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COSTA RICAN MEAT VALUE CHAIN DESCRIPTION: PRICE TRANSMISSION AS A TOOL

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Abstract

Price transmission analysis is an increasing research topic, especially for price taking countries such as Costa Rica. We describe the beef supply chain and provide a numerical implementation of Vector Error Correction Model (VECM) of price transmission for the meat market in order to observe the relationship between import prices of meat and their effects on national retail prices. To restore equilibrium, retail prices correct 8% of the error term monthly. Since the meat imports market of Costa Rica is complex, the analysis of others business partners as Nicaragua should be included in order to compare the influence of these in local retail prices.
Key words: *Beef industry, Costa Rica, price transmission, supply chain, transaction cost.*
JEL Codes: *Q11, Q17, C31*

1. Introduction

Estimates of trade benefits depend highly on different elements such as: new data on tariffs, incorporation of recent major reforms in trade policy, inclusion of preferential trade arrangements, and new poverty elasticities with respect to growth (van-der-Mensbrugghe, 2006), however, modern trade patterns respond to the spectrum of activities which enhance trade capacity and reduce trade frictions (Mirza, 2009).

Price transmission (PT) along supply chains is a popular subject; however, results differ significantly among products and among regions. Several factors intertwine conveying in circumstances in which price enhancements may not translate from producers to consumers or vice versa (Meyer & Von-Cramon, 2004).

Most developing regions are price-taking agents, and international prices are fundamental in determining an efficient distribution of domestic food prices (World Bank, 2012). Although commodity prices of food are set globally, transaction costs along the supply chain can cause producers and consumers in developing regions to face different prices to those set internationally, and these prices shape production and consumption patterns regionally. For agricultural products, transaction costs rise when the output is time sensitive (Baldwin & Clark, 2000).

Transaction costs (Coase, 1937) have gained importance in understanding governance structures in supply chains (Gereffi & Fernandez-Stark, 2011) and shaping trade patterns.

Supply chain performance and reliability are fundamental in global markets, and therefore, there is an increasing demand for quality logistics (The World Bank, 2014), which is a challenge for most developing regions.

Trade facilitation and lower transaction costs, can promote production and exports, as well as imports, according to comparative advantages (UNCTAD, 2013). From the supply perspective, even if world prices are high, regional producers may not engage in a more efficient production targeted to the exports market because they face high transaction costs. On the other hand, when food prices are high, consumption is discouraged, especially in poor regions.

Transport and transaction costs, market power, increasing returns to scale, product homogeneity and differentiation, exchange rates, border and domestic policies, affect price transmission (Vavra, Goodwin, & B, 2005). However; inefficient logistics increases trade costs and reduces the potential for global integration, therefore, supply chain reliability is a major concern for traders and logistics providers alike (The World Bank, 2014).

In this sense, it is important to characterize the Costa Rican meat value chain in order to identify key aspects, as the abovementioned, which can lead to inefficiencies along the value chain. This paper addresses the organization of the meat supply chain and analyzes the price transmission effect in order to understand on a deeper level how prices are formed nationally and the effect of international prices on these.

Costa Rica, as a developing price taking country, faces internal logistic issues especially when dealing with products that demand a cold supply chain. Efficiency of agriculture and farm agriculture are a national challenge. This research characterizes the beef supply chain as a case study It emphases on the analysis of price transmission along the meat supply chain: especially the effect of international meat prices into the local retail market and price formation for retail in the local Costa Rican market. From the trade facilitation perspective, it addresses how efficient institutional arrangements are in promoting trade, considering the effect of global prices on regional prices; how changes in prices in global market have an effect on other markets (Minot, 2011), taking the Unites States (US) beef market as one of the most important for local price formation.

Costa Rica is a net exporter of beef, however, there is an important local market, imports represent 9.6% of national consumption and exports 22% of total production (Corfoga, 2015). However, Costa Rican volume of production of meat is very small (253545 tonnes in 2013) when compared to world largest meat producers such as US (11698479 tonnes), Brazil (9675000 tonnes) and China (6408200 tonnes) (FAOSTAT, 2013); Costa Rican production represents 0.73% of US production, 0.88% of Brazil´s production and 1.33% of China´s therefore it is expected that changes in Costa Rican traded volume of meat will not affect world prices and consequently, it can be considered a small price taking country. On this regard, the analysis leads to a better understanding of the behavior of meat prices in Costa Rica and the extent to which domestic prices react to international prices.

