

Impact of changes in income on demand for meats in Mexico

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Abstract

In the last three decades the consumption of meats in Mexico has changed due to the variations in their prices and the income of the population. The present investigation analyzes the relationship between the income of the population and the demand for meats in Mexico from 1980 to 2016. The analysis of the demand was made from elasticities calculated by means of the almost ideal demand system model (AIDS). The results indicate that the consumption of chicken and sheep meat responds in greater proportion to the changes in the income of the population. Chicken meat has responded better to market changes, while the beef and pork industry faces international competition and the national poultry industry. It is concluded that the development of the meat industry in Mexico is subject to an improvement in the purchasing power of the population, in which case, the most benefited industry is chicken.

Keywords: consumption, elasticity, income, price.

Reception date: March 2019

Acceptance date: May 2019

Introduction

The increase in food prices worldwide is due, among other factors, to the increase in the price of fuels necessary for productive activity and the strong economic growth of countries with strong demand for food such as China and India. These countries have about 37% of the world population and presented an annual economic growth rate between 7 and 12% in the last two decades (Gandhi and Zhou, 2014). This has been reflected in an increase in the demand for basic products and an increase in their prices above the usual (Jenkis, 2011). Other factors that influence the price of food are weather phenomena, the use of food as inputs for biofuels, the increase in demand for meat by emerging countries and exchange movements (Bekkers *et al.*, 2017).

The agri-food sector has undergone important changes (Vinnari and Tapio, 2008). In developed countries whose income and well-being have grown, meat consumption represents a smaller share of household spending and the population's tendency is to consume organic and organic food (Poelmas and Rousseau, 2017). In developing countries, the impoverishment of an important part of the population limits their access to food, including meats (Berges and Casellas, 2007). High food prices affect low-income consumers in these countries (Bekkers *et al.*, 2017).

In Mexico, the income of the population has been affected by the precariousness of wages and the shortage of well-paid jobs. In the period from 1980 to 2016, the minimum wage showed a real decrease of 65%. This situation acquires more importance when observing that 60% of the PEA earns less than 3 minimum wages (INEGI, 2015). As a result, in 2016 there were 53.4 million people (43.6% of the total population) in poverty and 9.3 million people in extreme poverty. In addition, about 62 million inhabitants had an income below the welfare line and 24.6 million had a lack of access to food (CONEVAL, 2018).

The commercial opening has also influenced the meat market in Mexico. The beef cattle ranch was completely liberated upon the entry into force of the North American Free Trade Agreement (NAFTA) between Mexico, the United States of America and Canada, under the assumption that it was a competitive activity. However, in some regions such as the north of the country, livestock activity lacked infrastructure for production and marketing. The use of traditional technology generated low yields and high production costs compared to imported meat from the United States of America whose price was lower (Vidaurrezaga and Cortez, 2000). On the demand side, per capita consumption went from 23 kg in 1970 to 34 kg in 1990 and to 63 kg in 2012 (SAGARPA, 2012).

The decrease in real income in Mexico should cause a decrease in the demand for meat, mainly because the population in poverty does not have access to this type of food. On the other hand, the livestock production was modified with the commercial opening because the small producers did not manage to remain before the imports of cheaper meats, mainly from the United States of America. Therefore, the price of meat is modified affecting the demand. The objective of the article is to determine the effect of prices and changes in income on the demand for meats in Mexico.

To analyze the income-consumption and price-consumption relationship, an almost ideal demand system (AIDS) for meat in Mexico and, based on the parameters obtained, Marshall, Hicksian and income elasticities are obtained. The meats contemplated in this study are beef, pork, chicken, sheep and goat meat. The AIDS model data correspond to the 1980-2016 period and were obtained from the databases of the Food and Agriculture Organization of the United Nations (FAO), the Agrifood and Fisheries Information System (SIACON) of the Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA) and the Commercial Information System Via Internet of the Ministry of Economy.

Theoretical framework

Meat is an important source of protein and essential for human consumption and is considered a normal good for income (Balcombe and Davis, 1996). The higher the income of the population, the meat consumption is higher (Latvala *et al.*, 2012). In the lowest income deciles, chicken consumption responds in greater proportion to changes in household income. After the third decile the answer is given in smaller proportion (Salazar *et al.*, 2005). In some country's income elasticity of sheep and goat meat has been positive (Juma *et al.*, 2010). Sheepmeat is the most expensive in developed countries and its consumption depends on the income of the population and various cultural factors (Boutonnet, 1999).

