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Measuring market integration and pricing efficiency along regional maize-tortilla chains of Mexico

Análisis de la transmisión de precios en las cadenas regionales de comercialización de tortillas de maíz en México

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Abstract

When market performance is analyzed, a key issue to understand is the extent to which different agents in the supply chain respond to changes in price shocks. This paper explores the Mexican maize–tortilla chain through a price transmission analysis. It focus on a country-level study of the Mexican tortilla market by considering different regions and commercialization chains. Using a Vector Error Correction Model (VECM) the integration of the Mexican maize tortilla market between the inter-region *tortillería*, inter-region supermarket and intra-region *tortillería*-supermarket prices are investigated. The findings suggest that price transmission between *tortillerías* and supermarkets within a region seems to have triggered a shift in some consumers' place of purchase. Moreover, it demonstrates that cointegration level mainly depends of storage, logistics and transportation that could be the reason for the upsurge in variability of tortilla prices between states. These results appear to validate that radial transportation system in Mexico has benefited the central regions at the expense of the periphery regions, thus enabling *tortillerías* in Central regions to remain competitive with supermarkets and retain their market share.

Keywords
maize tortilla industry • Mexico • price transmission • supply chain

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Resumen

Cuando se analiza el comportamiento de los mercados, un elemento clave es entender hasta qué punto los diferentes agentes de la cadena de comercialización responden a los cambios en las perturbaciones de los precios. Este trabajo estudia las cadenas de comercialización de tortillas de maíz en México, a través, de un análisis de transmisión de precios. Este producto es una de las principales fuentes alimenticias en Mexico. Este estudio analiza diferentes regiones y cadenas de comercialización utilizando un Modelo de Corrección de Errores Vectoriales (VECM) para investigar la integración del mercado mexicano de tortillas de maíz entre diferentes agentes comercializadores. Estos agentes son la tortillería interregional, el supermercado interregional y los precios intra-regionales de la relación tortillería-supermercado. Los resultados sugieren que la transmisión de precios entre las tortillerías y los supermercados dentro de una región parece haber provocado un cambio en el lugar de compra de algunos consumidores. Lo anterior, demuestra que el nivel de cointegración depende principalmente del almacenamiento, la logística y el transporte, lo que podría ser la razón del aumento en la variabilidad de los precios de la tortilla entre estados. Estos resultados parecen validar que el sistema de transporte radial en México ha beneficiado a las regiones centrales a expensas de las regiones periféricas, permitiendo así que las tortillerías de las regiones centrales sigan siendo tan competitivas como los supermercados, permitiendo la conservación de sus cuotas de mercado.

Palabras clave
tortillas de maíz • México • transmisión de precios • cadena de suministro

Introduction

Tortillais the most important Mexican consumer good. It represents 38% of the protein, 45% of the calories and 49% of the calcium among the Mexican population's dietary intake (23). Maize is the traditional source of grain for this product and it is the most widely crop produced in Mexico.

Mexico produces 23 million t of maize and ranks fourth in producing countries in the world, after the United States, China and Brazil, with 224, 146 and 42 million t respectively (1). The maize tortilla industry plays a significant role in the Mexican economy, accounting for 1% of Mexico's GDP. The maize-tortilla industry directly employs about 225,000 workers in mills, flour factories, and *tortillerías* in the production of maize flour, maize dough (nixtamal), and maize tortillas (17). There are more than 78,000 *tortillerías* (tortilla bakeries) and mills distributed throughout México, employing over 2 million agriculture workers in the maize productive sector (7, 34).

There are two main processes in the production of maize tortilla: maize flour and nixtamal (maize dough*)*. The maize flour industry is highly concentrated, being their transportation and storage operations subsidized by the Mexican government in order to maintain tortilla prices stable (28). In contrast, the nixtamal industry is highly decentralized and usually not vertically integrated to the storage, logistics, and distribution of maize (31). In the case of mills and *tortillerías* they acquire maize from commercializing firms, who buy directly from producers, distribute and store maize in urban places, and sell to the *nixtamal* industry at higher prices, thus causing this type of tortillas to be costlier (35).

