



Characterization of factors determining the consumption of pork in the Metropolitan Area of the Valley of Mexico

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ABSTRACT - The objective of the present study was to learn the characteristics that affect pork meat consumption in the Valley of Mexico Metropolitan Area. Qualitative regression models (Logit and Probit) were used, and a survey of 440 consumers was carried out. The results showed that the sample of pork consumers was made up mostly of women (91.1%) aged between 30 and 59 years and families consisting of three or four persons. The variables that condition the consumption of this type of meat are the number of members in the family, generalized chicken meat consumption, level of household income, price of the product, and illnesses that restrict its consumption. The greatest marginal effects were caused by the following variables: level of family income and illnesses that limit its consumption, especially the latter, since pork meat is often associated with multiple illnesses. This is followed by preference of meat and number of members in the family, while price was of little significance.

Key Words: consumer perception, logit, marginal effects, pork meat, Probit

Introduction

Pork is considered as one of the three main red meats (including beef and mutton) in the diet of Mexicans. Its consumption is important for human development and healthy growth, as it is rich in proteins, minerals (iron and zinc), and vitamins, especially B vitamins (Mallaopoma et al., 2014). The main swine producers in the world are China (49.3%), the EU as a block (21.8%), the USA (10.2%), Brazil (3.2%), and Russia (2%). Mexico is in the tenth place worldwide, with 1.2% of the total 104.4 million metric tons produced in 2012. The main pork importer countries in the world are Japan (18.7%), Russia (14.4%), China (11.5%), Mexico (10.0%), and South Korea (9.7%). The main pork exporting countries in the world are the USA (33.5%), the EU (31.5%), Canada (17.3%), and Brazil (8.4%). Although Mexico does not figure among the top pork exporters, its pork exports have increased in the latest years, caused by Japanese demand in the meat market (Financiera Rural, 2012).

In Mexico, there are more than 979,000 swine-producing units, which produced 1.24 million t in 2012 (SIAP-SAGARPA, 2014). The main pork-producing states are Sonora, Jalisco, Puebla, Guanajuato, and Yucatan, which make up more than 60% of the total production in Mexico (Financiera Rural, 2012).

The total volume of the types of meat consumed by Mexicans in 2013 was 5,970,636 t, of which 41% is accounted for by poultry, 28% by beef, 26.5% by pork, and 4.5% by the rest (mainly mutton and chevon) (SIAP-SAGARPA, 2014).

In 2012, Mexican families allocated 22.7% of their income to food. From this budget, one out of every three pesos is used to buy meat products (poultry, pork, beef, mutton, and chevon) (SIAP-SAGARPA, 2014). The Mexican society has experienced changes in the last years in such aspects as family structure and the behavior of food purchasing and consumption, especially in large cities with greater population concentration, like Mexico City and the State of Mexico [The Valley of Mexico Metropolitan Area (VMMA)], where all kinds of foodstuffs are commercialized. One of these foodstuffs is undoubtedly pork, given its great nutritional, economic, and social value (INEGI, 2012).

The per capita consumption of pork in Mexico increased by almost 600 g in 2014, with respect to 2013, going from 16 to 16.6 kg. This is due to the propaganda and promotion

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that this type of meat received, as its consumption per person remained low in the previous decade, 15.7 kg per capita. This is because consumers associate pork with illnesses and the swine fever in 2009 (Proporcino, 2014).

The main market for pork in Mexico is the VMMA, which includes 18 municipalities of the State of Mexico and 16 delegations of Mexico City, with over 20 million inhabitants. This market is mainly supplied with meat from Jalisco and Guanajuato to cover an annually demand of 330 t (Proporcino, 2013). However, the factors that characterize the demand for this type of meat in the pork market, from the point of view of the buyer, are unknown.

Because of the above and given that the VMMA is the main center of consumption of pork at the national level, the objective of this study was to know the characteristics of the meat that the consumer considers when making his purchase. The hypothesis was that household income and price are not the only attributes that determine the purchase, but rather that there are other aspects of the population which condition the purchase, such as level of education, number of family members, meat preference, and illnesses that restrict its consumption.