The relationship between the price and the demand for meats has also been studied. Caraballo (2003) found that beef has an inelastic demand in Colombia. Other authors classify beef in steaks and special cuts and obtain an inelastic demand (Ramírez *et al.*, 2011, Balcombe *et al.*, 1996, Cruz and García, 2014). When calculating the price elasticity of pork demand in other countries, it was found that consumption is not very sensitive to changes in its price (Kariagannis *et al.*, 2000; Verbeke and Ward, 2001; García *et al.*, 2004). In Mexico, during the period from 1980 to 2005, the price elasticity of pork meat was estimated at -0.96 and when there was a closed economy, the elasticity was close to zero (Díaz *et al.*, 2007).

Thus, in a context of economic opening, the increase in pig imports that lower prices do not encourage their consumption (Pérez *et al.*, 2010). In countries such as the United States of America (Moschini and Meilke, 1989), Greece (Kariagannis *et al.*, 2000) and Canada (Chalfant *et al.*, 1991) the demand for chicken is inelastic. In Mexico the demand for chicken is elastic due to the fact that the use of better technology in its chicken production has caused a price decrease and therefore is a determining factor in the increase of its consumption (Moschini and Meilke, 1989; Quezada, 2001). For its part, the demand for sheep and goats is inelastic in several countries (Juma *et al.*, 2010) because these meats are not basic in the diet of the population.

Beef, chicken, pork, sheep and goat meat are substitute goods and variations in the price of some of them have an influence on the consumption of others. In the last 20 years, the consumption of meat in Mexico has presented a growth close to 85%. This was due to the population growth (30%) and the increase in the population's income in some periods. In the present article, the AIDS model is used to study the demand for meat. In the AIDS model, the most important elements are the price and the income of the consumer; therefore, several authors have used it to analyze the demand for goods.

Ramírez *et al.* (2011) used the AIDS model to calculate the Marshallian and Hicksian elasticities of beef, pork, chicken, egg and tortilla in Mexico. Balcombe and Davis (1996) applied the AIDS model to the consumption of bread, milk, cheese, meat, vegetables, sugar and fruits in Bulgaria. Thanagopal and Housset (2017) use the AIDS model to study the competitiveness of prices and the quality of products and services that France exports. Martínez and Vargas (2004) apply the AIDS model to 11 fruits in Mexico to measure the effect of prices on their consumption. The consumption of meat depends on its prices and the income of the population. The AIDS model is ideal for quantifying income-consumption and price-consumption ratios, in addition to analyzing the effect of prices and income on the meat industry in Mexico.

Materials and methods

The AIDS model was proposed by Deaton and Muellbauer (1980). In the first stage of the model, the consumer assigns his income optimally to the purchase of a group of goods and in the second stage the assigned income is distributed among the different goods (Hernández and Martínez, 2003). The Marshallian demand function expressed in participations on expenditure is given by the following AIDS model.

$$w_i = \alpha_i + \sum_{j=1}^n \gamma_{ij} \ln p_{jt} + \beta_i \ln \left(\frac{X_t}{P_t} \right) + u_{it} \dots \dots \dots (i= 1, 2, \dots, 5) \tag{1}$$

Where: w_i = It is the participation of the i th good in the group’s expense; $i, j= 1, 2, \dots, n$, n is the total of goods in the subgroup; $t= 1, 2, \dots, t$, t is the total number of observations in the sample; α_i = ordered to the origin; p_{jt} = prices of goods in the group in period t ; γ_{ij} = price coefficients; β_i = expense coefficients; X_t = total expenditure on the goods considered.

The participation of the i th good in the group’s expense is given by:

$$w_{it} = p_{it} q_{it} / \sum_{j=1}^n p_{jt} q_{jt}$$

P_t = is a Translog price index, whose logarithm is defined by:

$$\ln(P) = \alpha_0 + \sum_{i=1}^n \alpha_k \ln(p_{it}) + 1/2 \sum_{i=1}^n \sum_{j=1}^n \gamma_{ij} \ln(p_{it}) \ln(p_{jt}) \tag{2}$$

Where: p_i, p_j = prices of the goods in the group; α_0, α_k and γ_i = parameters to be estimated.

