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PRICE TRANSMISSION ANALYSIS FOR NICARAGUA RICE MARKET

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Abstract

Rice is the most important staple food for Nicaraguans. Analyzing price linkages among market levels is helpful for policy makers to evaluate the potential impacts of agricultural policy on producers and consumers, especially for a country such as Nicaragua which bases its economy largely on the agricultural sector. This paper analyzes pricing relationship between wholesale and retail levels of Nicaraguan rice market and tests for asymmetric price transmission. Rice and in general agricultural sector has an important role in Nicaragua economic. We used monthly prices for high quality rice data from January 2008 to January 2015 along with a model that is based on the Ward's model framework. We estimate the model using the autoregressive distributed lag (ARDL) approach. To check the stability of the long-run coefficient, the cumulative sum of recursive residuals (CUSUM) is applied. Also to test the direction of causality, the Granger causality test is used to judge the causality results and different lags have been applied. The results indicate that there is a bilateral relation between wholesale and retail prices. Based on our results, there is significant evidence to support asymmetry between the wholesale and retail sector, which indicates market inefficiency and distortion between these two markets.
Keywords:*Price transmission, Rice, ARDL, Nicaragua*
JEL Codes:*Q12, Q13, Q18*

1. Introduction

On average, human beings get about 48 percent of their calories from grains; rice and corn are among main staple foods for many people in developing countries. For example, "Gallo pinto" is a traditional dish in Nicaragua, consisting of rice and beans; it is eaten for breakfast or as an accompaniment to any meal.

According to Baquedano and Liefert (2014), wheat, rice, maize and sorghum are major food staples within the developing world, which two of these food stuffs- wheat and rice- are heavily imported by countries, while for the other two –maize and sorghum-domestic production meet the bulk of domestic needs.

Nicaragua bases its economy largely within the agricultural sector. Throughout history, the agricultural sector of Nicaragua has followed a tortuous path, which explains in part the pattern of a slow development process (Navarro, 1972), and still is a large rice producer in Central America.

In Nicaragua, two kinds of rice producers are common; upland rice farmers and irrigated rice farmers. Upland rice cultivation is mostly related to small producers, and takes place in mountains and plateaus on the rivers shore. Once the river waters retrograde after the rainy season, the uncovered, dry land is available for farming rice. The other type of production is common in the rice fields, where water is preserved using small irrigation ditches. Rice farmers, who practice irrigation are mainly large producers, and produce 60% of rice in

Nicaragua, they utilize advanced production technology. The large producers are organized in the Nicaraguan Rice Association (ANAR). ANAR has established strong negotiation capacity and defensive strategies, and it has required information about the market and prices. Irrigated rice farmers have their own vertical production integration with collection centers, storage, transport and milling. There is a strong relation between ANAR and the processing industry, wholesalers, and the government by under the Rice Producers' Support Program (PAPA). This alliance is financially beneficial for producers. On the other hand, upland rice producers have to pay for all the services individually, because they do not have any union with the government (Valdivia, 2016).

Based on a report by FAO (Pulver, 2002), almost in all Latin America and the Caribbean region countries (LAC), rice research is supported by the public sector and there is evidence of unsustainable development. In particular, it is the case in most countries in Central America because of poor education, health and elementary infrastructure. On the other hand, some countries such as, Colombia and Rio Grande do Sul, Brazil have a rice production check-off system that has sustained rice research and development for several years without public sector support and this system can be employed in other countries. Applying the production check-off provides adequate and secure finances to support the needs of the industry. Earnings from a production check-off would allow small countries to access to technologies and also support national evaluation efforts and crop management activities.

In 1995, irrigated rice grower associations, consisting of many countries, Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Guatemala, Nicaragua, Panama, Uruguay and Venezuela joined FLAR (Latin American Fund for Irrigated Rice). The objective of FLAR was providing germplasm[1] to member countries and establishing a mechanism for small countries to share in the development costs for elite germplasm and gain access to improved crop production technologies (Pulver, 2002).

