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EFFECT OF "GOLDEN PINEAPPLE INNOVATION" ON COSTA RICA'S PINEAPPLE EXPORTS TO U.S. MARKET: AN ECONOMETRIC APPROACH

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Abstract

An investigation was conducted on the effect of introducing a new variety of pineapple, known as golden pineapple (MD2) on the level of pineapple exports to the US market. Based on historical trade data from 1983 to 2017, a univariate structural econometric model was adjusted including variables related to export demand and isolating the effect of innovation through a binary control variable. The results obtained show that the effect of the innovation was a 25.27% increase in exports from Costa Rica to the North American market since the innovation was implemented.

Conveniently, agricultural policymakers should consider similar studies to visualize the impact that innovation has on agricultural activities, and based on this, to plan, research, develop, and innovate programs within the agricultural sector.

Keywords: *Innovation adoption, pineapples, agricultural trade, econometric models, Costa Rica*
JEL codes: *Q13, Q16, C01*

1. Introduction

Costa Rica has stood out as the largest exporter of fresh pineapple globally. According to Guevara, Arce, & Guevara (2017), this position of international relevance is based on ideal agro-ecological conditions, research in biotechnology by both the private and academic sectors, and the sophistication of the different links in the production chain.

The relevance of the pineapple activity in Costa Rica is reflected by the increase of the total production area, and according to SEPSA (2020), the area of pineapple production in the country represented 40,000 hectares in the year 2019, which contrasts with the figure for the year 2000, which reached 12,500 hectares. This change in the production area at the national level represented an increase of 220% in the period 2000-2019.

The impact of the pineapple activity in Costa Rica can be seen from different angles in which the micro and macroeconomic impact stands out. Based on Guevara et al. (2017) findings, the pineapple activity is a direct employer of 32,000 people and therefore generates 16,000 indirect jobs in related activities and services. Under this perspective, the income that is generated will remain in the communities and linked to micro, small and medium enterprises.

From a macroeconomic perspective, being an activity focused on trade links with international markets, it presents a net foreign exchange generating effect for the national economy. According to data from (SEPSA 2019; SEPSA, 2007), the agricultural sector provides positive behavior in the agricultural coverage trade balance, being the pineapple activity the second most important foreign exchange generator in the agricultural sector in 2019.

Costa Rica is the largest pineapple supplier for the United States market. According to PROCOMER (2018), the export of this fruit represents 34% of the agricultural exports, which placed the commercialization of this fruit in the second place of importance, only preceded by the export of bananas.

Therefore, given the interest that it generates for the different actors of the pineapple industry to maintain its strategic position in the international market; innovation must be considered as a disruptive element that generates competitive advantages in the medium and long term.

Consequently, this research addresses the quantification of the effect of the implementation of the MD2 variety and its effect on exports in the North American market.

For the above reasons, it is considered that the study of the pineapple sector, the effect of innovation, and the dynamics of Costa Rica's most important trade partner is pertinent and relevant to generate significant contributions to decision-makers.

2. Background of the Study

According to Altendorf (2017), since the 1970s, the purchase and sale of tropical fruits at an international level has gained dynamism, and thus, position itself as a category of economic importance for international trade.

The same author establishes as factors of this commercial increase the signing of free trade agreements, the facilitation of logistic processes, and the change in consumer behavior towards healthier options in their diet.

Based on the first findings of Huang (2004), it has been established that the main importing markets for tropical fruits are the countries of the European Union, North America, and Asia. This trend evidenced by the author has been consistent over time, which is rectified by the last study of Rabobank (2018), which states that the largest importer of tropical fruits such as banana, pineapple, and mango are the United States of America, followed by China in second place and Germany in third place.

Concerning the North American market, Ferrier (2014), establishes that the consumption of fruits in the United States has remained constant. However, the share of imported fresh fruit from 1990 to 2014 has increased from 12% to 34% of the available supply. More recently in a public opinion article, Karp (2018) analyzes the significant increase in fruit imports, which by 2018 acquisition more than 50% of the fruit market in the United States of America.