The maize tortilla value chain presents an important barrier to the entry for new competitors due to the high level of concentration in imports, storage and marketing of maize (34). Gasca (2014) suggested that government subsidies along the maize-tortilla value chain benefited large maize commercializing firms, which used their market power to finance speculative operations of storage, fleet, and export. Thereby exacerbating the effects of the rise in the international price of maize in the domestic market by causing price distortions along the maize-tortilla value chain. The tortilla demand is very inelastic to a change in price and it is considered to behave as a normal inferior good (21, 30). According to Wood *et al*. (2012), the income elasticity of demand for tortilla by non-poor and poor households is not significantly different from zero except for the urban non-poor who have a very small income elasticity, indicating that changes in income are unlikely to change tortilla demand. This is a reflection of the relevant status of tortilla as a staple that these households consume in the desired quantity. Therefore, low income household's standard of living has suffered the most as a consequence of price peaks events, such as, the tortilla crisis happened in 2007 (38).

From the supply side, *tortillerías* and supermarkets mainly distribute tortillas. The first have increased dramatically after the deregulation of the tortilla industry in 1998 (37). However, due to the highly inelastic demand for the consumption, its price has not decreased as would be expected in a competitive market but instead it has increased (23). Following Keleman *et al.* (2009), this situation could be exacerbated by the current public programs that incentivize the opening of new *tortillerías* and mills through subsidies.

The second player, supermarkets, accounted in 2014 for the distribution of 25% of the total maize tortillas commercialized in Mexico and they have emerged as a serious competitor of the traditional *tortillerías* (27). Supermarkets have a greater presence in northern and central parts of Mexico, having less presence in southern Mexico and rural areas (25). Throughout the last decade, regular food purchases at supermarkets of middle and high-income households have increased, this is reason to believe that at a medium-term supermarkets will consolidate their position as the primary competing channel of *tortillerías*, acquiring greater market share of tortilla sales at the expense of them (10).

With such a broad panorama, it should not be surprising that farmers and producers behave in different following the socioeconomic environment of their regions, therefore influencing the market performance along the supply chain of maize tortilla. This is due largely to asymmetries among segments of this chain, which conditioned the responses of industrial-scale corporations and small-scale family businesses.

When the performance of agricultural markets are analyzed, a key issue is the extent to which the different agents in the supply chain respond to changes in price shocks (29, 36). Therefore, the analysis of spatial price transmission is central in understanding the extent of the integration of economic agents into the market process (16). While studies of price transmission in a spatially separated contexts have received substantial attention in the literature [*e.g.* Ethiopia (12); Ghana (6) and Chile (35)], only a few studies have explicitly examined the impact of market chain structures on the transmission of price signals among regions.

The paper aims to fills this gap by exploring the performance of the Mexican maize-tortilla chain through a regional price transmission analysis. In particular, focus on a country-level study of the Mexican tortilla market by considering different regions and commercialization chains. Innovates by implement a Vector Error Correction Model (VECM) to determine the spatial price integration level of inter-region *tortillería* price, inter-region supermarket price and the intra-region *tortillería*-supermarket price. Since these goods should trade freely between the different regions in Mexico, it is hypothesized that tortilla price should be positively cointegrated with in their producing regions and between the two main selling points, *tortillerías* and supermarkets.

The article proceeds as follows: Sections 2 describes the data sources and methodology. Section 3 presents the results and discussion, respectively. Finally, Section 4 summarizes the main conclusions.

Materials and methods

Data description

A total of 362 weekly observations from the January 2007 to December 2013 were used to implement the VECMs (figure 1). Tortilla price series were acquired from the SNIIM (National Information System and Market Integration) (33) for each of the 50 urban centers spread throughout all of Mexico.