Material and Methods

The study was carried out in the VMMA, including the 16 delegations of Mexico City (Álvaro Obregón, Azcapotzalco, Benito Juárez, Coyoacán, Cuajimalpa, Cuauhtémoc, Gustavo A. Madero, Iztacalco, Iztapalapa, Magdalena Contreras, Miguel Hidalgo, Milpa Alta, Tláhuac, Tlalpan, Venustiano Carranza, and Xochimilco) and the 18 municipalities of the greater Mexico City in the State of Mexico (Atizapán de Zaragoza, Cuautitlán Izcalli, Coacalco, Cuautitlán, Chalco, Chicoloapan, Chimalhuacán, Ecatepec, Huixquilucan, Ixtapaluca, La Paz, Nicolás Romero, Naucalpan, Nezahualcóyotl, Tecámac, Tlanepantla, Tultitlán, and Valle de Chalco). To characterize the demand for pork, a qualitative regression model was used, which makes it possible to find the probability of an event occurring. These probabilistic models state that if X_i increases, $P_i = E(Y = 1/X)$ also increases (Gujarati, 2003). In these models, the dependent variable is dichotomic and the independent variables can be coded as intervals or categories. In other words, the values are predicted from a variable that can take two values or be continuous. The accumulated distribution functions that represent the 0 or 1 response models are logistic (Logit) and normal distribution (Probit).

The Logit model is represented by the following function:

$$P_k = E(Z = 1 | X_k) = \frac{e^{-(\beta_0 + \beta_1 X_1 + \dots + \beta_j X_j)}}{1 + e^{-(\beta_0 + \beta_1 X_1 + \dots + \beta_j X_j)}} \quad (1)$$

in which P_k is the probability that an event will occur; β_j , $j = 0, 1, 2, \dots, k$ are the coefficients to be estimated; and X_k corresponds to the group of variables that represent the characteristics of the consumer interviewed.

The Probit model (also known as normit) uses a standard normal distribution function, which may present some difficulty for its calculation, because it is an integral:

$$F(x', \beta) = \left(\frac{1}{\sqrt{2\pi}} \right) \int_{-\infty}^{x' \beta} e^{-(x' \beta)^2 / 2} d(x' \beta) \quad (2)$$

Each parameter (β_j) indicates the direction in which the probability moves when the explicative variable (x'_j) increases. In addition, the parameters quantify the marginal effects of the indirect variables on the probability of the dependent variable. The economic theory indicates that the marginal effect expresses, *ceteris paribus* (everything else being constant), the effect of a small change in an independent variable on the dependent variable (Wooldridge, 2008).

The following variables were used in the formulation of the Probit and Logit models: level of education (LE), number of family members (NFM), meat preference (MEPR), presence of illness in the individual (PRILL), household income (INC), and meat price (PRIC). To model the probability that the interviewee will eat pork, two options were set: does eat, denoted as 1 (success), and does not eat, denoted as 0 (failure). According to the previous classification of the individuals who eat pork from those who do not, it is known as discriminatory power, which can be represented through ROC (Receiver Operating Characteristics) curves. These are a graphic representation of discriminatory power. The more a curve approaches the top left corner, the higher the global accuracy of the test is, and the area under the ROC curve coincides with the probability that the identification of the individuals in the sample will be adequate among what is observed and what is expected.

To calculate the sample, the total population to be interviewed in the VMMA was considered, which was 18,240,060 inhabitants, according to the Population and Housing Survey of the INEGI (2005). The sample size was obtained through the following equation:

$$n = \frac{(p)(q)(N)(Z^2)}{E^2 (N-1) + Z^2(p)(q)} \quad (3)$$

in which, N is the total population of the study universe (18,240,060 inhabitants); n is the sample size; p is the

estimated positive variability percentage (50%); $q = 100 - p$ (negative variability); E is the allowed error or estimation accuracy (5%); and Z is the trust level: Z for tables = 1.96. Substituting the values:

$$n = \frac{(0.50)(0.50)(18,240,060)(1.96)^2}{0.05^2(18,240,060 - 1) + 4(0.50)(0.50)} = 384 \text{ interviews} \quad (4)$$

The calculated sample size was 384 interviews; however, 440 interviews were carried out, and a non-probabilistic sampling per quota was done. The selection criterion for the individuals was their disposition to be interviewed. The 440 questionnaires were obtained in the delegations and municipalities, which were ranked from highest to lowest population density. The individuals were interviewed in butcheries, public markets, commercial centers, parks, and food stores.