The homogeneity conditions are considered independent, so the model assumes the basic conditions of, additivity.

$$\sum_i \alpha_i = 1, \quad \sum_i \gamma_{ij} = 0 \quad y \quad \sum_i \beta_i = 0$$

Homogeneity.

$$\sum_j \gamma_{ij} = 0 \quad \forall_i$$

Symmetry.

$$\gamma_{ij} = \gamma_{ji} \quad \forall_i \neq j$$

The model used has the properties of a first-order approximation to any derivable demand system, with a functional form consistent with the family expenditure data as a flexible representation of any arbitrary demand system (Martínez and Vargas, 2004). To express the model in terms of linear equations, in the parameters the price index given in 2 is replaced by the Stone price index that is defined in equation 3.

$$\ln(P_t) = \sum_{j=1}^n w_{ij} \ln(p_{jt}) \quad 3)$$

Because the Stone index does not satisfy the property of commensurability, the Stone index is replaced by the Tornqvist index, which is an approximation of the dividing index and is superlative for the welfare aggregation function (Moschini, 1995). The Tornqvist index is defined as:

$$\ln(P_i^T) = 1/2 \sum_{j=1}^n (w_{jt} + w_{j0}) \ln(p_{jt}/p_{j0}) \quad 4)$$

Therefore, the system of linear equations to estimate is the following:

$$w_{it} = \alpha_i + \sum_{j=1}^m \gamma_{ij} \ln(p_{jt}) + \beta_i \ln\left(\frac{X_t}{P_t}\right) + \mu_{it} \quad (i=1, 2, \dots, m-1; t=1, 2, \dots, t)$$

The parameters α_i , γ_{ij} and β_i were estimated using the generalized least squares method (Hernández and Martínez, 2003).

Calculation of elasticities

To complete the interpretation of the almost ideal demand system, the Marshallian, Hicksian price elasticities and income elasticity are used for models with a linear approach to AIDS. The Marshallian elasticity shows the relation between the price and the quantity demanded of a good starting from the principle of maximizing the utility of the consumer subject to his income. On the other hand, the Hicksian elasticity is obtained by maximizing the expenditure required to maintain a certain level of utility; therefore, the consumer's restriction is not his income, but the level of utility (López and Alviar, 2001; Bevilacqua, 2006). The formulas for calculating the elasticities are the following.

Own or direct Marshallian price elasticities.

$$\varepsilon_{ij} = \frac{\gamma_{ij}}{w_i} - \beta_i - 1$$

Marshallian cross price elasticities.

$$\varepsilon_{ij} = \frac{\gamma_{ij}}{w_i} - \beta_i \left(\frac{w_j}{w_i} \right)$$

Elasticities own price or direct Hicksian.

$$\delta_{ii} = \frac{\gamma_{ii}}{w_i} - w_i - 1$$

Hicksian cross price elasticities.

$$\delta_{ij} = \frac{\gamma_{ij}}{w_i} + w_j$$

Spending elasticities.

$$\eta_i = 1 + \beta_i / w_i$$

The estimators of the model parameters are γ_{ij} and β_i ; while w_i is the average proportion of the expenditure of the *i*th good of the group of meats analyzed (Martínez and Vargas, 2004). The elasticities were obtained by the SYSLIN/SUR procedure of the statistical package Statistical Analysis System. In the procedure, the restrictions of homogeneity, additivity and symmetry were added.

Results and discussion

Table 1 shows the system of linear equations estimated using the AIDS model. In each row the estimators of the Marshallian demand functions of each meat are presented. The Marshallian demand expresses the participation of each meat in the total expenditure of meat. The estimators α_i , are the ordered to the origin, the estimators γ_i , are the coefficients of the prices and β_i are the coefficients of the expense. Below each variable, the approximate standard error is presented and the data with an asterisk is not significant at a 5% significance level.

Table 1. Estimated parameters.

	Interc	Prices (γ_i)					Cost
	α_i	γ_i Bovine	γ_i Porcine	γ_i Chicken	γ_i Ovine	γ_i Caprine	β_{iMR}
Bovine	2.2643	0.1969	-0.0843	-0.0934	-0.0158	-0.0034	-0.1265
	0.2413	0.043	0.0651*	0.027	0.00482	0.00145	0.0159
Porcine	2.1795	-0.0843	0.0224	0.0725	-0.0054	-0.0052	-0.1214
	0.3869	0.0651*	0.1083*	0.0464*	0.00782*	0.00224	0.0254

	Interc	Prices (Y_i)					Cost
	α_i	$Y_{i \text{ Bovine}}$	$Y_{i \text{ Porcine}}$	$Y_{i \text{ Chicken}}$	$Y_{i \text{ Ovine}}$	$Y_{i \text{ Caprine}}$	β_{iMR}
Chicken	-3.5802	-0.0934	0.0725	0.0393	-0.0164	-0.0021	0.2561
	0.1765	0.027	0.0464*	0.0247	0.00422	0.00114	0.0117
Ovine	-0.0167	-0.0158	-0.0054	-0.0164	0.0322	0.0054	0.0013
	0.0273*	0.00482	0.00782*	0.00422	0.0057	-	0.00181*
Caprine	0.1531	-0.0034	-0.0052	-0.0021	0.0054	0.0052	-0.0095
	0.00833	0.00145	0.00224	0.00114	-	0.00192*	0.000552

Prepared with the departure base of Proc Syslin of Sas. * = not significant at 5%.

