****
Variable	Value of **p-1**	τ_{τ}	$\tau_{\beta\tau}$	τ_{μ}	$\tau_{\alpha\mu}$	τ	τ
QE	7	-6.3430[a]	4.9084	-3.5770	3.5996	0.4417	-6.7695[a]
AT	1	-5.03843[a]	-3.25242	-3.76146	3.72534	-0.73775	-9.18376[a]
PD	17	-3.10422	0.82644	-3.04139[b]	0.86021	-2.92922	-2.35811[b]
YF	14					-1,37265	-2,68272[a]

Source: Research data

[a] Significant at 1%. [b] Significant at 5% significant level [critical values in Fuller (1976) and Dickey-Fuller (1981)]

[*]Model 1 - $\Delta y_t = \alpha + \beta T + \eta y_{t-1} + \sum_{i=1}^{p-1} \phi_i \Delta y_{t-1} + e_t$ encompassing three versions: with constant and trend, including a constant and without trend, and without constant and trend.

[**] Model 2 - $\Delta\Delta y_t = \eta \Delta y_{t-1} + \sum_{i=1}^{p-2} \phi_i \Delta\Delta y_{t-1} + e_t$ defined after identified the non existence of deterministic terms.

Table 2 presents the estimated coefficient for the matrix of contemporaneous relations associated to the structural VAR model. The coefficients are statistically significant and present the expected signs, except by the attractiveness index. However, a negative contemporaneous relation shown at Figure 3 is identified between prices received for exports and quantity exported. As mentioned before, an increase in the world supply of mangoes may cause a reduction in export prices through the years considered for the analysis. In addition, contemporaneous relations of exchange rate devaluation can also have a negative impact upon mango exports.

Table 2 – Estimated matrix of contemporaneous relations

Influence		Estimated coefficient	Standard deviation
from	upon		
AT	QE	-0.6572145	0.533998
PD	QE	-1.0786628[a]	0.310583
AT	PD	0.4425375[a]	0.173788

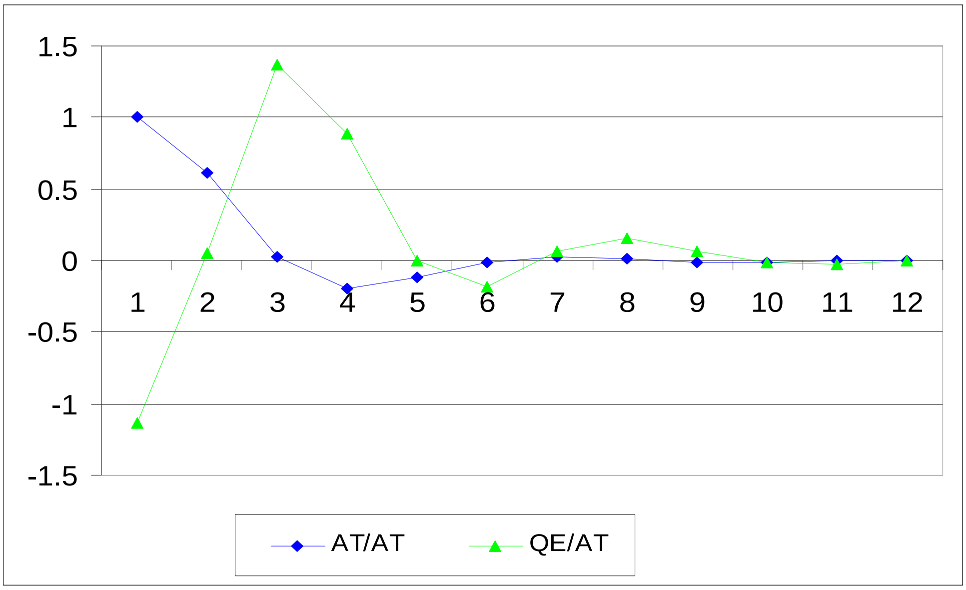
Source: research results

[a] Statistical significant at 1 percent

The effects of shocks upon the variables in the model are represented in Figures 4 to 7. The results are related to effects 12 periods after the injection of the shock and reported in terms of the accumulated value through this period.