The variables in the interview were categorized by question sections: sociodemographic classification of the interviewee (name, place of origin, gender, age, level of education, number of family members, etc.); referring to meat consumption (total income and income destined to buying meat and other foodstuffs, preference of type of meat (chicken, beef, and pork), and restrictions to eat meat; and regarding the identification of the main characteristics of pork consumption, such as frequency (weekly or monthly) of meat consumption, type of meat or steaks eaten, prices, places of purchase, and aggregate services of the meat.

The data obtained from the interviews were collected from December 2009 to May 2010 and captured into a structured spreadsheet in EXCEL, in which the data were analyzed descriptively and processed to estimate the models using the SAS (Statistical Analysis System, version 9.3) computer software.

Results

The results were analyzed in a first stage through the relative frequency analysis according to the information obtained from the questionnaire applied. The sample of interviewed consumers had a geographical distribution of 62.0% in Mexico City (13 delegations), and 37.9% in the State of Mexico (eight municipalities) (Table 1).

According with the data, the pork consumer sample was mostly made up of women (91.1%) aged from 30 to 59 years, with families consisting of three or four persons. Moreover, 56.4% of the individuals in the VMMA spent between 21 and 50% of the household income on foodstuffs, while 30% destined 20% or less of the household income to this item.

Regarding the purchase of foodstuffs for the household, including the different types of meat, 87.7% of the interviewees make the decision, although they were not necessarily the head of the household.

Of the total population, 54.3% eats pork. From these, most of them (81.1%) have a low consumption, one to four times a month, while 13.4% of them have medium consumption, five to eight times a month, and the remaining 5.5% consume pork more than eight times a month.

With respect to the household income of pork consumers, 51.1% of the interviewees have low income (US\$ 375.00 or less), 37.3% of them have medium incomes (US\$ 375.00 to US\$ 1127.00), and only 11.6% have high incomes (more than US\$ 1127.00) – mean exchange rate January 1st to December 31st, 2014, US\$ 1.00 = 13.3085 Mexican Pesos (Banxico, 2015).

According to the population interviewed, 74.3% showed no restrictions in consuming pork, while 25.7% showed limitations in consuming it, especially people over 60 years old. The causes to avoid the consumption of this meat are high cholesterol (4.8%), diabetes (2.7%), high blood pressure (2.0%), high levels of uric acid (1.8%), and other causes (14.4%).

In the case of the Logit model, the Hosmer-Lemeshow test was used. It establishes the risk deciles or probability of the event estimated by the model. If there is high coincidence between the observed and the expected data, the Ji square statistic that contrasts both distributions will show no significance for the hypothesis test, in which H_0 establishes that all the coefficients are equal to zero, a good fit of model is concluded. In other words, the model describes how well the observations fit. In the case of the present research work, the value of P was 0.7655, which indicates a good fit. For the same model, the chi-square of the likelihood reason was 65.41 and $P \leq 0.0001$, which shows that it fits significantly. As for the adjustment of the Probit model, the Likelihood Quotient Index

Table 1 - Distribution of interviews

Delegation	No. of interviews	Municipality	No. of interviews
Álvaro Obregón	40	Nezahualcóyotl	42
Coyoacán	31	Coacalco	26
Iztapalapa	30	Chicoloapan	23
Xochimilco	30	La Paz	22
Cuauhtémoc	29	Chimalhuacán	21
Iztacalco	20	Texcoco	20
Magdalena Contreras	20	Chalco	12
Gustavo A. Madero	19	Ecatepec	1
Miguel Hidalgo	18		
Azcapotzalco	14		
Benito Juárez	11		
Venustiano Carranza	10		
Cuajimalpa	1		

(LQI), also called McFadden R², was used, obtaining a value of 0.10769, which confirms a good fit of the model (Table 2).

The ROC curve expresses the discriminatory power, which in the case of the Logit model was 70.73% of concordant pairs and, therefore, an area under the curve of 0.7073. This results in an acceptable discriminatory power, according to Hosmer’s general rule table, since the more the curve approaches the top left corner, the higher the global accuracy of the test is. This means that 70.73% of the observations of the research sample coincide with the probability of the expected data of the model (Figure 1).

When performing the chi-square test with a 10% significance level, four variables were statistically significant: NFM, MEPR, INC, and PRILL. The variable excluded from the model was LE, since it was not significant at P>0.1 and a negative estimator sign. With respect to the PRIC variable, it was not included in the models since it showed little variability. This was because it dealt with transversal cut data. This means information on a single moment in time and which describes the consumption of the families in a certain region. The results of the Logit and Probit models showed no qualitative differences (Table 3).