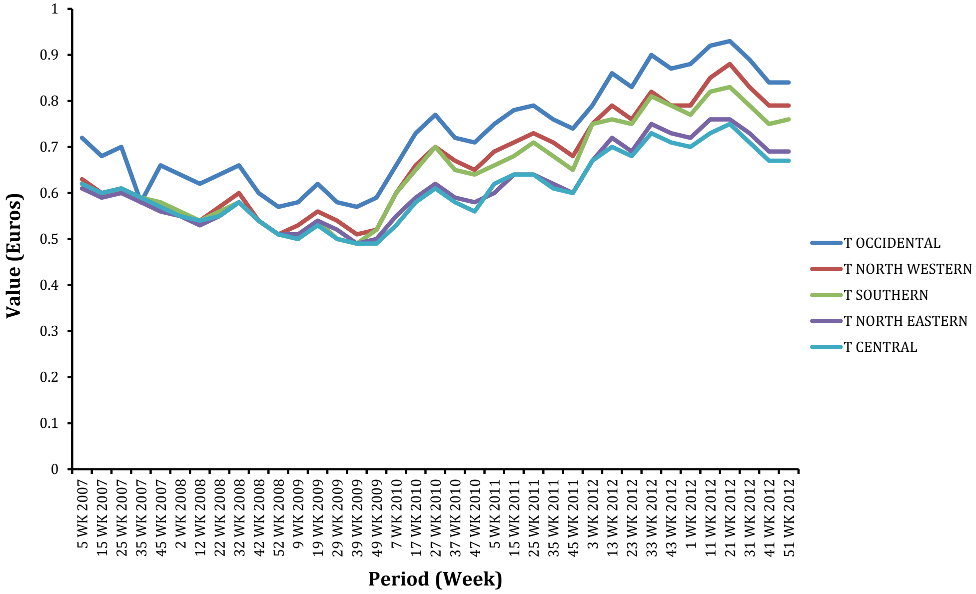

Figure 1. Average prices of tortilla for the 5 regions considered on this study (expressed in Euros).

Figura 1. Precios promedio de tortilla para las 5 regiones consideradas en este estudio (expresadas en Euros).

In order to classify each price pair according their sales channels (supermarket and *tortillería*), the ENIGH 2006 and ENIGH (National Survey of Household Income and Expenditure) 2012 surveys were used to compare the percentage share of tortilla purchases consumers made at each channel.

Price data was transformed to the historic Euro value because price fluctuations distort the value of economic values measured in nominal values (32). In this sense, since there is no daily or weekly consumer price index measurement, transformation to Euros was decided over the dollar or Mexican Peso given to the lower inflation level in the European Union during the time being considered (13).

All price series were transformed to natural logarithms to enable the coefficient's interpretation as elasticity. The Mexican urban centers were identified following the classification of the Mexican Secretariat of Agriculture, Livestock, Fisheries, Rural Development, and Food (SAGARPA). These centers were sorted by regions according their distance and population level (17).

The regions are: North West, North East, Occidental, Central and Southern Distinct variables for tortilla (from items bought) and for regions (from chain variable containing state information). The sample was filtered for tortillas that were bought in urban centers of more than 100,000 habitants and in the respective region. This allowed a deeper analysis regarding the proportion of urban household tortilla purchased by supermarkets or *tortillerías* for the respective region and year (table 1).

Price transmission analysis

Well integrated markets play an essential role in reducing risks caused by supply and demand shocks by facilitating adjustments in trade flows across space, and in doing so reducing price variability faced by consumers and producers (4).

Market integration can be measured through short and long run price transmission elasticity, which measures the effect of a price change for a good in one market of the price in another market (39).

Most of price transmission research in Mexico has been centered on analyze the effect of international price shocks on Mexican maize markets and the dynamic of vertical price transmission along the tortilla industry. For example, Motamed *et al.* (2008) analyzed the price transmission between US yellow maize and Mexican white maize.

Table 1. Average distance and population for each region considered on this study.
Tabla 1. Distancia promedio y población para cada región considerada en este estudio.

Av. Distance between regions	North Western	North Eastern	Occidental	Central	Southern	Population
North Western	N/A	1091	1442	1776	2300	10,307,316
North Eastern	1091	N/A	736	1136	1623	17,200,470
Occidental	1442	736	N/A	448	935	23,437,097
Central	1776	1136	448	N/A	601	38,807,720
Southern	2300	1623	935	601	N/A	22,583,935

Source: INEGI (2014) / Fuente: INEGI (2014)

Their findings demonstrated a weak evidence of cointegration between these two prices, further suggesting that public subsidy programs could affect the convergence of price shocks between them. Araujo-Enciso (2011) studied the vertical price transmission for the Mexican Tortilla Industry by analyzing how social capital influenced price transmission between maize, maize flour, and maize tortilla. The work that most resembles this analysis was done by Appendini and Quijada (2010) who analyzed the production and consumption strategies of staple food (maize-tortilla) by rural households of Mexico.