2. Description of the meat supply chain

The success of agricultural trade, and in particular for perishable products, depends on the efficiency of related logistic systems and the ability to connect effectively and reliably to global supply chains.

There are several institutions involved with cattle production, safety standards and overall production and market assessment. One of the main actors in beef assessment in Costa Rica is CORFOGA, whose main objective is to promote beef production and commercialization (Law N° 7837, 1998).

The National Ministry of Agriculture (MAG) is involved in farm's technical assessment and in controlling phytosanitary requirements through The National Phytosanitary Service

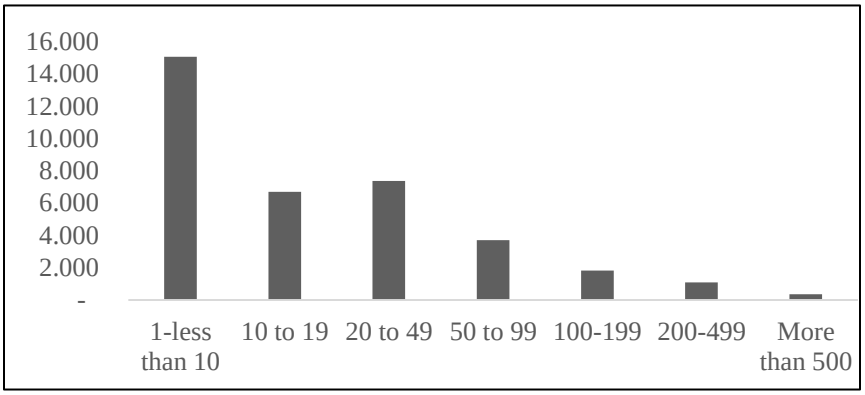
(SFE). Other institutions such as Procomer (national institute for trade promotion) and the National Ministry of Economy work with market information such as national and international prices and provide as well general analysis of the supply chain. CORFOGA is the main source of Costa Rican information regarding profitability, costs, statistics and market analysis of the national meat industry.

There are finance programs especially designed for small and medium farmers held by the national banking system as well as other financial institutions, which have worked with small and medium livestock farmers in order to improve their farming conditions by offering low interest-rate loans.

2.1. Primary Production

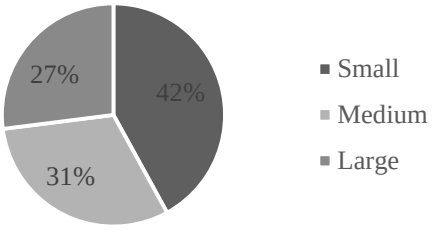
According to the 2014´s national agricultural census, there are 37171 livestock farms in the country (INEC, 2014), however, 42% correspond to beef production, 32.1% to dual-purpose cattle, 25.6% to dairy production and only 0.03% as work force (INEC, 2014). In terms of the geographic scope, more than half of cattle production is located in the Northern regions of the country, specifically in Alajuela (34%) and Guanacaste (22%) (INEC, 2014).

Cattle production is also one of the most extensive agricultural activities in the country since 1044909 hectares are dedicated to pastures; which is 43% of agricultural land in the country (INEC, 2014). Most farmers are small according to Costa Rican standards, since they have less than 100 animals. The distribution of cattle for meat production is tilted towards the small farmers, which can be observed in figure 1 and figure 2.



Source: Data from INEC, 2015

Figure 1. Farmers by Hectares. Costa Rica, 2015



Source: Data from INEC, 2015

Figure 2. Famers Distribution by Herd Size, Costa Rica, 2015

Although most farmers are small, large farmers produce around 27% of beef in the country, farms above 500 hectares represent only 0.9% of Costa Rican farms.

2.2. Auctions

Cattle in Costa Rica is mostly traded through auctions as one of the first links of the supply chain. Once a farmer makes the decision of selling most of it is traded through auctions; there are 23 auctioning establishments and price formation for cattle in the country is based on these. Auctions are geographically located relative to the amount of cattle produced in each region of the country *i.e.* both, Alajuela (25.2%) and Guanacaste (22.1%) are as well the main contributors to cattle auctioning (CORFOGA, 2012). Price formation in this link of the supply chain is mainly determined by supply and demand however, prices may fluctuate according to cattle specific characteristics.