In Figure (1), production level, yield and harvested area for Nicaragua during last decades have been depicted.

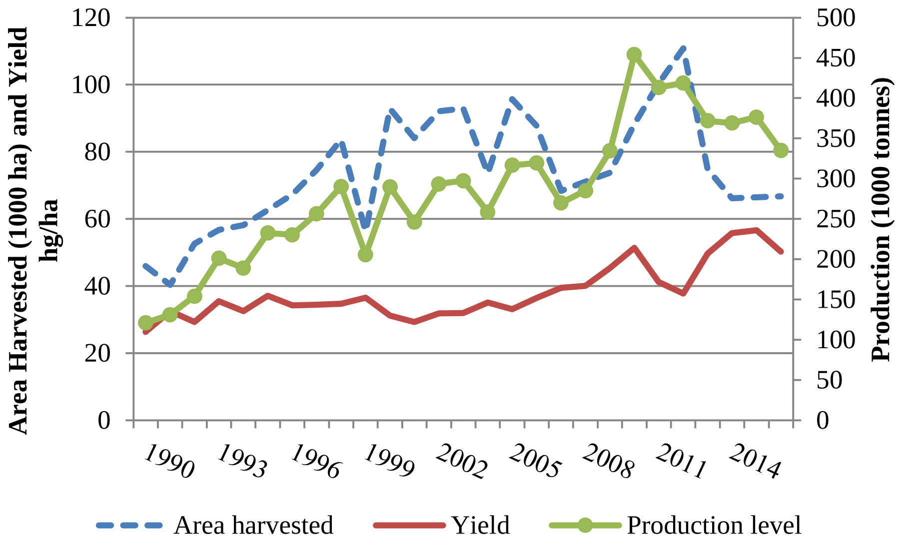

Figure 1. Nicaragua Rice Production from 1990 to 2016
Source: FAOSTAT, FAO

1- The genetic material of germ cells.

It is obvious in the graph that, production level, as well as harvested area and yield, have never represented a smooth path over time. However, they all have increasing rate in recent years that is consistent with the increasing evolution of rice production quantity in past years. In table (1), a comparison of this evolution for selected commodities is provided.

Table 1- Trend of Production Quantities for Selected Commodities in Nicaragua

Commodity	**[1000 t]**				**Annual growth rate [%]**		
	1996	2001	2006	2011	1996-2001	2001-2006	2006-2011
Paddy rice	230	246	320	448	10.35	50.4	80.81
Coffee	49.9	66.8	70.46	104	60.01	10.07	80.1
Meat	85.83	117	177	261	60.39	80.63	80.08
Oil crops	31.75	42.61	57.74	73.69	60.06	60.27	5
Cocoa bean	00.2	00.3	10.4	10.74	80.45	36.08	40.44
Cereals	674	755	895	1101	20.3	30.46	40.23
Coarse grain	444	590	575	613	20.77	20.47	10.29

Source: FAOSTAT, FAO

Based on the table (1), paddy rice has the highest annual growth rate among other crops during 2006-2011. It is while for cocoa bean there is a sharp decline from 2001-2011.Also, table (2) represents Nicaragua commodities availability for consumption. Rice was the second available food in 2011.

Table 2- Nicaragua Top Ten Commodities Availability for Consumption in 2011

	Commodity	**Quantity [kcal/capita/day]**
1	Maize and products	631
2	Rice (Milled Equivalent)	406
3	Sugar (Raw Equivalent)	396
4	Wheat and products	207
5	Beans	184
6	Milk - Excluding Butter	131
7	Soybean Oil	91
8	Poultry Meat	80
9	Palm Oil	72
10	Bovine Meat	30

Source: FAOSTAT, FAO of the UN, Accessed on May 26, 2014. http://faostat.fao.org/site/368/default.aspx#ancor

2. Background Literature

Since rice is one of the important world's three leading food crops, there are some studies that look at the linkage between price dynamics of rice and poverty in low income countries such as, Indonesia, Liberia, Bangladesh (e.g. McCulloch 2008; Tsimpo and Woden, 2008; Vu and Glewwe, 2011, among others). There are another group of studies that focus more on the price dynamics of rice and other products, such as a study by Brenna (2003), who studied rice market in Bangladesh.