Table 2 and 3 show the elasticities (Marshallian and Hicksian) price of demand, cross price and expenditure. The values of the main diagonal represent the price elasticity of the demand; that is, the effect of the price of certain meat with respect to itself. The elasticities outside the main diagonal represent the cross-price elasticity of the demand the negative values indicate a complementary relationship between the meats studied, while the positive values represent a substitution relation.

Table 2. Marshallian elasticities.

Elasticities	Bovine	Porcine	Chicken	Ovine	Caprine	E. of cost
Bovine	-0.3376	-0.1269	-0.1504	-0.0384	-0.0026	0.66
Porcine	-0.1333	-0.8034	0.3661	-0.0126	-0.0095	0.59
Chicken	-0.6215	-0.0127	-1.1257	-0.0659	-0.0231	1.85
Ovine	-0.8484	-0.3015	-0.8725	0.672	0.2812	1.07
Caprine	0.0081	-0.1713	0.0586	0.407	-0.6122	0.31

Calculated based on outputs from Proc Syslin of Sas.

Table 3. Hicksian elasticities.

Elasticities	Bovine	Porcine	Chicken	Ovine	Caprine
Bovine	-0.8314	0.0875	0.0106	-0.0231	0.0063
Porcine	0.0999	-1.2229	0.508	0.0019	-0.0019
Chicken	0.0732	0.5574	-1.1713	-0.0343	0.0086
Ovine	-0.4403	0.036	-0.587	0.6541	0.298
Caprine	0.1359	-0.0612	0.114	0.4175	-0.6354

Calculated based on outputs from Proc Syslin of Sas.

Marshallian demand is obtained under the assumption that the individual maximizes his utility subject to his income; therefore, the elasticity of expenditure or income is presented only in the Marshallian elasticities table. In the eighties the real price of beef was very unstable due to high inflation rates (Ferrusquia, 1985). Domestic producers did not invest in the development of the industry (López, 1996; Palacios, 2002) and large supermarkets appeared that encouraged the import of bovine meat at a lower price than the national one (López, 1996).

After the 1990s, the policy of reducing subsidies in Mexico (Chauvet, 1997; García *et al.*, 2000) encouraged imports and economic stability after the 1995 crisis generated a slight increase in consumption. The Marshallian price elasticity for beef is 0.34 and shows that the consumption of this meat is not very sensitive to changes in its price. The Hicksian price elasticity also showed that beef has an inelastic demand (-0.83). In the 1980s, investment in infrastructure for pig production in Mexico was very low (Corona, 2006). Lack of investment encouraged the importation of pork to meet domestic demand.

Imports at low prices discouraged domestic production and slightly promoted consumption (García *et al.*, 2004). The demand for pork meat is inelastic according to the Marshallian price elasticity (-0.80). As of 1996, chicken meat is the most consumed in Mexico (Márquez *et al.*, 2004; Benítez *et al.*, 2010). The increase in per capita consumption of chicken meat was due to the decrease in its price. The decrease in the price of chicken meat was due to the heavy investment in infrastructure for its production compared to the production of other meats (Corona, 2006). The Marshallian and Hicksian elasticities obtained indicate that the demand for chicken is elastic (-1.13 and -1.17) and allow us to observe that the chicken industry has responded best to changes in the meat market (Eales and Unnevehr, 1988).

Sheepmeat has a Marshallian price elasticity of 0.67 and goat meat of -0.61, which reflects a low response of consumption to changes in their prices. These meats are the least consumed in the world (Madruga and Bressan, 2011) and therefore their inelastic demand is explained. In Mexico, the consumption of sheep meat is higher in the center of the country and the deficit in production is covered by imports from Australia, New Zealand, the United States of America and Chile (Soto and Delgado, 2010).

Goat meat has a high nutritional value (Webb *et al.*, 2005) because it is rich in proteins and with low levels of fat (Carlucci *et al.*, 1998); however, their participation in the consumption of red meats in the world is only 6% (Felix *et al.*, 2001). In Mexico, the share of goat meat consumption is less than 1% within the group of meat analyzed. Goat consumers prefer to consume the meat that is produced in the country (Rebollar *et al.*, 2007) because it is used in traditional dishes such as cabrito, barbecue and birria; for this reason, it is not common to market it in carcass since it is consumed fresh.