This work explores spatial price transmission of maize tortilla for 5 regions distributed throughout Mexico by considering the most important urban centers and the supermarket channels. To estimate the speed of price transmission between regions, an approach based on Engle and Granger (1987) was used. Two price series $\mathcal{P}_t^A$ and $\mathcal{P}_t^B$ from regions A and B respectively are cointegrated if each is a non-stationary process (integrated of order 1 or I(1)) and if the residuals ε_t of the long-run relationship between these prices are stationary (integrated of order 0 or I(0)).

$$p_t^A = \beta_0 + \beta_1 p_t^B + \varepsilon_t \qquad (1)$$

Before the price transmission model can be modeled, stationarity, cointegration level and long run cointegration need to be verified. The Leybourne (1995) and Otero and Smith (2012) critical values were applied to testthe stationarity for each price series. When the existence of unit roots are confirmed, it is possible to formulate a test for cointegration vectors, that is, the long run equilibrium relations. In general terms, in the presence of two variables y_t and x_t which are I (1) the residuals will be I (1).

However, if this variables are I(0), y_t and x_t are called cointegrated. The cointegration level between series was ranked according the Johansen trace method (18) and the optimal lag was decided by the Akaike Criterion and Final Prediction Error (21). The test results are presented in table 2 (page 285). Assuming that $\mathcal{P}_t^A$ and $\mathcal{P}_t^B$ are indeed cointegrated, a vector error correction model (VECM) for these two prices are estimated. The VECM takes the following general form equation 2*.

The adjustment parameters α_p^{AB} and α_p^{BA} measure the speed with whicp price transmission takes place. Hence, they are the parameters of interest in the following stages of this analysis. Error correction, and thus cointegration between $\mathcal{P}_t^A$ and $\mathcal{P}_t^B$, requires that $\alpha_p^{AB}<0$ and $\alpha_p^{BA}>0$. For example, if $\mathcal{P}_t^A$ is too high with respect to $\mathcal{P}_t^B$ then $\hat{\varepsilon}_t^*$ will be positive. In this case, and in equation (2) ensure that p^A falls and p^B increases in the next period, thus driving these prices closer to the long-run relationship. Overall, the long- run price transmission elasticity (ß$_1$) and short term error corrections terms (α_1 & α_2) for *tortillería* prices between regions (3 pairs), supermarket prices between regions (2 pairs) and finally, between supermarket and *tortillería* prices with in regions (2 pairs) were estimated. Therefore, 7 VECM's were implemented by using price pairs corresponding to each *tortillería*-supermarket and regional centers interactions (table 3, page 285).

* $$\Delta p_t^A = \gamma_0 + \sum_{i=0}^{2} \gamma_i^B \Delta p_{t-1}^B + \sum_{i=1}^{2} \gamma_i^A \Delta p_{t-1}^B + \sum_{p=0}^{3} \alpha_p^{A_B}\, \hat{\varepsilon}_{t-1}^* + v_t^A$$

$$\Delta p_t^B = \delta_0 + \sum_{i=0}^{2} \delta_i^A \Delta p_{t-1}^B + \sum_{i=1}^{2} \delta_i^A \Delta p_{t-1}^B + \sum_{p=0}^{3} \alpha_p^{A_B}\, \hat{\varepsilon}_{t-1}^* + v_t^B$$

Table 2. Cointegration ranks according the Johansen Trace Method (18).
Tabla 2. Rankings de cointegración de acuerdo con el Método de Johansen (18).

Region	Rank	Eigen value	Trace Test	P-value
T. North Western - T. North Eastern	0	0.1318	57.741	0.0000
	1	0.0183	6.689	0.3886
T. North Western - T. Southern	0	0.1251	55.981	0.0000
	1	0.0211	7.738	0.2825
T. North Eastern - T. Southern	0	0.1387	60.342	0.0000
	1	0.0176	6.433	0.4179
S. Occidental - S. Southern	0	0.1055	45.259	0.0000
	1	0.0141	5.118	0.5871
S. Occidental - S. Central	0	0.1540	66.266	0.0000
	1	0.0161	5.8813	0.4858
T. Central - S. Central	0	0.0376	14.890	0.0172
	1	0.0028	1.0174	0.3647
T. Occidental - S. Occidental	0	0.0493	18.004	0.0189
	1	0.0008	0.2873	0.5919

Table 3. VECM Results for the Bivariate Cointegration.
Tabla 3. Resultados del Modelo Vectorial de Correccion de Errores.