Generally, market integration and price transmission analysis is a rich area in the literature, and many studies have been done using different methods. Studying price interaction is beneficial because it would lead to the better recognition of a market. In a competitive market, it is expected that the effects of a policy are transferred fully to consumers. However, some empirical studies in the food market reported that the price transmission was faster when there was an increase in the upstream market prices compared to when there was a decrease. Usman and Haile, (2017) investigated the price transmission from producers to retailers in cereal markets. Based on the result of symmetric price adjustments in cereal markets they conclude that input price changes may have positive long run implications for food security and welfare of the poor in Ethiopia.

The issue of price transmission can be discussed from the vantage point of agricultural policy reforms. The presence of an asymmetric price transmission would lead to over-estimating the benefit of a support policy for final consumers (Vavra and Goodwin, 2005).

Baquedano and Liefert (2014) investigated price transmission in consumer markets of developing countries to examine whether prices in urban consumer markets are cointegrated with prices in the world agricultural markets. Their study consists of over 60 country/commodity pairing including, wheat, rice, maize and sorghum in the major urban centers of selected countries in Asia, Latin America, the Caribbean and sub-Sahara Africa. Using a single equation error correction model they found that the movement of domestic consumer prices to new equilibrium with the world prices is relatively slow. Surathkal, *et al.* (2014) also investigated the dynamic relationship between wholesale and retail prices of U.S beef sector; they did a test for product differentiation in cuts and quality grades. Using TAR and MTAR approaches, they found that there are significant asymmetric effects; however, this effect varies across quality grades. They concluded that the adjustment of beef prices at the retail level is influenced by the level of quality. Darbandi and Saghaian (2016) studied price adjustment of the U.S. beef sector with a focus on the Great Recession. They found this market has an asymmetric price adjustment, pointing to inefficiency of the supply chain in this market.

Arshad and Abdel-Hameed (2014), examined the cointegration and causality relationships between the farm and retail prices in the Malaysian fruit market. Using monthly data for period 2000-2010 and Granger causality tests they found a long run unidirectional relationship from farm prices to retail prices.

Fiamohe, *et al*. (2013) using a threshold model, studied local rice markets in Benin and Mali, while they consider two sides of the market, production and consumption sides. Using monthly price series from 2000 to 2010, their results for Benin indicated that the price transmission between markets was asymmetric; conversely, the results for Mali indicated symmetric price transmission, they conclude this is because of the prevalence of lower transaction costs in Mali.

Girapunthong, *et al.* (2003) analyzed price transmission in the United States fresh tomato markets among the producer, wholesale and retail levels. They used a total of 448 monthly observation and Granger causality test to analyze the direction of causality. Their results indicate that unidirectional causality from producer to retail level exists and asymmetric price response was observed between wholesale and both producers and retailers. Retail prices reacted faster to rising wholesale prices than to falling prices. Wholesale prices, however, reacted faster to declining producer price than to rising producer price.

Silvapulle and Jayasuriya (1994) studied Philippines rice market integration, their results based on Johansen's multiple cointegration techniques indicate that the Philippines rice markets are generally well integrated into the long-run with Manila as the dominant market. There is another study that considers Indonesian rice market by Alexander and Wyeth (1994).They applied error correction mechanism to test cointegration and market integration and found supply sources are more important than demand sources in driving prices.

In summary, analyzing agricultural products have received considerable attention, however, in our knowledge there is no study for Nicaragua rice market that focuses on price relationship, and hence this study would be among the first studies in this area. As Taubadel and Meyer (2001) discussed, asymmetric price transmission is not only important because it may point to gaps in economic theory, but also because its presence is often considered for policy purposes to be evidence of market failure.