Auctions' size varies widely, while CGUS (10.7%) and El Progreso (9.1%) are the largest ones, Parrita´s auction and Campo Ayala, handle volumes of 0.8% and 0.1% of total cattle auctioned in the country (CORFOGA, 2012). According to CORFOGA´s estimations, countrywide auctioned cattle is distributed to other auctions (3%), to processing plants (27.6%) and back to farms (72.1%).

2.3. Processing Plants

From 23 auctioning establishments, there are only 5 processing plants, 4 of them located in the Great Metropolitan Area (3 in Alajuela and 1 in Heredia) and the other one in Puntarenas. Processing plants may either buy and commercialize the product themselves or may also process meat for third party independent firms.

2.4. Buyers: National and international

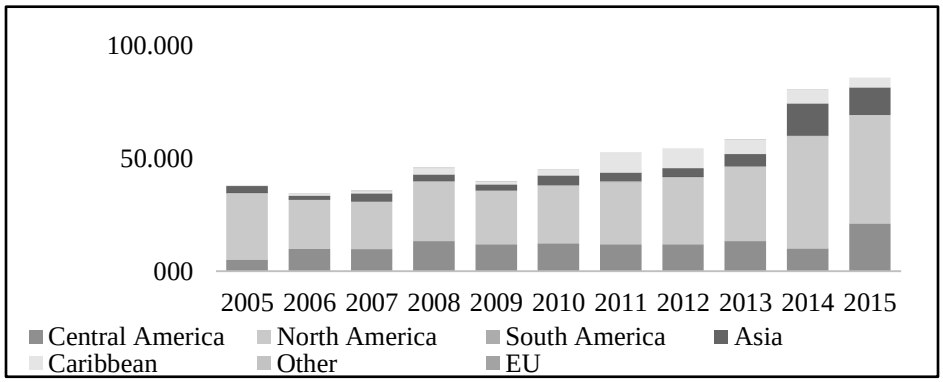
Meat is an important asset for Costa Rican consumers, since prices of some beet cuts are included in the national estimation of inflation rates. These meat cuts were the ones included in this research. Price ranges for meat consumption vary widely, however meat is transported nationwide.

International buyers of Costa Rican meat are mainly located in North America. Meat data considered for trade are fresh, frozen and beef residues and Costa Rica exports more frozen meat than fresh meat.

In 2015, fresh meat was exported to North America (52%), Central America (40%) and the Caribbean (8%) (Procomer, 2015). The North American market has been very volatile in the past 10 years but has followed a growing trend since 2011. Costa Rica exports frozen meat to several destinations as well. However, exports to North America more than double all other destinations. Asian exports increased significantly in 2013 and have remain steady ever since. Meat residues have two main exports markets, North America and Asia.

In 2015, 85909 tonnes of beef were exported, 54% was frozen meat, 0.38% was fresh and 8% were meat residues. Historical exports and 2015 meat exports per destination are shown in the figure 3.

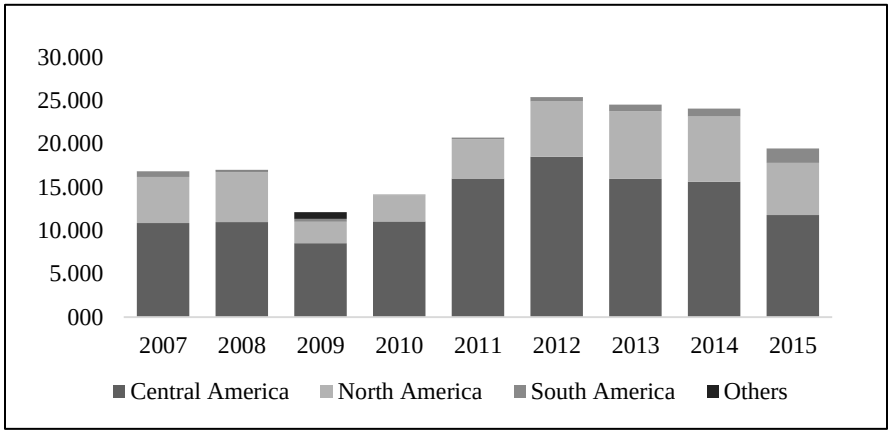
Fresh beef imports come mainly from Central America, as well as frozen meat imports. However, the latter is also imported from North and South America; since 2013 North America has been the main source for frozen meat imports. The meat residue market for Costa Rica follows a similar trend in which North America has historically imported larger amounts of beef but since 2014, Central America is the main source for Costa Rican beef imports.