The aforementioned market dynamics present significant fluctuations depending on the product analyzed. Specifically, in this case of the pineapple, by the year 2014, the participation of the imported fruit reached more than 90% and for the year 2018, indicates that the participation is 99,99% (Karp, 2018). Both authors indicate as a common source the data of the Economic Research Service of the Department of Agriculture of the United States.

Based on UNCTAD (2016), a large proportion of pineapple imports in the North American market are generally distributed by the same transnational corporations that centralize production in the countries of origin, through vertical integration strategies. In contrast to this reality, there is also imported fruit from independent producers. According to the same author, the market structure of pineapple imports concludes consistently in the retail sector.

The introduction of the pineapple MD2 variety dates to 1961, with the creation of the Pineapple Research Institute (PRI) in Hawaii (Thalip, Tong & Ng, 2015; Frank. 2003). This organization was created by Dole, Del Monte, and Maui Pineapple Company, whose objective was focused on joint research and the creation of new pineapple varieties. In 1975, by mutual agreement, the PRI was shut down and the developed hybrids passed to the control of the Maui Pineapple Company. However, one of the hybrids called 73-114, later known as MD2, was taken to Costa Rica to conduct a pilot plantation in 1980.

According to the investigation of Frank (2003), due to the potential business represented by the MD2 pineapple, an attempt was made to create a patent to protect the variety. However, the Maui Pineapple Company rejected the proposal to make a joint patent. Additionally, Del Monte had carried out commercial tests of the fruit since the late 1980s and early 1990s, which made it impossible to create a patent for a product that had been sold in the market.

The MD2 variety was introduced to the global market in 1996, as an innovation of Del Monte. Due to the high demand for the new pineapple variety and its rapid introduction to the market, Del Monte increased prices by 50% compared to the market average. According to the review given by the author, a 25-pound box cost up to $ 20 for the retail sector. Therefore, retailers also raised their prices to a profit margin of up to $ 3 per fruit (Frank, 2003).

In the previous context, retail chains wanted a larger volume of MD2 pineapple. However, Del Monte conditioned the shipments to the retail as a greater number of bananas and melons from the company.

Several local and international sources refer to the benefits perceived in the MD2 variety. The advantages of this variety are the uniform color, sweet taste, higher vitamin C content, less fiber, less acidity, thinner peel, smaller fruit, and longer shelf life. (Zahner, 2012; Joy, 2016)

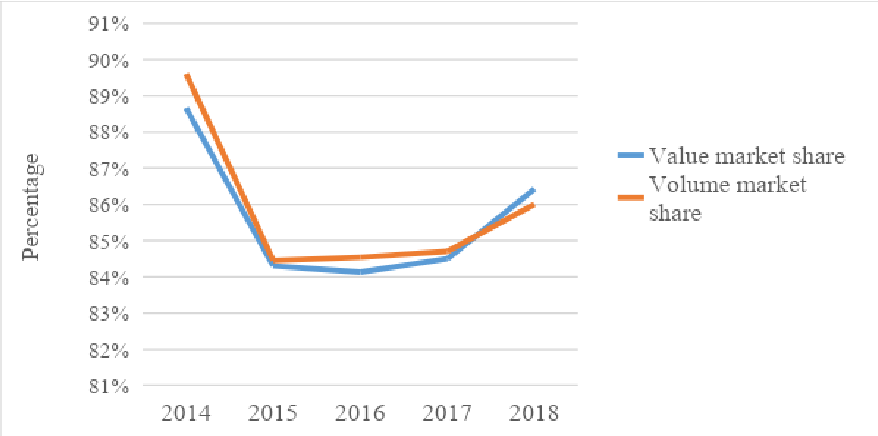
An important aspect of the innovation of this variety according to the North American market, is that it has a longer shelf life, 30 days instead of 21 days. (Zahner, 2012; Joy, 2016). This aspect allowed a potential increase in the market of fresh pineapple in the United States of America since the fruit was consumed mainly in canned form due to the previous short shelf life. This new market window generated extensive benefits for the pineapple export sector in Costa Rica.