The outline of this note is as follows, in next sections both econometrics model and estimation process will be discussed. Then empirical results and conclusion are provided.

3. Econometrics Model

In order to check the asymmetry of price transmission from terminal market to retail market the following model is adopted, in which two levels of prices exists; prices at one level of the marketing chain are related to prices at another by $R_t = f(W)$, where R may be the price at the retail level and W the price at the wholesale level. The general case is where R is related to W through a distributed lag function.

$$R_t = \alpha_{0t} + \sum_{j=1}^{k} \alpha_j W_{t-j+1} + \varepsilon_t \quad (1)$$

If asymmetry occurs, then α_j differs depending on whether W_t is less than or greater than W_{t-1}. Using Young's (1980) framework, the W variable can be split into two, one section capturing price rises and the other price falls. Equation (1) can be rewritten as:

$$R_t = \beta_{0t} + \sum_{j=1}^{k} (\alpha'_j W'_{t-j+1} + d''_j W''_{t-j+1}) + \varepsilon_t \quad (2)$$

Finally, after doing some math[2] we will reach equation (3), based on that the hypothesis of asymmetry will be tested. In this study retail prices and wholesale prices for rice will be considered.

$$R_{1t} = \lambda_{0(t)} + \lambda'_0 H_{1(t)} + \lambda'_1 H_{2(t)} + \lambda''_0 H_{3(t)} + \lambda'_1 H_{4(t)} + \varepsilon_t \quad (3)$$

Where:

$$H_{1(t)} = \sum_{j=0}^{3} [W_{t-j} - W_0]$$

$$H_{2(t)} = \sum_{j=0}^{3} [W_{t-j} - W_0] \phi_j$$

$H_{3(t)} = \sum_{j=0}^{3} [W''_{t-j}]$, and

$$H_{1(t)} = \sum_{j=0}^{3} [W''_{t-j}] \phi_j$$

R represents the retail price, W is the wholesale price, W'' is the falling wholesale price and ε_t is a random error term. ϕ_j is some weighting of the lags. Following Girapunthong *et al.* (2003) we set $\phi_j = j^{(1/3)}$.

The asymmetric hypothesis tests whether price changes at one level are symmetric in response to increases and decreases in prices at other levels of the market system. If the null hypothesis that retail price response is symmetric to both increases and decreases in wholesale prices is rejected, then we conclude there is asymmetric behavior between wholesale and retail price levels (Girapunthong, *et al*. 2003).

3.1 Empirical Model

Since we are using monthly series of data in this study, it is necessary to do the stationary test before estimating the equation (3), we applied augmented Dickey-Fuller test and based on that the model will be estimated by Autoregressive Distributed Lag (ARDL) approach.

To begin with, we test for the null of no cointegration against the existence of a long-run relationship. Unlike other cointegration techniques (e.g., Johansen's procedure) which require certain pre-testing for unit roots and that the underlying variables to be integrated of order one, the ARDL model provides an alternative test for examining a long-run relationship regardless of whether the underlying variables are I(0), I(1), or fractionally integrated (Oskooee and Wing Ng, 2002).

First, the existence of a non-spurious long-run relationship in levels between the retail prices and the wholesale prices must be tested. Second, the long-run relationship and the error correction model for the producer price are estimated, and based on the estimated coefficients we interpreted the asymmetry hypothesis.

4. Empirical Results

The results of the stationary test are provided in the table (3).Since we are to estimate equation (3), hence it is required to do stationary test for all variables in equation (3). This is to ensure that the variables are not I(2) stationary to avoid spurious results. Following Akmal (2007) in the presence of I(2) variables, the computed F-statistics provided by Pesaran,*et al*. (2001) are not valid because bounds test is based on the assumption that the variables are I(0) or I(1).