Interactions	Variables	ß1	α1	p-value	α2	p-value	Durbin Watson Test	Dist. Reg. (Km)
Inter-regional Supermarket Cointegration	ΔLogP ^{Central} / ΔlogP $_{Occidental}$	-0.8626	-0.1258	0.0024 ***	0.1552	0.0002 ***	1.8698	448
	ΔLogP ^{Southern} / ΔlogP $_{Occidenal}$	-0.8995	-0.0361	0.3982	0.1679	0.0001 ***	1.8213	935
Inter-regional *Tortillería* Cointegration	ΔLogP ^{Southern} / ΔLogP $_{NorthEastern}$	-0.9178	-0.1956	0.0009***	-0.0776	0.2198	1.8932	1623
	ΔLogP ^{Southern} / ΔLogP $_{NorthWestern}$	-0.9867	-0.2178	0.0001***	-0.0867	0.1756	1.8390	2300
	ΔLogP ^{NorthWestern} / ΔlogP $_{NorthEastern}$	-0.9156	-0.1810	0.0075***	0.0687	0.2287	1.8817	1091
Intra-regional *Tortillería*-Supermarket Cointegration	ΔLogP $^{T.Occidental}$ / ΔlogP $_{S.Occidental}$	-0.4976	-0.0886	0.0003***	-0.0390	0.2561	1.8516	N/A
	ΔLogP $^{T.Central}$ / ΔLogP $_{S.Central}$	-0.5567	-0.1056	0.0002 ***	-0.0701	0.0886	1.9984	N/A

Results

Observing table 4 (page 286) the average sale prices of tortillas at supermarkets are considerably lower than *tortillerías* in all regions. When both mean prices are compared, it was found that supermarket prices between regions are smaller than *tortillería* prices, further suggesting higher volatility due to the atomization of these last sale points.

Table 4. Time series avg. price in Euros for period January 2007 - December 2013.
Tabla 4. Precio promedio en Euros para el periodo enero 2007 - diciembre 2013.

Region & Point of Sale	Avg. Price in Euros	Standard Deviation
Tortillería_Occidental	0.615	0.077
Tortillería_North Western	0.733	0.105
Tortillería_Southern	0.664	0.105
Tortillería_North Eastern	0.652	0.098
Tortillería_Central	0.608	0.072
Supermarket_Occidental	0.438	0.101
Supermarket_North Western	0.456	0.100
Supermarket_Southern	0.435	0.099
Supermarket_North Eastern	0.459	0.112
Supermarket_Central	0.429	0.095

Source: SNIIM (2014) / Fuente: SNIIM (2014)

The Leybourne (1995) and Otero and Smith (2012) critical values confirmed that 12 of the 25 pairs and 15 of 25 pairs are cointegrated of order 1, respectively. For all price pairs, the Durbin Watson statistics are both close to 2, meaning that there is low auto-correlation of the residuals, all results are available upon request. These findings confirm a long-term bivariate cointegration relationship in the following pairs: *Tortillería* Central-SupermarketCentral, *Tortillería* Occidental-Supermarket Occidental, *Tortillería* North Eastern-*Tortillería* Southern, *Tortillería* North Western-*Tortillería* Southern, *Tortillería* North Western-*Tortillería* North Eastern, Supermarket Central-Supermarket Occidental, Supermarket Occidental-Supermarket Southern. The Johansen trace test method confirmed a bivariate cointegration rank 1 for 7 price pairs. These results are presented on table 2 (page 285).

With respect to the VECM estimation results, the cointegration parameters for each pair of regional interactions are presented in table 4.

Discussion

Inter-Regional Supermarket

For the Occidental-Central price pair, the long-term elasticity ($ß_1$) was 0.86, that is, a 1% increment in the price of Central region would generate an average increment of 0.86% in the prices of the Occidental region. Both short-term error correction terms indicate a proper (negative) and significant adjustment toward equilibrium represented by α_1 (-0.13) and α_2 (0.15). These results demonstrate that prices between Occidental and Central regions follow each other, being the Central region's α_1 the dominant price maker, since it corrects less than the Occidental region.

In contrast with ß parameters, the average lower correction time toward equilibrium of Central-Occidental is consistent with the negative impact of distance.

Despite its shorter avg. distance (435 km), the Central-Occidental pair has the lower $ß_1$ (0.86) with respect to the Occidental-Southern pair, which presents a $ß_1$ of 0.90 and a distance between them of 935 km. This is not consistent with the concept that distance should have a negative impact on price transmission. According to ASERCA (3), the way supermarkets determine their prices could be a factor in the asymmetric relation between price transmission and distance. For example, in most of Mexican supermarkets, the consumer price is determined by their regional headquarters, which define an average of 40% margin independent of the localization of each one (28). This could generate a relative market segmentation, which seem to have triggered a shift in the consumer preferred place of purchase and a lack of cointegration within the Southern, North Western and North Eastern regions.