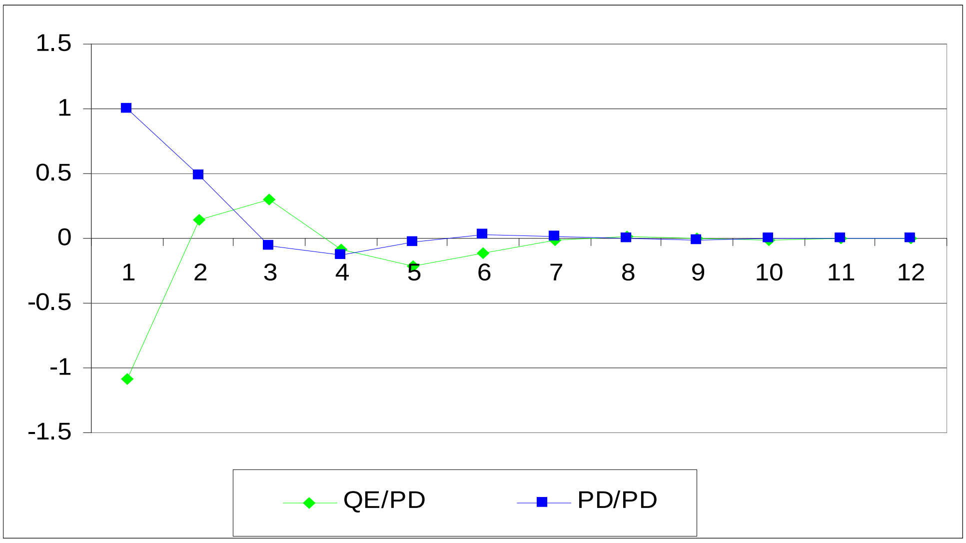
Figures 4 and 5 show the shocks in variables that determine the export supply function for mangoes in Brazil. The results suggest a negative contemporaneous relation between the attractiveness index upon mango exports. However, the accumulated effect of a 1 percent increase in the attractiveness index causes a positive accumulated effect of 1.24 percent in mangoes export quantity (Figure 4). The results also suggest that domestic prices have a negative contemporaneous impact upon exported quantity, since domestic price of mango increase by 1 percent causes a reduction of 1.07 percent in the exported quantity (Figure 5).

Figure 4 – Response function of *quantum* exported (QE) of mangoes to a shock upon the attractiveness index (AT)



Source: research results

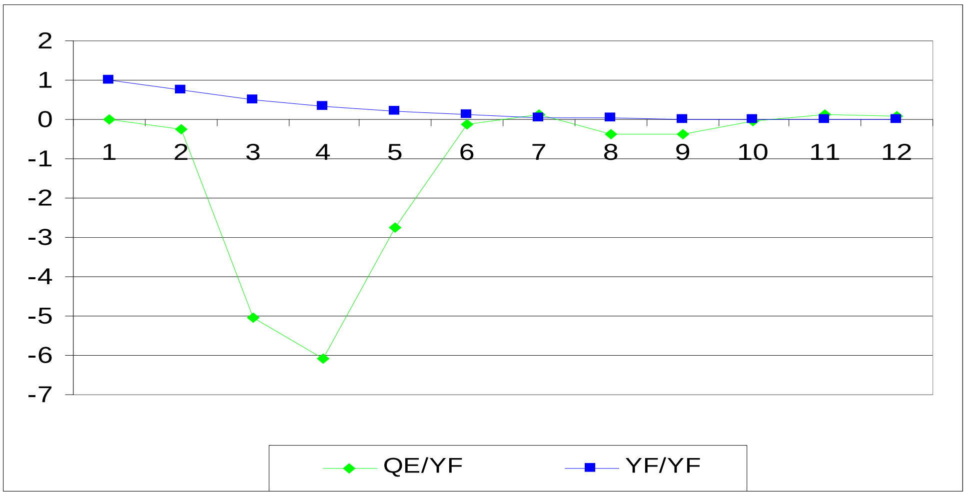
Figure 5 – Response of quantity exported (QE) of mangoes to a shock in domestic prices (DP)



Source: Results

Figure 6 presents the *per capita* income effect upon mangoes export quantity. It shows a negative impact between domestic income increase and mango exports, particularly in the third and fourth months. A positive shock of 1 percent in per capita income can accumulate and reduce exports by 14.73 percent at the end of the period.