Table 3- Augmented Dickey-Fuller test statistics
Null hypothesis: The variable has a unit root

Variables	Test for unit root in Level	Test for unit root in First difference
R	-1.434	-9.135***
H_1	-3.540**	-
H_2	-2.685	-4.255***
H_3	-3.540**	-
H_4	-3.40*	-

Note: ***,**,* indicates significant at1%, 5% and 10% respectively

It is shown in Table (3) that the variables are stationary at both level and first difference; therefore we employed ARDL approach to estimate equation (3).Appling ARDL approach has some advantages. First, it is applicable irrespective of whether the underlying regressors are purely I(0), purely I(1) or mutually co-integrated. The statistic underlying this procedure is the common Wald or F-statistic in a generalized Dickey-Fuller type regression, which is used to test the significance of lagged levels of the variables under consideration in a conditional unrestricted equilibrium error correction model (ECM) (Pesaran, *et al*., 2001). Second, ARDL approach is more robust and performs better for small sample sizes (such as in this study) than other co-integration techniques (Akmal, 2007).

The first step in estimation ARDL is to assure there is a long-run relationship between variables. To do that, we subtracted the sum of the coefficients of dependent variable with lags from one and then divided it by sum of standard error of those coefficients, and then we compared the computed t-statistics with critical statistics provided by Banerjee, Dolado, and Mestre(1992), since computed t-statistic is greater than critical value, hence the null hypothesis that says there is no long-run relationship is rejected.

In the second step, we estimated the long run and short run coefficients of the same equation and results are provided in the table (4) and (5) respectively.

Table 4- Autoregressive Distributed Lag Estimates (1,0,0,0,0)

Dependent variable is R			
Variables	**Coefficient**	**Std. errors**	**Prob**
R (-1)	0.177	0.111	0.115
H_1	0.374***	0.606	0.00
H_2	-0.292***	0.038	0.00
H_3	0.436**	0.188	0.016
H_4	0.007***	0.002	0.004
Constant	0.282	0.646	0.663
R-Squared = 0.965			
R-Bar-Squared =0.963			
F-Stat (prob-value) = 413.54 (0.00)			
Durbin's h-statistic = -7.7071[.000]			

Note: ***,**,* indicates significant at 1%,5% , and 10% respectively.

We would use the coefficients in this table to test the existence of long run relationship among the variables. While it is conformed that there is a longrun relationship, the results are provided in table 5.

Table 5. Error Correction Representation for the Selected ARDL-Model

Dependent variable is dR= R –R(-1)			
Variables	**Coefficient**	**Standard error**	**Prob**
dH_1	0.372***	0.606	0.00
dH_2	-0.292***	0.038	0.00
dH_3	0.436**	0.188	0.016
dH_4	0.007***	0.002	0.004
dconstant	0.282	0.646	0.663
Ecm (-1)	-0.822***	0.111	0.00
R-Squared = 0.670			
R-Bar-Squared = 0.648			
F-Stat (prob-value) = 30.13 (0.00)			
D.W statistic = 2.204			

Note: ***,**,* indicates significant at 1%, 5% , and 10% respectively.

The most important point in this table is the coefficient for the ECM term. This coefficient indicates that how quickly the impact of a shock can be adjusted to achieve the longrun equilibrium. Based on the results, since ECM term is significant and has the negative sign as expected, we can say after any distortion from the equilibrium, in each month 0.82(out of 1) portion of disequilibrium would be adjusted.

Finally, to investigate the stability of the long-run coefficients together with the short run dynamics, the cumulative sum (CUSUM) is applied. A graphical representation of CUSUM is shown in Figure 2.