Twenty-three years after the launch of the MD2 variety in the international market, this variety has become the global benchmark in the pineapple trade. Additionally, the impact of this innovation in Costa Rica is partially reflected in the progressive increase of the harvested area and the leading participation of the global market.

According to FAOSTAT (2020) data, the area sown in 1996 was 8,195 hectares in the country, compared with 44,500 hectares in 2017. This growth represents an increase of 36,305 hectares planted, equivalent to an increase of 443% during that period.

According to the international market, 49.7% of global pineapple exports during 2018 proceed from Costa Rica. Additionally, the pineapple of Costa Rica during the same year obtained 86.43% of the US market share in terms of imported value. (See figure 1).

Some special conditions that allowed the positioning of Costa Rican pineapples in the United States are the proximity between the country and the destination market, political and legal stability for the installation of multinational pineapple companies, variety of climates, and the sowing of the MD2 variety in the country since 1980. The production of that variety of pineapple for more than four decades This last factor has been favored with the continuous research of companies, research centers, and universities for four decades continuously.



Source: Research findings with COMTRADE data, 2020

Figure 1. Changes in Costa Rica's Positioning in the United States Pineapple Market among 2014-2018

Based on the results of Figure 1, it is important to mention that the market share, as a partial indicator of competitiveness, should be visualized as a result of the interaction of different factors, such as the growth of the import market, the growth of pineapple imports of each one of the market suppliers and consumer preferences.

Table 1. United States Real Growth Rate of Pineapple Imports from Producer Countries among 2014-2015

Pineapple origin	Real trade value-2015 ($)	Real trade value-2014 ($)	Real growth rate 2014-2015
World	620.620.300,258	645.421.208,211	-3,84%
Costa Rica	523.206.589,681	572.231.770,646	-8,57%
Mexico	39.167.413,613	22.687.131,817	72,64%
Honduras	26.721.155,604	21.358.999,971	25,10%
Guatemala	7.609.826,634	7.872.386,032	-3,34%
Thailand	8.215.699,605	10.625.188,328	-22,68%

Source: Research findings with COMTRADE data, 2020

Table 2. United States Real Growth Rate of Pineapple Imports from Producer Countries among 2015-2016

Pineapple origin	Real trade value-2016 ($)	Real trade value-2015 ($)	Real growth rate 2015-2016
World	655.571.491,391	620.620.300,258	5,63%
Costa Rica	551.538.161,051	523.206.589,681	5,41%
Mexico	47.051.612,923	39.167.413,613	20,13%
Honduras	26.942.543,717	26.721.155,604	0,83%
Guatemala	9.181.402,400	7.609.826,634	20,65%
Thailand	9.046.413,722	8.215.699,605	10,11%

Source: Research findings with COMTRADE data, 2020

Table 3. United States Real Growth Rate of Pineapple Imports from Producer Countries among 2016-2017

Pineapple origin	Real trade value-2017 ($)	Real trade value-2016 ($)	Real growth rate 2016-2017
World	666.662.758,692	655.571.491,391	1,69%
Costa Rica	563.321.813,341	551.538.161,051	2,14%
Mexico	43.963.190,428	47.051.612,923	-6,56%
Honduras	29.125.760,541	26.942.543,717	8,10%
Guatemala	10.758.572,597	9.181.402,400	17,18%
Thailand	8.226.184,408	9.046.413,722	-9,07%

Source: Research findings with COMTRADE data, 2020

Regarding the competitors of Costa Rica, it is important to highlight the increase in the real growth rate of imports from Mexico, Honduras, and Guatemala. Despite the previous behavior, the adverse effect on Costa Rica's market share in the North American market is low due to the high volumes and their corresponding traded value.

2. Literature Review

It has been considered that global demand for exports from developing countries is not directly affected by price changes, which have a positive impact on GDP, as suggested by Khan (1974).

Thaver & Bova (2014) tested the approach of cointegration to estimate Ecuador's export demand function with the US with special emphasis on dollarization's impact on exports. They developed two different export demand models; the first one defines real exports as a function of the US real GDP, relative prices, exchange rate volatility, and dollarization; and the second one relates real exports to US real GDP, real exchange rate, volatility, and dollarization.