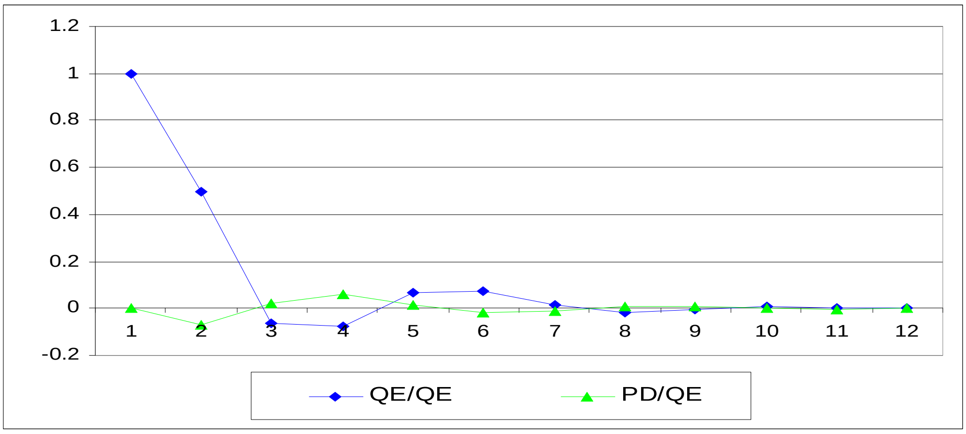
Figure 6 – Response function of quantity of mango (QE) to an income shock (YF)



Source: research results

The impact of a shock in exported quantity upon domestic price is presented in Figure 7. According to the results, an increase by 1 percent in exports at the end of the period may result in a slight increase in domestic prices, by 0.0124%. The estimated positive relationship between these variables was expected, considering that an increase in quantity exported implies in a lower domestic supply, with positive pressure upon prices. This result can be associated to the fact that a great part of domestic production of mangoes is consumed internally resulting in a lower relation between domestic prices and quantities exported. In fact, only 11 percent of all Brazilian mango production was exported by 2004 (IBRAF, 2005).

Figure 7 – Response function of mango domestic price (PD) to a shock in quantity exported (QE) of the product



Source: Research data

Table 3 presents the variance error decomposition of the prediction of a variable representing the quantity exported of mangoes. It can be observed that the attractiveness index and domestic price explain, in average, about 9.5 and 9 percent, respectively of the variance of the forecast error for quantity exported. Income shows a lower influence of approximately 6.46 percent, according to the period considered.

Table 3 – Historic decomposition of the variance of the forecast error of export quantity of mango (QE)

Months	Std deviation	QE	AT	PD	YF
1	0.525	84.480	4.370	11.150	0.000
2	0.578	86.993	3.621	9.378	0.008
3	0.603	80.070	8.142	9.232	2.556
4	0.622	75.783	9.603	8.749	5.865
5	0.625	75.081	9.483	8.953	6.484
6	0.627	75.046	9.511	8.989	6.454
7	0.627	75.040	9.518	8.987	6.454
8	0.627	74.988	9.571	8.980	6.461
9	0.627	74.970	9.580	8.978	6.472
10	0.627	74.969	9.581	8.978	6.472
11	0.627	74.967	9.582	8.978	6.473
12	0.627	74.967	9.582	8.978	6.473

Source: research results

The variance of forecast error for the attractiveness index is explained both by quantity exported and also by income (Table 4). Since this index is constructed based on a series of price received by exports and by effective real exchange rate, the quantity exported of mangoes and income explain a small portion of the variance of forecast error of this variable. Table 5 shows this decomposition for the domestic price variable. There seems to be a strong relationship with the attractiveness index, since it contains price received by mango exports. Starting at Period 7, the attractiveness index explains about 13.13 percent of the variance of forecast error for domestic prices. It must be stressed that an estimated contemporaneous relation between the attractiveness index and domestic prices were equal 0.44, indicating a significant relation between these variables.