Following Araujo-Enciso (2011), Mexican supermarkets have seen their market share increased, while corner stores and street vendors have seen their joint market share reduced. The factors underlying this situation are diverse. First, they show an increasing consumption of tortilla among urban areas. In these areas, the supermarkets concetrate the sales of tortilla, thus generating a trade-off effect with respect to the rest of sale´s points (14). Second, regarding prices of tortillas, maize participation in the cost structure of the development of satellite tortilla mass dough is over 68% as opposed to maize meal pathway (5). As a result, the increase in the price of maize flour or dough is reflected directly in the price of tortillas sold in *tortillerías* and supermarkets. Due to the greater bargaining power of the supermarkets, they obtain more attractive customer prices in relation to corner stores and street vendors.

On the other hand, Keleman et al (2009) demonstrated that supermarkets would acquire greater market share as the overall *tortillería* prices remained high and supermarket prices remained low. Of the findings, it is expected that supermarket increases their market power allowing a more intense participation of the overall maize-flour industry on these sale points. Although not all supermarket prices present evidence of cointegration between regions, the difference in regional prices is small when compared to the range of average *tortillería* prices. This can be attributed to the vertical integration of flour companies in buying grain directly from producers on contract, grain storage, and logistical distribution. They have many plants strategically distributed throughout Mexico and buy directly from producers, store and distribute grains to their own facilities and also sell maize at a premium to the nixtamal industry (27). In addition, supermarkets have the financial resources to wholesale purchase, have great storage capacity, and bargaining power. Therefore, they can negotiate flour prices for all their stores throughout all of the regions and define their prices to have less variability with in regions (31).

Inter-Regional *Tortillería* Cointegration

It was found that *tortillería* prices in the peripheral regions of Mexico presented evidence of cointegration with each other while the central regions did not present significant evidence of such behavior. The lack of cointegration between central and peripheral regions is an interesting finding that could be attributed to the radial transportation system and storage re-distribution activities in Mexico, which is centered in the Central region (22, 29).

When long-term elasticities are analyzed, it was found that all coefficients of the inter-region *tortillería* pairs are near to one. Among them, the North Western-North Eastern pair has the shortest average distance (1091 km), the largest $ß_1$ (0.92) and the lowest α_1 (-0.18) of the three relations.

Further confirming the assumption that distance has a negative effect on price transmission.

When Southern-North Eastern and Southern-North Western price pairs are compared, it was found that long term elasticities and short error correction terms are larger for the first one than for the second. Following to Mc Michel (2009), net production and consumption among these regions could be a factor in the determination of these parameters. When terms of production are compared, North Eastern regions a net consumer of white maize and 90% of their production is concentrated in the Spring-Summer cycle.

The Southern region is slightly a net importer and it has cyclical maize production with deficits and surpluses and produces nearly 80% of its maize in the spring-summer cycle. The North Western region is the biggest net exporter of maize in Mexico and accounts for about 80% of the autumn-winter production (9).

Considering these seasonalities, since the North Western region is the only net producer among them, the likelihood of trade is definitely greater between the North Western and the Southern regions. Therefore, it is clear that larger trade flows can be accounting for increasing levels of price transmission and faster adjustments toward equilibrium from net producing to net consuming countries.

Despite their higher prices and looking at tortilla place of purchase, the *tortillerías* of Central region could been able to retain their market share (76%). This could be explained by an inelastic consumer behavior and greater competitiveness of *tortillerías* in these regions that were previously confirmed by Retes-Matilla and Reyes (2010).

Intra-Regional *Tortillería*-Supermarket Cointegration

It was found that Central region presented the highest long-term elasticity ($ß_1$=0.50) and the fastest error correction term (α_1=-0.11) when compared with the Occidental region, which present a long-term elasticity of 0.49 and an error correction term of -0.08.

The fact that elasticities differ significantly from 1 could be attributed to the higher costs of production (30% higher than supermarkets) and quality differences of *tortillerías* for which certain consumers are willing to pay a higher price (10). Nevertheless, these regions are the only presenting evidence of long-term price cointegration between supermarkets and *tortillerías*.