Thaver & Bova (2014) found that in long term, GDP has a positive and elastic effect on Ecuador's exports; while volatility is positive and inelastic, the relative prices of real exchange are not statistically significant.

The effects of exchange-rate volatility on real exports have been analyzed, sometimes using regressors to be felt fully contemporaneously, but in other cases, the exchange-rate volatility has been considered as a regress variable (Arize, 2006). According to this author, export demand behavior does not follow the restrictive simple stock adjustment mechanism that has been commonly used in several studies; instead, a less stringent process could be modeled based on a modified error-correction model.

Other researchers have found that the real income, either contemporaneous or lagged of the country which imports, the real exchange rate, and several dummy variables that capture some structural changes along the time explain very well the level of exports that a small country makes to the big one (Arize, 2006; Aydin, 2004; Thaver & Bova, 2014).

Erdem & Nazlioglu (2008), analyzed the determinants of Turkish agricultural exports to the European Union (EU) by estimating the gravity model for the panel of 23 trading partners in the EU covering the period 1996-2004. They found that conventional variables such as the size of the economy, the importer population, arable land, and the distance of the gravity model explain the export flows. Like these, several authors use the same variables among others (Hilbun et al, 2006; Jayasinghe & Sarker, 2007; Koo, Kennedy, & Skripnitchenko, 2006).

In a much deeper focus, many authors have found that export performance exhibited a multidimensional structure, confirming the complex nature of these phenomena. Specifically, the three main areas of external influence: environment, firm characteristics, and strategy account for close to 70% of the variance in the case of Brazilian exports (Carneiro, da Rocha, & da Silva, 2011).

The commercial success of innovation depends on several factors like company size that involves low time to market and the access and integration of technological assets. However, in those products of lesser novelty in the market, they develop continuous improvement and adjustment of their value proposal towards the markets of interest. (Barlet, Duglet, Encaoua, & Pradel, 2000)

Caldera (2010), conducts a study focused on the effect of innovation on the decision to export products or services. In the results of the econometric model according to the available information panel, it is first concluded that there is a greater probability of exporting when a company has implemented the innovation. In second place, the probability of export is prioritized over the companies that have generated their innovations to improve their products other than those innovations that focus on cost reduction. Finally, there is also a higher probability of export in those enterprises that generate product innovations compared to those that implement process innovations.

The effect of innovation on exports can be measured using a dummy variable, assigning a value of 1 if the company innovates and 0 if it does not. This is equally applicable to both product and process innovations, as demonstrated by authors such as Basile, 2001.

3. Methodology

3.1 The Model and Variable Specification

The econometric model includes the harvested area based on the principles of the Nerlove partial adjustment model (Nerlove, 1956), which considers planting expectations and their constant adaptation according to the characteristics of the environment. This element considered in the econometric model is used in similar studies in a partial way for a specific crop and in an aggregate way for the whole agricultural sector (Nmadu, 2010; LaFrance & Burt, 1983). In Costa Rica, the harvested area is particularly dependent on exports to international markets. This aspect shows the constant adjustment of the harvested area according to the dynamics of international trade.

It is considered appropriate to measure the effect of the innovation through a binary dummy variable since it captures the increase in the export flow from the moment of its implementation. For this research, the effect of product innovation is measured as it is done, among others, by authors such as (Basile, 2001; Caldera, 2010)

The econometric model for this research is defined as follows:

$$Y_t = \beta_0 + \beta_0 REXPP_t + \beta_2 RGDP_t + \beta_3 POPU_t + \alpha_1 A_t + \alpha_2 A_{t-1} + \theta INN_t + u_t \tag{1}$$

Where:

Y_t: export volume in tons for each *t* year

$REXPP_t$: real export price for each *t* year

$RGDP_t$: real U.S. Gross Domestic Product for each *t* year as income proxy variable

$POPU_t$: U.S. population in each *t* year, as market size proxy variable

It was testing linear forms as logarithmic, selecting the best functional form after applying the AIC and BIC information criteria. The effect of innovation (INN) is measured through a binary variable in which 1 represents the year in which the MD2 variety is present in the market and 0 otherwise.

