Price Transmission along the Supply Chain of Strawberries in Mexico

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Abstract

By combining data from multiple sources, we model supply and demand of strawberry in Mexico for the 1970-2013 period. The main purpose of the study is to measure transmission of prices in this sector. Producer prices, wholesaler prices, exporter prices, and consumer prices are components of the model. Our three-stage least squares regression results show, consistent with the literature, that the pass-through of price changes is imperfect; that is, a price change at the producer level is not fully transmitted to domestic consumers and exporters. (Dickey-Fuller Augmented and Ljung-Box tests were performed to ensure efficiency of estimators.) Furthermore, a change in producer prices has a higher impact on the domestic market than in the exports market, in percentage basis. However, higher price mark-ups in the export market compared to domestic market's make exporting more attractive to Mexican strawberry producers. Results of this study may have important implications as both supply and exports of strawberry from Mexico have experienced high growth in the last decade, with more than 90% of strawberry being exported to the U.S. According the Mexican Department of Agriculture, volume harvested of strawberry grew 2.14 times from 2003 to 2014 while exports did 2.88 times.

Keywords: Strawberry, price transmission, simultaneous equations

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Problem Statement

We model supply and demand of strawberry in Mexico. Our main purpose is to understand how prices are transmitted within the supply chain. Producer prices, wholesaler prices, exporter prices, and consumer prices are components of the model. As the stylized market structure in Figure 1 shows, producer prices impact consumer prices indirectly through wholesaler prices, and impact directly export prices. We think this study is relevant due to (1) the renewed interest on foods price transmission among researchers an policy makers given the structural changes in food and retail sectors (Drabik, Ciaian, and Pokrivcab, 2016), (2) the economic relevance of strawberries from Mexico imported into the U.S. (Wu, Guan and Whitaker, 2015), and (3) the expected increase in exports of Mexican strawberry (Arnade and Kuchler, 2015). We are aware of no other study modeling the strawberry industry in Mexico. In this preliminary version of the paper, selected results of the model are discussed only. Additional tests are tabulated and discussed in the complete manuscript.

Model and Data

We model supply and demand by implementing three-stage least squares regression. Our simultaneous equations model has,

$$QS_t = \beta_{11} + \beta_{12} P\_PR_t + \beta_{13} A_t + \beta_{14} Y_t + \beta_{15} QS_{t-1} + \varepsilon_{1t} \quad (1)$$

$$QD_t = \beta_{21} + \beta_{22} P\_CR_t + \beta_{23} I_t + \beta_{24} P_t + \beta_{25} S\_I_t + \beta_{26} S\_G_t + \beta_{27} C_t + \beta_{28} QD_{t-1} + \varepsilon_{2t} \quad (2)$$

$$P\_PR_t = \beta_{31} + \beta_{32} F_t + \beta_{33} W_t + \beta_{34} G_t + \beta_{35} PT_t + \beta_{36} P\_PR_{t-1} + \varepsilon_{3t} \quad (3)$$

$$P\_WH_t = \beta_{41} + \beta_{42} P\_PR_t + \beta_{43} S\_I_t + \beta_{44} G_t + \beta_{45} P\_WH_{t-1} + \varepsilon_{4t} \quad (4)$$

$$P\_EX_t = \beta_{51} + \beta_{52} P\_PR_t + \beta_{53} P\_WH_t + \beta_{54} G_t + \beta_{55} P\_EX_{t-1} + \varepsilon_{5t} \quad (5)$$

$$P\_CR_t = \beta_{61} + \beta_{62} P\_WH_t + \beta_{63} G_t + \beta_{64} P\_CR_{t-1} + \varepsilon_{6t} \quad (6)$$

Equation (1) shows supply of strawberry as a function of producer prices, acreage harvested, yield, and lagged supply. (Variables are described in Table 1.) Presumed consumption, in Eq. (2), is determined by consumer prices, consumers' disposable income, size of the population, price of substitutes (we use prices of grape and prices of imported strawberry), price of a complementary good (e.g., price of cream milk, an important complement for consumers of strawberry in Mexico), and lagged consumption. Producer prices, embedded in Eq. (1) are modeled in Eq. (3) as dependent upon lagged prices, input costs, and labor cost; namely, cost of fertilizer, price of gasoline, cost of strawberry plants, and minimum wages. Wholesaler prices is modeled as a function of lagged prices, producer prices, prices of imported strawberry, and price of gasoline (Eq. (4)). Eq. (5), export prices, is affected by both producer and wholesaler prices, gasoline, and lagged export prices. Finally, consumer prices, an explanatory variable of demand in Eq. (2), is a function of wholesaler prices, gasoline prices, and previous year's consumer prices. Nominal variables were adjusted to real terms by using the consumer price index.