Income in Mexico and expenditure elasticity

In Mexico, national income has had a very low growth rate. From 1980 to 2013 the national income increased on average 2.3% per year (Rodríguez and Lima, 2015). The purchasing power of the minimum wage decreased due to the high inflation rates that were presented from 1980 to 2000. As of 2000, the minimum wage has not decreased, but it has not managed to increase its purchasing power. In 2015, 15% of the population in Mexico had an income below a minimum wage, 25% had an income between 1 and 2 minimum wages and 21% between 2 and 3 minimum wages; that is, 61% of the population received less than 3 minimum wages (216 pesos per day) (INEGI, 2015). The deterioration of income has a greater effect on the population in poverty and vulnerable in food (Echenique, 2017).

It is analyzing the relationship between the income of the population and the consumption of meats in Mexico it is possible to observe that all the analyzed meats are normal goods. Beef, pork and goat meat are necessary normal goods since the change in consumption is in smaller proportion to the change in income. On the other hand, the response of consumption of chicken meat (Verbeke and Ward, 2001) and sheep meat to changes in consumer income is in greater proportion. A 1% increase in Mexican consumer income is reflected in a 0.66% increase in beef consumption; therefore, it is a necessary normal good.

The population that is located in the lowest income deciles increase their consumption in a greater proportion to the increase in their income. In 1992, Mexico estimated an income elasticity of 1.3 for beef (Golan *et al.*, 1999). In those years when the country emerged from a deep structural crisis, small changes in the income of the population affected in a greater proportion to the consumption of this meat. The slight recovery of the income of the consumers has caused that the beef becomes a normal good necessary at present.

Chicken consumption in Mexico is very sensitive to changes in income. If it is taken into account that 63.6% of the population has incomes of less than two minimum wages (INEGI, 2015), the result obtained is consistent with that found with other authors. Porcine meat has an income elasticity of 0.59, which indicates that it is a basic good for Mexicans. Until 2005 it had an average elasticity of 0.55; however, it is very different from the one calculated in 1992 when it was 1.15 (Golan *et al.*, 2001). The expenditure elasticity for sheep meat is greater than 1. It is explained because in Mexico this meat is considered as traditional food (Buotunnet, 1999; Webb *et al.*, 2005) at parties and weekends.

The cost of meat already prepared is between 200 and 250 pesos per kilogram and due to the low income that a large part of the population receives, movements in the income slightly affect the consumption of sheep. Chicken is a substitute for all meats; but it has a more marked relationship with pig meat and beef; that is, if the price of pork and beef increases chicken consumption increases (Golan *et al.*, 2001). This result is due to the fact that in Mexico chicken meat has a lower price and with a low income population, an increase in the price of beef and pork causes a decrease in the real income of families with low deciles; therefore, there is a substitution effect on chicken meat (Ferrusquía, 1985; Díaz *et al.*, 2007; Morris, 2009).

The Hicksian elasticities of Table 3 show the previous substitution effect, with an elasticity of 0.09 and 0.08 between chicken meat and beef; and an elasticity of 0.51 and 0.55 between chicken meat and pork meat.

Conclusions

In the period from 1980 to 2016 the prices of bovine, porcine, ovine and caprine meat in Mexico were not very sensitive to movements in their prices. This indicates that if the commercial opening influenced on the prices of these meats, the effect was not so severe in the demand. On the other hand, chicken consumption is very sensitive to changes in its price; therefore, the improvements in technology and the commercial opening that cheapened prices were decisive for chicken to become the most consumed meat in the country.

Cross-price elasticities show that the decline in pork consumption was not due to the price of beef because they have a very weak substitution effect. The price of chicken meat is the one that has a greater substitution effect on pork consumption. In the analyzed period, the price of bovine meat practically does not affect the consumption of chicken and pork and the prices of chicken and pork also do not affect the consumption of beef. The foregoing suggests that the price of chicken meat has been decisive in the movement of demand for meat in Mexico; mainly in the decline in the consumption of pork.

These cross-price elasticities also show the low importance of sheep and goat meat in the diet of Mexicans, since the prices of these meats do not affect the consumption of chicken, cattle and pigs. Sheep and goat meat are not part of the basic diet of Mexicans, but it is very consumed in special events and days; in this market these meats do have a substitution effect.

The comparison of expenditure elasticities indicates that under a scenario of economic growth and the income of the country's population, the most benefited sector will be chicken production. An improvement in the level of income would increase the consumption of meat in general and the variations in prices only cause a substitution effect between them. The imports of cheaper meats are not reflected in the consumption, the favoring of the meat industry in the country is determined by the improvement of the living conditions of the population; mainly from the income level.

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