Table 4 - Historic decomposition of the variance of the forecast error of attractiveness index (AT)

Months	Standard deviation	QE	AT	PD	YF
1	0.097	0.000	100.000	0.000	0.000
2	0.116	1.226	95.488	0.816	2.471
3	0.118	3.106	93.515	0.929	2.450
4	0.120	3.613	91.825	1.055	3.508
5	0.122	3.533	90.723	1.199	4.546
6	0.122	3.696	90.385	1.197	4.722
7	0.122	3.828	90.249	1.211	4.712
8	0.122	3.841	90.226	1.220	4.713
9	0.122	3.842	90.223	1.221	4.714
10	0.122	3.843	90.217	1.220	4.720

11	0.122	3.843	90.215	1.220	4.722
12	0.122	3.844	90.214	1.220	4.722

Source: research results

Table 5 - Historic decomposition of the variance of the forecast error of domestic price of mango (PD)

Months	Standard deviation	QE	AT	PD	YF
1	0.168	0.000	6.487	93.513	0.000
2	0.192	2.986	7.709	88.080	1.224
3	0.195	3.233	9.338	85.965	1.464
4	0.202	5.150	12.430	80.696	1.724
5	0.203	5.249	12.516	80.313	1.922
6	0.204	5.425	12.923	79.657	1.995
7	0.205	5.465	13.138	79.143	2.254
8	0.205	5.479	13.129	79.088	2.305
9	0.205	5.514	13.144	79.037	2.304
10	0.205	5.516	13.145	79.030	2.308
11	0.205	5.517	13.147	79.027	2.308
12	0.205	5.518	13.149	79.024	2.310

Source: research results

Table 6 presents the decomposition of forecast error variance for income. As expected the sequence *yf* development is relatively independent of shocks upon all other variables. Starting from period 5 the relationship with the attractiveness index becomes stronger where the real effective exchange rate is aggregated.

Table 6 – Historic decomposition of the variance of forecast error for income (YF)

Months	Standard deviation	QE	AT	PD	YF
1	0.019	0.000	0.000	0.000	100.000
2	0.024	0.321	0.167	0.108	99.404
3	0.026	1.194	1.464	0.500	96.842
4	0.027	2.016	3.100	0.658	94.226
5	0.028	2.417	4.038	0.686	92.859
6	0.028	2.579	4.319	0.709	92.393
7	0.028	2.647	4.361	0.737	92.255
8	0.028	2.667	4.366	0.754	92.213
9	0.028	2.669	4.369	0.758	92.204
10	0.028	2.669	4.371	0.759	92.201
11	0.028	2.669	4.372	0.759	92.200
12	0.028	2.669	4.372	0.759	92.200

Source: research results

4.2 Impacts of technical requirements

As mentioned before, the estimated value for the relation between exported quantity and domestic price (also called flexibility) considering the accumulated effects along 12 months is equal 0.0124 percent, which is a relatively small magnitude. Despite of the size of the impact it indicates that non-compliance of a technical requirement – which could reduce mango exports in a given market – would have a negative impact upon domestic prices.

The results associated with the simulation of bans in Brazilian exports for the major importing markets and its effects upon total quantity exported and domestic price are presented in Table 7.

Table 7 – Simulation of restrictions upon exports of Brazilian mango by the United States and by the European Union

	United States		European Union	
Restriction %	Export reduction%	Fall in domestic prices %	Export reduction %	Fall in domestic prices%
100%	23.16	0.29	71.26	0.88
80%	18.53	0.23	57.01	0.71
60%	13.90	0.17	42.76	0.53
40%	9.27	0.11	28.50	0.35
20%	4.63	0.06	14.25	0.18

Source: research results

Since European Union mango exports present a higher participation of Brazilian exports, the impacts of restrictions in the quantity imported by the bloc are relatively higher. The results indicate that if a technical requirement imposed by the EU implies in export ban if it cannot be accomplished, total Brazilian exports of mango would fall by 71.26 percent and domestic prices could decrease by 0.88 percent. If the same happened with United States imports, the estimated results indicate a reduction in total mango exports of 23.16 while domestic prices could reduce by 0.29 percent. It must be observed, however, that even if exports to these markets were not totally prohibited, the fall in domestic prices resulting from restrictions to enter these markets would be significant. The lower domestic price resulting from cut in external sales of the product can impact total receipts of Brazilian mango producers. In addition it is important to stress that producers who have a greater part of its product directed to external markets would be exposed to higher losses.

5 FINAL CONSIDERATIONS

The article presents the results of simulations about possible impacts of an export ban due to technical requirements imposed to Brazilian mango exports. These impacts upon domestic prices are evaluated based on a vector autoregressive model. The results suggest that the VAR and the theoretical structure delineated to represent export supply function are appropriate for the analysis. Results of a change in price received for exports and real effective exchange rates, combined into the attractiveness index presented an important effect upon the exported quantity. This effect was more pronounced two months after the shock. Positive shocks on domestic prices and income caused significant reductions in Brazilian mango exports.