Additionally, the model includes the effect of the area harvested from pineapple in Costa Rica for the period *t*, named as (A_t) and the lagged period of the previous year (A_{t-1}), because this crop develops practically oriented towards exportation and not towards the local market. Besides, Costa Rica is an international benchmark in pineapple productivity.

The GDP level and the population for each year were used first, and then both were combined to use the real per capita income instead.

3.2 Data

Regarding the data used in the model, the data of the different variables correspond to the period 1983-2017. Therefore, 35 data were obtained per variable.

The data on international trade flows between the United States and Costa Rica, export volumes and export value were obtained through the UN COMTRADE database.

The model needed a variable that reflected the volatility of the international price and the willingness to pay the North American market for Costa Rican pineapple. For this reason, a proxy variable of the unit price was constructed. This variable was calculated by dividing the exported value by the exported amount through the data obtained previously.

The unit prices obtained in the time series were decreased throughout the consumer price index of the United States, using the year 2017 as the base year. This index was obtained through the global development indicators of the World Bank.

The Gross Domestic Product (GDP) variable of the United States and Population were included into the model as possible explanatory variables of the dynamics of the US economy. Data were obtained through the global development indicators of the World Bank.

The variable of the area harvested was used to relate the dynamics of the demand in the destination market with the sowing planning in Costa Rica and show whether there is any link with the innovation presented in the model. The data of this variable was obtained through the FAOSTAT database.

4. Results and Discussion

The proposed explanatory variables were transformed by logarithms, with the purpose that the regression coefficients show elasticities.

4.1 Stationery and Correlation Testing

The following table shows how the original series, previously transformed by logarithms, have a mostly non-stationary condition of one of the patterns proposed by Dickey and Fuller. After the first differentiation, almost all the time series proved to be stationary except for the population variable (POPU).

The correlation between the originally proposed explanatory variables is presented in the table below, and the correlation between the variables is presented after simplifying the model using a logarithm variable creation of the per capita real income LRGDPPC, where the variable of real income was merged with the population to achieve an economy with degrees of freedom in the model.

With the simplification of the variable mentioned above, we tried to reduce the effect of the presence of severe multicollinearity in the data since only 35 observations of the time series are available.

Table 4. Unit Root ADF Test for The Time Series Used

Variable	Test without constant		Test with constant		Test with constant and trend	
	tau	*p-value*	*tau*	*p-value*	*tau*	*p-value*
Variable in levels						
LEXPQ	3.0964	0.9992	-2.4171	0.1369	-5.8273	0.0017***
LREXPP	0.7870	0.8829	-2.8212	0.0553*	-2.0529	0.5716
LRGDP	2.7950	0.9989	-0.8298	0.8102	-1.9860	0.6084
LPOPU	0.4512	0.8118	-4.4084	0.0010**	-1.4240	0.8543
LRGDPPC	1.9608	0.9886	-0.8030	0.8178	-2.5001	0.3281
LARHA	2.6591	0.9974	-3.8261	0.0062***	-1.7281	0.7390
Variables in first difference						
ΔLEXPQ	-0.9869	0.2905	-7.8376	1.82E-07***	-3.4030	0.0509**
ΔLREXPP	-5.6860	7.98E-07***	-2.9184	0.0432**	-3.1432	0.0963*
ΔLRGDP	-2.51204	0.01367**	-3.9075	0.0052***	-3.8099	0.0286**
ΔLPOPU	-0.4564	0.5177	-0.6144	0.8652	-3.6326	0.0271**
ΔLRGDPPC	-3.3122	0.0016***	-3.9463	0.0047***	-3.7863	0.0302**
ΔLARHA	-3.6099	3.03E-04***	-3.8093	0.0066***	-4.0099	0.0182**

Note: Augmented Dickey-Fuller test for testing down from 9 lags, criterion AIC

Table 5. Correlation Matrix for Regressors

	LREXPP	LRGDP	LPOPU	LARHA
LREXPP	1.00	-0.893	-0.909	-0.835
LRGDP		1.00	0.992	0.946
LPOPU			1.00	0.936
LARHA				1.00
LRGDPPC				
Correlation between simplified regressors				
	LEXPP	LARHA	LRGDPPC	
LEXPQ	1.00	-0.835	-0.867	
LARHA		1.00	0.942	
LRGDPPC			1.00	