All variable in the model are expressed in natural logarithms so that estimated parameters represent elasticities. The model partially relies on previous studies (e.g., García, García, and García (2003)

provide a framework to model agricultural commodities in Mexico; The Mexican committee for the agroindustry and producers of strawberry (Comité de la Agroindustria y Productores de la Fresa A.C. (2010)) suggests relevant inputs for this industry; and Hernández-Soto, Garza-Carranza, and Guzmán-Soria (2011) model strawberry exports). We use data from several sources, including The Mexican Department of Agriculture, The Mexican Council for Agriculture, FAO, The Mexican Ministry of Economy, The Central Bank of Mexico, and NASS / USDA. The study covers the 1970-2013 period.

Preliminarily Results

Table 2 provides three-stage least squares results. (For the purposes of this proposal we tabulate and discuss statistically significant results only.) Dickey-Fuller Augmented and Ljung-Box tests were performed to ensure efficiency of estimators (Verbeek, 2012). Producer prices, *P_PR*, significantly impact both export prices and consumer prices. These results are relevant for the central purpose of this study (Figure 1). A 10% increase in producer prices impacts export prices 2.3%, Eq. (5). (Interestingly, this impact on export prices is lower than the impact of producers' own expectations according to previous season prices, which is 5.6%, i.e., P_PR_{t-1}, Eq. (3).) A 10% increase in producer prices also impacts, indirectly through wholesale prices (Eq. (4)), consumer prices by 4.1% (0.593 in Eq. (4) times 0.699 in Eq. (6)). (Coefficient of determination for each equation in the model are within the range of studies modeling supply and demand of agriculture and livestock sectors in Latin America, e.g., Díaz, Mejía, and Del Moral (2007), Rossini (2008), Sabbagh-Sánchez et al. (2011)).

These results suggest that a typical strawberry producer in Mexico would prefer to sell its product to wholesalers in the domestic market (5.9%) rather than to the export market (2.3%). The analysis of price differences (exporter prices minus producer prices, and wholesaler prices minus producer prices), however, shows that the producer is better off selling its product to exporters. (In this analysis, we use average and median prices during two periods, 1970-2013 and 1994-2013; the exports markets became even more attractive after 1994. Results will be tabulated in the complete version of the manuscript.) This result is consistent with previous studies (e.g., Arana-Coronado and Trejo-Pech (2014)'s survey to strawberry producers) and with the cost structure of this crop when reaching such markets (specifically, accessing the export market requires strict adhesion to certain agricultural and food safety practices from producers).

Finally, in the full version of this article, we expect to discuss the relationships of other estimators in the model, disaggregate the data for further analysis (for instance, changes in demand are observed after 2004), and test potential structural changes. Implications of results will also be provided.

Conclusions

This study analyzes price transmission within the supply chain of strawberry in Mexico, covering 1970 to 2013. We model supply and demand using simultaneous equations. The three-stage least squares regression preliminary results show that (1) the signs of estimated parameters are according to economic theory, (2) producer prices impact both consumer prices (indirectly though wholesalers) and export prices, (3) a change in producer prices has a higher impact on the domestic

market than in the exports market in percentage basis, and (4) higher price mark-ups in the export market than in domestic markets make exporting more attractive to Mexican strawberry producers. Thus, the pass-through of price changes in the Mexican strawberry supply chain is imperfect; that is, a price change at the producer level is neither fully transmitted to domestic consumers and to exporters, consistent with the literature. Results of this study may have important implications as both supply and exports of strawberry have experienced high growth in the last decade, with more than 90% of strawberry being exported to the U.S. According the Mexican Department of Agriculture, volume harvested of strawberry grew 2.14 times from 2003 to 2014 while exports did 2.88 times.