The flexibility concept, that measures the effect of a change in exported quantities upon domestic prices, indicated that an export ban due to non-accomplishment of a technical requirement, for example, could result in a negative pressure upon domestic prices. Even though the resulting magnitude of the effect seems relatively small, if added to a reduction in exports, it can represent an expressive impact upon their income. For producers that have a greater portion of their production dedicated for exports, an export ban or a trade ban can have serious consequences in a short run. If the burden to adapt to requirements is too high and/or requires technical knowledge that is not immediately available in the country, these producers are left with the sole alternative to exit external markets.

These results also support the need to qualify products and national exporters to comply with the technical requirements, which is becoming progressively restrictive at the importing countries. In addition, investments towards certification programs and indicators of quality patterns of Brazilian fruits should also be important alternatives.

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ANNEX 1: PROCEDURE TO TEST FOR UNIT ROOTS PRESENTED BY ENDERS (1996)

Este anexo resume o procedimento proposto por Enders (1996) para testar a presença de raiz unitária. A partir da equação na sua forma mais geral, descreve-se os passos necessários para o teste:

$$\Delta y_t = a_0 + \gamma y_{t-1} + a_2 t + \sum_{i=2}^{p} \beta_i \Delta y_{t-i+1} + \varepsilon_t \qquad (4)$$

Primeiro passo: como é mostrado na figura 4, inicia-se ajustando o modelo menos restritivo (geralmente incluindo tendência e constante), utilizando a estatística t_t para testar a hipótese nula $\gamma = 0$. Testes de raiz unitária têm baixo poder para rejeitar a hipótese nula. Assim, se a hipótese nula de uma raiz unitária é rejeitada, não há necessidade de prosseguir. Conclui-se que a seqüência de $\{y_t\}$ não contêm raiz unitária.

Segundo passo: se a hipótese nula não é rejeitada, é necessário determinar se foram incluídos regressores determinísticos a mais no passo 1 acima. Testa-se a significância da variável tendência sob a nulidade da raiz unitária (utiliza-se a estatística $t_{ßt}$ para testar a significância de a_2). Deve-se tentar confirmar este resultado testando a hipótese $a_2 = \gamma = 0$ usando a estatística F_3. Se a tendência não for significativa, segue-se para o passo 3. Caso contrário, se a tendência for significativa, é preciso testar novamente a presença de raiz unitária ($\gamma = 0$) usando a distribuição normal padronizada. Depois disso, se for concluído que a tendência foi indevidamente incluída na equação estimada, a distribuição limite de a_2 é a normal padronizada. Se a nulidade da raiz unitária é rejeitada, conclui-se que $\{y_t\}$ não contém uma raiz unitária. Se a hipótese nula não for rejeitada, conclui-se que $\{y_t\}$ tem uma raiz unitária.

Terceiro Passo: estima-se a equação (4) sem o termo tendência. Testa-se para a presença de raiz unitária usando a estatística t_μ. Se a hipótese nula for rejeitada, conclui-se que o modelo não contém uma raiz unitária. Se a hipótese nula de uma raiz unitária não for rejeitada, verifica-se a significância da constante (usa-se a estatística $t_{a\mu}$ para testar a significância de a_0, dado $\gamma = 0$). A confirmação adicional deste resultado pode ser obtida testando a hipótese $a_0 = \gamma = 0$ usando a estatística F_1. Se a constante não é significativa, estima-se uma equação na forma $\Delta y_t = \gamma y_{t-1} + \sum_{i=2}^{p} \beta_i \Delta y_{t-i+1} + \varepsilon_t$ e procede-se ao passo 4. Se a constante é significativa, testa-se a presença de raiz unitária, usando a distribuição normal. Se a hipótese nula de existência de raiz unitária é rejeitada, conclui-se que a seqüência de $\{y_t\}$

não contém raiz unitária. Caso contrário, conclui-se que a seqüência $\{y_t\}$ contém uma raiz unitária.

Quarto passo: estima-se a equação (4) sem tendência e sem constante, ou seja, estima-se um modelo na forma: $\Delta y_t = \gamma y_{t-1} + \sum_{i=2}^{p} \beta_i \Delta y_{t-i+1} + \varepsilon_t$. Usa-se a estatística t para testar a presença de raiz unitária. Se a hipótese nula de existência de raiz unitária for rejeitada, conclui-se que a seqüência $\{y_t\}$ não tem raiz unitária. Caso contrário, a seqüência $\{y_t\}$ contém uma raiz unitária.