Note: Correlation Coefficients, using the observations 1983 – 2017. 5% critical value (two-tailed) = 0.3338 for n = 35

4.2 OLS and GLS Modelling

The following table shows the results obtained for the adjustment of the three proposed models, and it is possible to conclude that the best model that has the best performance was number three, which was obtained by the GLS method applied to model two to correct the first-order autocorrelation that is presented.

The model 1 presents a good adjustment according to the coefficient R^2, however, the sign obtained for the variable POPU is negative and contrary to expected. A similar situation occurs with the variable EXPP since the negative sign was expected and the opposite was obtained.

This model showed the presence of heteroskedasticity and first-order autocorrelation, as shown by the Breusch-Pagan and Durbin Watson tests when rejecting the null hypothesis of no presence of these problems.

On the other hand, the model 2 presented a better fit, but above all, the regression coefficients presented the expected signs. The problem with this model was the presence of first-order autocorrelation and the condition of the non-normality of the regression residues.

We proceeded to adjust model 3 starting from the first-order correlation coefficient (rho) and applying the generalized least squares method (GLS). This model no longer presented problems with the first-order autocorrelation, and the residuals show homogeneity of variance and normality at 10% of significance.

The signs of the regression coefficient showed the expected results and all of them are practically statistically significant, at 1%, 5%, and 10%, except for the case of the coefficient for the real export price, which did not have statistical significance despite presenting the correct sign.

The area harvested shows a strong effect on exports as expected from the pineapple sector oriented to international trade in Costa Rica. Another reason is the fact that Costa Rica being a small country is exporting to large markets and when the market is very high and wide, the small country should not set any limits to its exports because the larger the harvest the higher the level of exports. The signs obtained for the real price and population are according to expected, as the elasticity for the price value of -0.24732 is similar to -0.39, reported by

Wiranthi and Mubarok for canned pineapple Indonesian exports (Wiranthi & Mubarok, 2017).

Table 6. OLS and GLS Results for The Models Proposed

Variable	Model 1 (OLS)		Model 2 (OLS)		Model 3 (GLS)[a]	
	Parameter	*p-value*	Parameter	*p-value*	Parameter	*p-value*
$LREXPP_t$	0.09944	0.85250	-0.37450	0.17890	-0.24732	0.3375
$LRGDPCC_t$			4.99519	3.34E-07***	3.89183	1.55E-05***
INN_t			0.15611	0.12180	0.25275	0.0093***
$LARHA_t$			0.41218	0.00500***	0.46803	0.0002***
$LARHA_{t-1}$			0.21463	0.07030*	0.32549	0.0015***
$LRGDP_t$	7.63094	0.00010***				
$LPOPU_t$	-2.46661	0.54710				
Intercept	-135.13	9.96E-10***	-48.14	6.68E-07***	-28.30	2.18E-05***
R^2	0.965624		0.990909		0.988864	
Adjusted R^2	0.962298		0.989285		0.986802	
AIC	14.49399		-33.86200		-51.29564	
BIC	29.13979		-24.70384		-42.31659	
Log-likelihood	-3.24699		22.931		31.64782	
rho	0.526325		0.272402		-0.064666	
Breusch-Pagan Test	17.674	0.000513***	8.10845	0.087686**	8.40505	0.13528*
Durbin Watson Test	0.613688	6.02E-08***	1.215098	0.000649***	2.124164	0.37807
LM test for AR (1)	12.0872	0.001571***	2.353040	0.136675	0.491609	0.74087
Normality Test (ji^2)	6.59713	0.036936**	3.00486	0.222589	2.65671	0.26491
Root Mean Squared Error	0.26549		0.12327		0.09274	
Theil's U	0.57495		0.41052		0.38067	

Note: a = using a rho value 0.272402 from model 2 to autocorrelation correction on GLS method

The innovation INN has a strong effect on exports representing a plus of 25.27% annual rate over the condition without innovation. This positive effect is reported by other researchers (Nguyena et al, 2008; Ghazalian & Furtan, 2007).