Source: Procomer, 2016

Figure 3. Historical Costa Rica Beef Exports

There were 19454.94 tonnes of imported meet in 2015, 51% were frozen meat, 40% fresh meat and the rest were beef residues. Historical records of meat imports are shown in figure 4 (Procomer, 2016).



Source: Procomer, 2016

Figure 4. Historical Costa Rican Beef Imports

Most exports and imports are targeted to the North American market and specifically to US, therefore it influences the Costa Rican prices and market decisions taken by farmers and buyers whether to export/import or to consume in the local market.

The further analysis of price transmission is specified for retail price and import price, since our goal is to address trade facilitation assessment on how beef import prices translate to consumers in retail prices.

3. Price Transmission Theoretical Framework

PT could be horizontal or vertical; the first one is focused on the spatial dimension. Kharel and Koirala (2011) mentioned that spatial price relationships help to understand how

price transmission occurs from one region to another in order to identify if regional markets are integrated. Conversely, vertical PT, which is analyzed in this research, focuses on the link between import, farm, wholesale and retail prices.

Goodwin (2006) pointed the three most important aspects of vertical PT:

a. "The extent of adjustment, *i.e.*, how big of a response is triggered by a shock of a given size

b. The timing of the adjustment, *i.e.*, are there significant lags in adjustment

c. The extent to which adjustments are asymmetric, *i.e.*, Do positive shocks trigger different adjustments than negative shocks".

In relation to asymmetry of adjustments, sometimes the theoretical models do not match with the real price behavior, therefore, economists have tried to explain the asymmetry in price transmission (APT) and why it occurs. If, for example, prices at the wholesale level increase (or decrease), the price at the retail level should move accordingly and immediately. However, Peltzman, (2000) confirmed that APT is more common than symmetric PT among markets such as food, textile, chemical, petroleum and others. Output prices have a tendency to react faster to input price increases than to decreases. Others studies also refer to APT among primary products such as dairy (KInnucan & Forker, 1987), pork & beef (Hahn, 1990) and fresh vegetables (Ward, 1982).

In this case vertical price transmission is analyzed, using Blend Cow import meat prices (form USA) and retail domestic price time series. Blend cow series were selected because of the high influence that US is expected to have along the Costa Rican domestic meat prices. In this sense, other studies use "big players" time series in order to determine the global to domestic price transmission; Hassanzoy, et al., (2015) use Thai and Pakistani prices as representatives of global rice price in order to run a VECM and obtain the extent of price transmission to domestic rice prices, at the end, one conclusion states that "a shock in the global prices of low quality rice may have a long-lasting effect on domestic prices of low quality rice as compared to their high quality counterparts affecting domestic prices of high quality rice". While it is true that on this paper there is no segmentation of meat qualities, we used Blend Cow as a representative time series for global meat prices and then we analyzed its transmission to domestic meat prices.

The results from this paper could enhance the effectiveness of policy decisions in order to reduce the vulnerability of small households to external shocks in meat prices, which could lead to higher levels of welfare among the economy.

4. Methodological framework

From an intuitive point of view a stationary series is one that "has no systematic change in mean (which means no trend), no systematic change in variance and if strictly periodic variations have been removed" (Chatfiel, 2004, p.12). These properties are described as follows.

$$E(X_i) = U \text{ (constant mean)} \quad (1)$$

$$Var(X_i) = E(X_t - U)^2 = \theta^2 \text{(constant variance)} \quad (2)$$

$$Cov(X_t, X_{t-s}) = E[(X_t - U)(X_{t-s} - U)] = \gamma \text{ (constant covariance)} \quad (3)$$

As a first step, stationary condition should be tested. The most well-known test to proof stationarity is the Augmented Dickey Fuller (ADF) test.