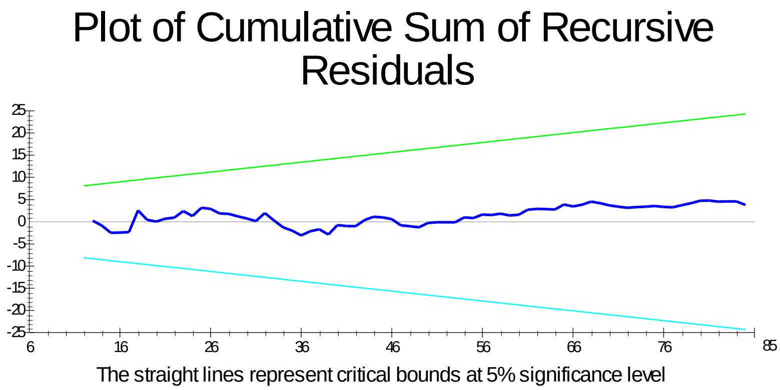

Figure 2. Cumulative Sum of Recursive Residuals (CUSUM)

As it is clear from Figure 2 the plot of the CUSUM is within the boundaries, and hence this statistic confirms the stability of the long run coefficients of regresses. As Akmal (2007) discussed in his paper the null hypothesis (i.e., that the regression equation is correctly specified) could not be rejected if the plot of this statistic remains within the critical bounds of the 5% significance level.

The parameter estimates of the pricing asymmetry models in equation (3) are represented in the table (4) and (5). Significant test on H_1 and H_2 at 99% confidence level suggests a price linkage in the rice market of Nicaragua. The significant tests on H_3 and H_4(asymmetry effect) for retail-wholesale price relationships suggest that there is significant evidence of asymmetry. Furthermore, the intercept is positive; although it is not significant statistically, it represents the range of the marketing margins between the two market levels.

To check the direction of causality, Granger causality test has been done, and the result is reported in table 6.

Table 6- Pairwise Granger Causality Test

Null Hypothesis	**F- Statistic Lag1**	**F-statistic Lag 2**
Wholesale price does not granger cause retail price	5.761 (8.E-06)	21.056 (5.E-08)
retail price does not granger cause wholesale price	1.999 (0.0519)	2.871 (0.062)

Note: numbers in parenthesis are probabilities.

The null hypothesis for this test indicates that there is no linkage from wholesale prices to retail prices and vice versa. Since the computed F-statistic in each scenario is large enough and is strongly significant, then we can reject both null hypotheses; therefore there is a bilateral relationship between prices of these two levels of rice market. It implies that every change in wholesale prices is conveyed toward the final consumers, and on the other hand, any change in retail level prices is transferred to the wholesale level. Therefore, implementation of any policy such as price ceiling that led to the change of prices in one stage of the rice market would result in the welfare change of the whole market finally.

5. Conclusions and Suggestions

This study investigates the price relationship between retail and wholesale level prices of Nicaragua rice market, there is no similar study in this area. We used monthly time series data from January 2005 to January 2015. Because of the nature of time series data, first we checked the stationary level of data and based on the level of stationary we decided to estimate the model using ARDL model. Based on the result asymmetry exists among these two levels of rice market of Nicaragua, implying that there is market distortion between producer and retail markets. Learning price linkage among market levels is helpful to evaluate the potential impacts of agricultural policy on producers and consumers.

One important implication is related to the issue of food security and welfare of the rural and farmer. In the presence of the symmetric price adjustments price changes in the input market are transferred fully to the downstream market. Therefore, reduction of input costs has a positive long run impact on both producers and consumers. Because consumers would benefit from the price reduction at the input market as much as the producers. However, in the presence of asymmetric price adjustments, since prices are not fully carried into consumers, the welfare impact of reduced cost of inputs is not distributed equally.

Also for future study, considering price relation between domestic and international rice market is suggested, since after signing the United States and Central America Free Trade Agreement (CAFTA), there were tariff exemptions to rice imported, with the condition that the tariff exemptions benefits would not go to the consumer but to producers. Therefore, these kinds of study would be helpful for rice market policy maker in Nicaragua.

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Footnotes:

1 - For details about the deriving the equation refers to Girapunthong*et all*. 2003