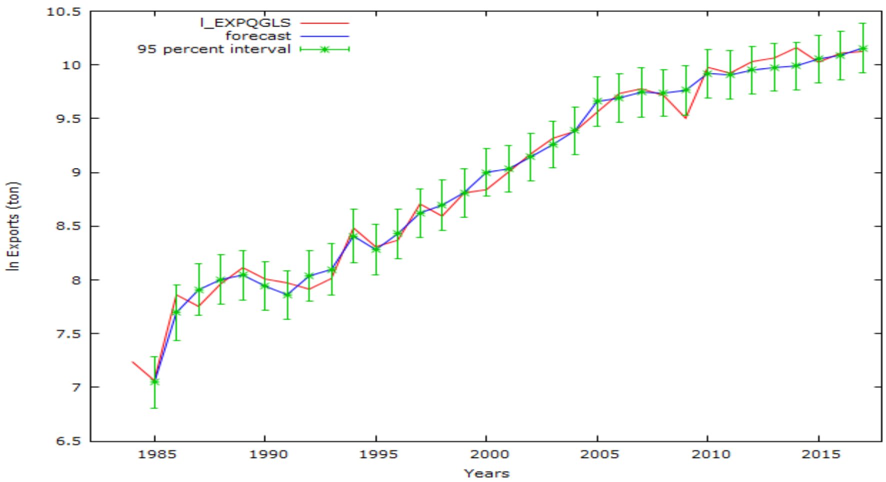
The following table shows the result of the Engle-Granger cointegration test for the transformed regression variables used in modeling with the generalized least squares method (GLS). It can be observed how non-stationary the variables are while the residues of the multiple regressions of cointegration are stationary, so there is no spuriousness in the statistical relationship found.

Table 7. Cointegration Engle-Granger test for Variables in GLS Regression

Variable	*Test with constant*		Test without constant		Criteria
	tau	*p-value*	*tau*	p-vlue	
$LEXPQGLS_t$	-0.95429	0.7713			non-stationary
$LREXPPGLS_t$	-2.16955	0.2177			non-stationary
$LRGDPPCGLS_t$	-0.69944	0.8452			non-stationary
$LARHAGLS_t$	-0.29649	0.9231			non-stationary
$LARHAGLS_{t-1}$	-0.29649	0.4113			non-stationary
INNGLS	-1.78211	0.3899			non-stationary
Cointegration regression residuals			-4.69468	3.137e-006***	stationary

Note: Augmented Dickey-Fuller testing down from 1 lag

It is possible to observe in the following graphic how the model forecasts quite well the tons exported from Costa Rica to the United States Market with stable prediction intervals and low prediction error.



Source: Research findings

Figure 2. Forecasting Pineapple Exports from Costa Rica to U.S. Market, Period 1983-2017

5. Conclusions

This research allows us to conclude that the innovation of a new variety released to the market called "golden pineapple" has brought a general benefit to the Costa Rican export sector because it raised the annual level of pineapple exports to the US market by 25.27%.

The effect of innovation in the case study presented, allowed the growth of economic activity in Costa Rica, which has allowed the generation of employment sources, securing foreign currency, the opening of other small and medium-sized related companies. These effects together have generated dynamism in the Costa Rican rural economy.

Additionally, the innovation has allowed to obtain a comparative window concerning other countries that produce fresh pineapple internationally. This effect generates distinction of the Costa Rican product, which facilitates the entry into new markets and the consolidation of current customers.

It is considered important that both the public and the private sector should work together under an innovating agenda of the agricultural sector, which would allow in the medium and long term, in an organized way, to raise the agricultural competitiveness of Costa Rica.

It is suggested that future research will allow us to assess the cost-benefit for the society of investment in innovations of new varieties of crops against the benefits that the society receives.

The governments of small countries with a dynamic export sector of agricultural products such as Costa Rica promote policies for innovation in exportable crops, that's why research such as this, provide data to support decision making.

6. Acknowledgments

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