Considering the autoregressive model:

$$X_t = \rho X_{t-1} + \varepsilon_t \quad t=1,2,\ldots, \tag{4}$$

Where $X_0 = 0$, ρ is a real number, and $\{\varepsilon_t\}$ is a sequence of independent normal random variables with mean zero and constant variance θ^2. In this sense, "the time series X_t converges (as $t \to \infty$) to a stationary time series if IρI < 1. If IρI = 1, the time series is not stationary and the variance of X_t is $t\theta^2$.Then if IρI > 1, the time series is not stationary and the variance of the time series grows exponentially as t increases" (Dickey & Fuller, 1979, p. 427)

Once stationary condition is confirmed, the relationship between variables should be tested using a cointegration test.

Let's assume the following relationship between two prices in different levels of the value chain.

$$P_t^B = B_0 + B_1 P_t^A + u_t \tag{5}$$

In which P_t^A is the exogenous variable; P_t^B is the endogenous variable; u_t is the white noise error and we assume that P_t^B and P_t^A are both I(1). In this case if u_t~I(0), this would imply that there is a parameter that makes the previous relation stationary. Putting all pieces together, if u_t~I(0) then the null hypothesis of non-cointegration is rejected, and if u_t~I(1) the null hypothesis cannot be rejected.

If the non-cointegration hypothesis is rejected, an ECM could be run. As mentioned by Vavra and Goodwin (2005), the ECM is a dynamic model in which the variable´s movement in period t is related to the t-1 period's deviation from long-run equilibrium. Having this in mind, the ECM is a method that represents the data in two components. The first one is the long run equilibrium and the second one is the short run disequilibrium dynamics. Then if first difference is subtracted on both sides, we can obtain the following model.

$$\Delta x_t = \propto_1 (y_{t-1} - \beta x_{t-1}) + \sum_{j=1}^{p-1} \gamma_{1j}^* \Delta x_{t-j} + \sum_{j=1}^{p-1} \delta_{1j}^* \Delta y_{t-j} + \varepsilon_{1t} \tag{6}$$

$$\Delta y_t = \propto_2 (y_{t-1} - \beta x_{t-1}) + \sum_{j=1}^{p-1} \gamma_{2j}^* \Delta x_{t-j} + \sum_{j=1}^{p-1} \delta_{2j}^* \Delta y_{t-j} + \varepsilon_{2t} \tag{7}$$

Where β is the long run equilibrium and α_1 and α_2 are the correction terms if y and x are in disequilibrium. In this sense, α_1 and α_2 express the magnitude of the correction which can also be translated into time. In addition to this, the model specification is an important issue, in which the number of lags introduced into the model can be obtained by the Akaike Criterion (AIC), Hannan-Quin (HQ) and Schwarz criterion (SC).

5. Numerical Implementation

Import (Blend cow) and retail price series were obtained from CORFOGA, all of them in US$ per kilogram, from January 2007 to May 2014.

As a first step, stationarity condition was proved. Table 1 shows the results of unit root test. Augmented Dickey-Fuller (ADF) test was applied on all the data series in their long forms. The number of lags was obtained from the Schwarz criterion. The results show that the two variables possessed unit-root. This is showed by T-statistics values which do not allow rejecting the null hypothesis of non-stationarity. Consequently differentiated time series were obtained, by applying first differencing. Then the ADF test was applied to the differentiated series. In table 1 the ADF statistics for the first differenced series can be

observed, which shows that the null hypothesis of non-stationary can be rejected after first differencing, in other words, the two variables become stationary after first differencing.

Table 1. Augmented Dickey Fuller Test

	Import price		**Retail price**	
Period	**Coefficient**	**t-statistics**	**Coefficient**	**t-statistics**
2007-20014	0,0044	0,9647 (0)	0,0037	1,61 (0)
	D1_Import price		**D1_Retail price**	
Period	**Coefficient**	**t-statistics**	**Coefficient**	**t-statistics**
2007-20014	-0,7558	-7,1853 (***) (0)	-1,0016	-7,3905 (***) (1)

Given the fact that the Import and Retail series became stationary after first differencing I(1), we tested if there is a long run relationship among Import and Retail prices. It is quite important to proof the stationary condition before running a cointegration test; this is because a cointegration process can be found between non stationary variables; however that relation could be spurious.

In order to find out the long run relationship, an Engle-Granger test was applied. As a first step, a cointegration regression was conducted, from which we obtained the residuals u_t. In this case, an ADF unit root test was applied to residuals. The cointegration regression used the retail price as a dependent variable and the import price as exogenous. Table 2 shows the result from the cointegration test.