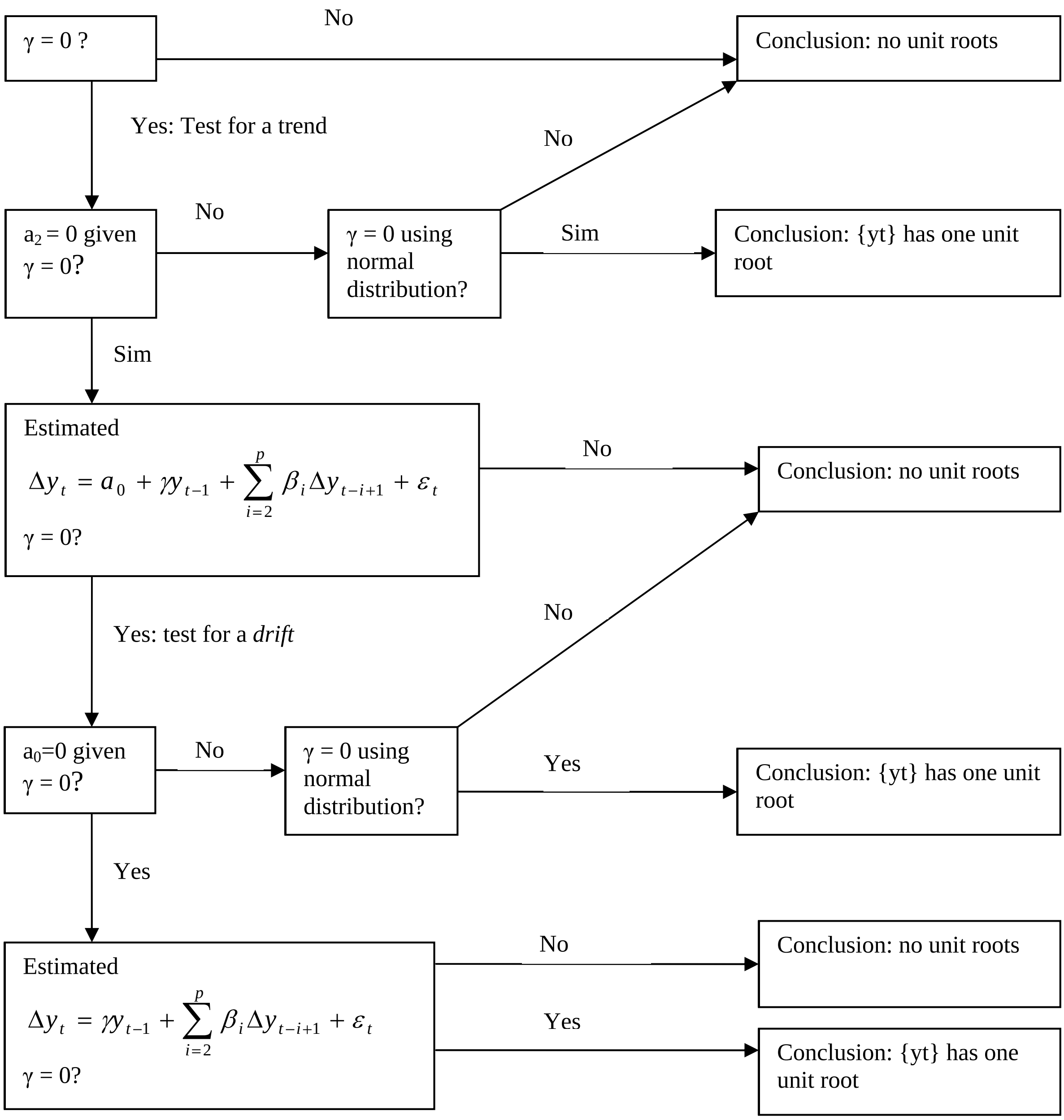

Figure 1: Procedure for testing for unit roots

Source: adapted from Enders (1996).

The coefficient that allows the identification of stationarity of the series is γ; if $\gamma=0$, the equation is expressed in first differences such that there is one unit root; if $\gamma < 1$ the process is stationary.