Taking the estimations of Table 3, the Logit model for the probability of the occurrence of the event (consumption) is shown here:

$$P_k = E(Z=1 | X_g) = \frac{e^{-(1.2229+0.1552NFM-0.3339INC-0.1975MEPR-1.5642PRILL)}}{1+e^{-(1.2229+0.1552NFM-0.3339INC-0.1975MEPR-1.5642PRILL)}}$$

The predictive power is the capability that the model has to predict the dependent variable, based on the values of the independent variables. To evaluate the predictive power of the model, the R² value was used, 0.1381. This value indicates a moderate predictive power.

Table 2 - Adjustment statistics of the models

Model	Indicator	Statistical value
	Hosmer-Lemeshow	0.7655
Logit	Chi-square	65.4128
	Pr>ChiSq	<0.0001
Probit	Likelihood Coefficient Index	0.10769

Table 3 - Estimations of the parameters of the Logit and Probit models

Model	Logit			Probit		
	Coefficient	Wald Chi-Square	Pr>ChiSq	Coefficient	Chi-Square	Pr>ChiSq
Intercept	1.2229	5.8865	0.0153	0.7493	6.12	0.0133
NFM	0.1552	4.9063	0.0268	0.0949	5.10	0.0239
MEPR	-0.1975	2.9393	0.0865	-0.1210	3.02	0.0822
INC	-0.3339	7.3529	0.0067	-0.1990	7.12	0.0076
PRILL	-1.5642	39.1953	<.0001	-0.9574	41.21	<.0001

NFM - number of family members; MEPR - meat preference; INC - household income; PRILL - presence of illness in the individual.

The estimated Probit model was replaced in Equation 2:

$$F(Z) = \left(\frac{1}{\sqrt{2\pi}}\right) \int_{-\infty}^{x_i\beta} e^{-(0.7493+0.0949NFM-0.1210MEPR-0.1990INC-0.9574PRILL)^2/2} dz$$

The NFM variable showed a positive effect on the pork consumption model in the VMMA.

The variable MEPR had a negative effect, since consumers preferred chicken meat, due to the risks of consuming red meats in the VMMA.

Another variable that had a negative effect on pork consumption was INC. This indicates that consumers with low incomes are not willing to eat pork, given the high prices of the product.

Another variable that conditioned the purchase of meat is PRILL, because in the VMMA, the major problems of the people are cholesterol and diabetes.

Regarding the signs of the parameters estimated for each variable, they indicate the direction in which the probability moves when the explicative variable increases (pork consumption). For the MEPR variable, the coefficient

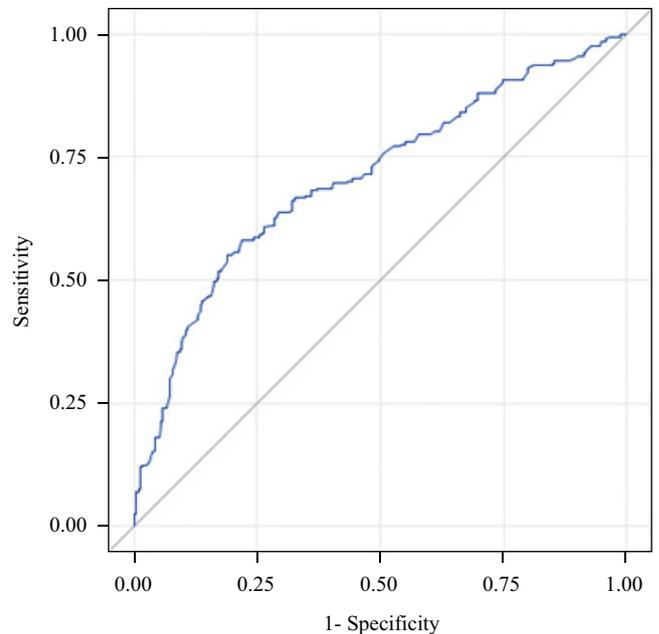


Figure 1 - Receiver Operating Characteristic (ROC) curve.

is negative, indicating that consumption decreases since chicken or beef is preferred, causing an indirect relationship. In the case of INC, if the household income increases (*ceteris paribus*), pork consumption decreases, since pork consumers with higher income choose another, higher priced, meat such as beef. Moreover, it is also due to their consumption preferences.