Table *2*. Cointegration Test

	ADF test of residuals	
Period	**p-value**	**t-statistics**
2007-20014	0,01519	-3,20603 (***)
Test statistics: 1%: -2,56 (***); 5%-1,94(**); 10%: 1,62(*)		

The null hypothesis of unit root is rejected for the residuals; this is how it can be state that Retail and Import prices hold a stable long run relationship and a non-spurious result can be found. Once cointegration condition was tested, a Vector Error Correction Model between Retail and Import prices can be run. The following equations correspond to the VECM between retail and import prices for the period 2007 to 2014.

VECM Retail-Import prices

$$\begin{bmatrix}\Delta P_t^{Retail}\\ \Delta P_t^{Import}\end{bmatrix} = \begin{bmatrix}-0{,}08^{(***)}\\ 0{,}05\end{bmatrix} u_t \quad \begin{matrix}+0{,}18\Delta P_{t-1}^{Retail}(*) - 0{,}09\Delta P_{t-1}^{Import} + e_t^1\\ +0{,}01\Delta P_{t-1}^{Retail} + 0{,}29\Delta P_{t-1}^{Import}(***) + e_t^2\end{matrix} \tag{8}$$

$$\begin{bmatrix}\Delta P_t^{Retail}\\ \Delta P_t^{Import}\end{bmatrix} = \begin{bmatrix}-2{,}69^{***}\\ 1{,}60\end{bmatrix} \quad \begin{matrix}(1{,}78^{*}) & (-0{,}53)\\ (0{,}11) & (2{,}66^{***})\end{matrix} \tag{9}$$

The equation number 8 shows the short run adjustment parameters for the retail and Import prices. The retail ECM coefficient in the short run was negative and statistically significant at 1% level with a value of 0.08. This implies that it corrects roughly 8% of the disequilibrium in one month, and it would take 12,5 (1/0.08) months or one year and half month for full correction back to the initial equilibrium showed right before the distortion.

On the other hand equation number 8 also shows the short run adjustment parameter for the import prices, in this case the import ECM coefficient in the short run is positive, however it is not significant. This result suggests the import price does not react against changes at the retail level of Cost Rica.

This results support the hypothesis that retail prices do the correction once the long run equilibrium is disturbed; thing that does not occur with the Import prices. This is an expected result because of the small size of the Costa Rican meat market, and the lack of price stability tools and governmental policy. Also the import series analyzed come from a "big player" which is not affected by the changes of the Costa Rican domestic prices.

6. Discussion and Conclusions

Power asymmetry along the supply chain is evidenced in the decreasing number of supply chain actors; while there is a large number of farmers in the country, there are only 5 processing plants. Small and medium farmers represent the largest group of farmers within the cattle production sector, nonetheless, larger farmers usually have more access to international information, because their linkage to international markets is tighter. Nonetheless, once processed, meat is re-distributed to a set of small, medium and large establishments. Therefore, bargaining power is tilted towards actions and to a higher degree towards large processing plants.

Price formation is relatively transparent at farmers' level because it is set trough open auctions and prices from are available to a national degree. Prices at retail level are also available for stakeholders within the national market. CORFOGA plays an important role in providing information related to production quantities and prices at different stages along the supply chain and therefore the governance structure of the supply chain is ruled by a market structure leaded by auction prices.

Abovementioned characteristics suggest the efficient of price transmission along the supply chain is far from ideal, since it takes 12.5 months on average for retail prices to restore the retail-import long run equilibrium.

Price changes of blend cow in US markets cannot explain to a full degree Costa Rican retail prices, although Costa Rica is a price taking country. Even tough, US is on the most important markets, the quantity of meat imported from Nicaragua has been increasing during the last years, in this sense, it would be interesting to use Nicaraguan time series to conduct future research with VECM methodology and compare those results with the once showed in this research. This could be important because it will show which time series (Blend cow or Nicaraguan) has the greater impact on the Costa Rican meat price behavior.

This is an exploratory research targeted to improve the understanding of the meat market in Costa Rica. The results supported the initial hypothesis, however is necessary to conduct future research with more data in order to confirm the results obtained. Another important analysis that could be conducted is the measure of asymmetry in price transmission in order to find out the Costa Rican domestic price reaction against increase or decrease of the import price.

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