As demonstrated by Espejel-García (2012), due to they low prices, they are the only two regions where *tortillerías* have been able to retain their larger market share. It can be attributed to the greater importance placed on the price of tortilla by the low and middle-income households.

From this results, infers that the most affected by tortilla's high price are the lower income consumers, who have neglected their quality preference of the nixtamal tortilla by giving greater importance to the price and quantity in order acquire sufficient tortillas to meet their basic dietary needs. In this sense, since consumer preferences have shifted low price as a priority in order to meet basic consumption needs, in seeking for the lowest tortilla prices, they have shifted their place of purchase preference for the cheaper channels, which are: supermarkets, corner stores, and street vendors (15).

Overall, it is very likely that costs structure is much higher for *tortillerías* in regions where supermarket and *tortillería* prices are not cointegrated. The extra cost is likely to emanate from higher transportation costs, which result in higher maize prices. Therefore, infers thath *tortillerías* in peripheral regions are not able to react to lower prices of supermarkets, as their market share has eroded.

In contrast, *tortillerías* located in the Central region, which are cointegrated with supermarkets, have maintained their market share due to the combination of greater price transmission and an inelastic demand for tortilla elaborated at *tortillerías*.

These findings appear to validate that radial transportation system in Mexico has benefited the central regions at the expense of the periphery regions, enabling *tortillerías* in Central regions to remain competitive with supermarkets and retain market share. Given that commodities like maize have relative low prices, they are very sensitive to transportation, warehousing and transfer cost. Therefore, it is reasonable to believe that white maize costs could be up to double the price in the extreme areas of Mexico.

From this results, infers that the price of maize paid to producers is not directly related to the big increases in tortilla prices or tortilla price high variability. Instead it attributes their price formation to distribution costs and intermediaries. From a policy perspective, the Mexican government must revise the subsidy policies that primarily benefit grain commercializing companies and large firms. The lack of competition in storage and distribution of maize has adversely affected the end consumer, *tortillerías* located in the periphery, and nixtamal mills located in the periphery.

The World Bank (2007) recommend that the government allow the banking sector to provide better financial mechanisms to maize producers, like allowing them to use their inventories as collateral to acquire loans. This would empower producers and would give them a greater flexibility in commercializing their product, potentially benefiting the nearest *tortilla* consumer markets.

Furthermore, subsidies to *tortillerías* should not encourage new players in an already saturated market, but rather they should encourage the efficient production and the proper economy of scales required to produce *tortillas* at a competitive price. Additionally, FIRA (2014) recommends that *tortillerías* use marketing to promote consumption of their better quality tortillas, so that they are able to maintain market share even when their price is above the supermarket price.

Nevertheless, a lower the cost structure for *tortillerías* would be needed in order to retain the *tortillería* market share necessary for the *tortillerías* currently in business. Achieving proper production economies of scale and direct linkages between maize producers and *tortillerías* is essential to reduction of costs required to maintain their competitiveness.

Conclusions

The aim of this research was todetermine the spatial price transmission level of the Mexican maize tortilla market across different market chains and regions. The results were heterogeneous, demonstrating some evidence of price cointegration between regions for supermarket and *tortillería* prices and within regions between the places of purchase.

The findings of this paper were than viewed in light of the ENIGH survey results, which demonstrated changes in the place of purchase of tortillas between the years 2006 (prior to the crisis) and 2014 (after the crisis). These surveys reveal a notice able reduction in consumption at the *tortillería* channel and an increasing consumption at supermarket or resellers of supermarket tortilla, like corner stores or street vendors. The regions with the greatest consumer reaction seem to be the regions with the lower levels of price transmission between the different market chains.

The *tortillerías* of Central and Occidental regions enjoy some of the lowest tortilla prices in Mexico, which can be attributed to the cheaper logistic costs of such regions. These regions have a strong supermarket cointegration between them and unlike the other three regions; these are the only two that have evidence of long-term cointegration between supermarket price and *tortillería* price. Accordingly, it is concluded that maize producers and tortilla producers would benefit from a direct transaction through the reduction of commercialization mark up of maize.

Further research is recommended to understand the causes of the regional variability. For example, a technique of dimensionality reduction could be performed, to measure the impact of factors such as insecurity, fuel prices and storage capacity in the spatial price transmission of tortilla.

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