Tables and Figures

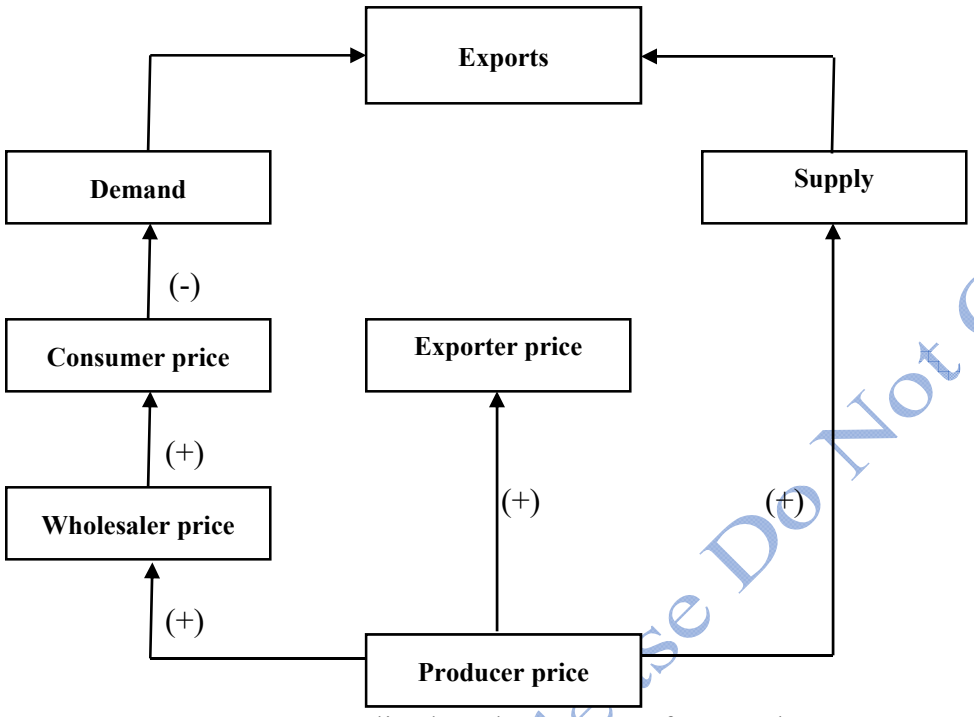

Figure 1- Stylized market structure for strawberry

Table 1- Variables and sources

Var	Description	Measure	Years (Source)
QS	Supply of strawberry	Ton	1970-1979 (FAO) 1980-2013 (SAGARPA)
P_PR	Producer price	MP/Ton	1970-1979 (FAO) 1980-2013 (SAGARPA)
A	Acreage harvested	ha	1970-1979 (FAO) 1980-2013 (SAGARPA)
Y	Yield	Ton/ha	1970-1979 (FAO) 1980-2013 (SAGARPA)
QD	Demand of strawberry	Ton	1970-2013 CNA- Estimated by authors
P_CR	Consumer price	MP/Ton	1970-2013 SNIIM
I	Disposal income per capita	MP	1970-2013 BANXICO
P	Population	Persons	1970-2013 INEGI
S_I	Price of imports of strawberry in Mex	MP/Ton	1970-2013 C.N.A.
S_G	Consumer price of substitute grape	MP/Ton	1970-2013 SNIIM
C	Consumer price of complement cream milk	MP/Lt	1970-2013 SNIIM
F	Cost of fertilizer	MP/Ton	1970-2013 FAO
PT	Cost of strawberry plants	MP/Ton	1970-2013 NASS / USDA
G	Gasoline price in Mexico	MP/Lt	1970-2013 INEGI
W	Minimum wage in Mexico	MP/day	1970-2013 INEGI
P_WH	Wholesaler price	MP/Ton	1970-2013 SNIIM
P_EX	Export prices strawberry	MP/Ton	1970-2013 INEGI

Sources:
SAGARPA is the Mexican Department of Agriculture. In particular, data are obtained from Servicio de Información Agroalimentaria y Pesquera (SIAP). http://www.siap.gob.mx/.
FAO is Food and Agriculture Organization of the United Nations (FAOSTAT). http://faostat.fao.org.

CNA is The Mexican Council for Agriculture. Demand, or presumed consumption, is estimated from CNA database as Production plus Imports minus Exports.
SNIIM is The Mexican System of Markets Information, an office of the Ministry of Economy. http://www.economia-sniim.gob.mx/nuevo/.
BANXICO is the Central Bank of Mexico. http://banxico.org.mx.
INEGI is the Mexican Institute of Statistics, Geography and Informatics. http://www.inegi.org.mx/.
NASS is The National Agricultural Statistics Service, US Department of Agriculture. http://wwww. nass.usda.gov/.
All databases were accessed from July through December 2014.

Table 2- 3SLS regression results

Equations and Variables	**Estimate**	**St. errors and Rsq.**
Eq. (1): Supply		R^2=0.85
P_PR_t***	0.028	0.008
A_t***	0.509	0.137
QS_{t-1}***	0.545	0.094
Intercept	0.746	1.117
Eq. (2): Consumption		R^2=0.80
P_CR_t***	-0.643	0.080
I_t***	1.331	0.134
Intercept *	3.023	1.812
Eq. (3): Producer prices		R^2=0.55
W_t**	0.188	0.081
P_PR_{t-1}*	0.557	0.112
Intercept ***	3.327	0.935
Eq. (4): Wholesaler prices		R^2=0.86
P_PR_t***	0.593	0.080
G_t**	-0.018	0.007
P_WH_{t-1}***	0.319	0.081
Intercept	1.114	0.721
Eq. (5): Export prices		R^2=0.57
P_PR_t***	0.226	0.079
P_EX_{t-1}***	0.638	0.096
Intercept	1.558	1.099
Eq. (6): Consumer prices		R^2=0.89
P_WH_t***	0.699	0.057
G_t***	0.014	0.004
P_CR_{t-1}*	0.111	0.066
Intercept***	2.116	0.512

Level of significance: * 10%; ** 5%, *** 1%.

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