The coefficients do not have a direct interpretation but can be used to quantify the marginal effects of the explicative variables in the consumption of pork, using the value given by the means of the sample of independent variables. For example, for the NFM variable, one-point increase for the previous variable with the Logit model increases the probability of consuming beef by 0.0454%, while in the Probit model, there is an increase of 0.0332% (Table 4).

The marginal effect of the PRILL variable is 0.4582%, in the Logit model, and 0.3358%, in the Probit model, which indicates that the consumers decrease their consumption of meat in those proportions if this variable increases by one percentage point. The value is high because consumers mainly associate pork with cholesterol (high fat content in the arteries) and multiple illnesses.

Discussion

Regarding the purchase of foodstuffs for the household, Segovia (2005), Schnettler et al. (2006), and Odriozola (2009) in Venezuela, Chile, and Argentina, respectively, observed that women (the housewives) decide the purchase of meat; this result is similar to that obtained in the present study.

In relation to Mexican pork consumption, this is like the study by Odriozola (2009), who reported that from the consumers in the provinces of Resistencia, Sáenz Peña, and Charata in Argentina, 52.3% of the population ate pork once a week, given their preference for this meat due to its taste, the variety of possible dishes, and its ease of preparation. It also coincides with García (2003), in a study on the characterization of pork consumption in the city of Córdoba, Argentina, where people eat pork once a week.

The household income level of Mexican pork consumers, according to Mouteira et al. (2009), are similar

in their paper on consumer perception of pork in Ciudad de la Plata, Argentina: 35.2% of the consumers had an income of US\$ 173.27 or less (low), 50% had an income from US\$ 173.38 to US\$ 462.04 (medium), and the rest had an income from US\$ 462.16 to US\$ 693.06 (high); of these interviewees, the ones that most consumed pork were in the medium income range, 31.7% of them. On the other hand, Arana Coronado et al. (2012) mentioned that 62.9% of Mexican pork consumers stated to have incomes ranging from US\$ 157.87 to US\$ 638.69 a month. These results are similar to those found in the VMMA.

Relative to the restrictions to not consume pork in the VMMA, these coincide with the stated by Schnettler et al. (2008), in which older people significantly decreased their beef, pork, and mutton consumption and replaced them by white meats, associated with a lower risk of illness. Also, Odriozola (2009) found that, in three provinces in Argentina, the main reasons not to eat pork are because the inhabitants do not like the taste, mistrust it, have religious reasons, and have perception that it is harmful to human health.

Regarding the effects, the variable NFM in México was positive. In this regard, Schnettler et al. (2008) mentioned that families made up of three to four members consume the greatest amount of pork, especially those with children under 12 years old, being the number of members a significant factor within the family group at the moment of choosing meat purchasing.

As for the variable MEPR, which was negative for VMMA, according to Arenas Hernández et al. (2010), 96.6% of the population in the VMMA prefers and consumes chicken meat. This is attributed to the price and the low fat content of the meat. Arana Coronado et al. (2012), in their case study, mentioned that the interviewed Mexicans mostly prefer and consume chicken meat (47%), followed by beef (41%), and lastly pork (18%), mainly because people care for their health and family economy.

Another variable that had a negative effect on pork consumption was the household income. To this respect, Mouteira et al. (2009), in their research work on consumer perception of pork in Ciudad de Plata, Argentina, showed that 35.2% receives an income of US\$ 173.27 or less (low income), who consume 100 g of pork a month. In other words, meat is a luxury commodity for poor people, so the lower the acquisitive power, the less is their meat consumption. Thus, Tellez et al. (2012) and Benítez et al. (2010) stated that income and meat consumption are positively correlated in developing countries such as Mexico, where as the income increases, so does the expenditure in meat consumption and the demand for meat.

Table 4 - Marginal effects

Variable	Logit	Probit
NFM	0.0454681	0.0332878
MEPR	-0.0578605	-0.0424428
INC	-0.0978208	-0.0698026
PRILL	-0.4582548	-0.3358243

NFM - number of family members; MEPR - meat preference; INC - household income; PRILL - presence of illness in the individual.

Finally, another variable that conditioned meat purchasing is the PRILL. This agrees with García (2003), who found that the citizens of Córdoba, Argentina, consume almost no pork since it is hazardous for human health, because it contributes to rise cholesterol. Likewise, Odriozola (2009) found that in three cities in Argentina, the main reasons for the lack of pork consumption is because they do not like the taste and it affects their health, increasing body fat (cholesterol). Meanwhile, Arana Coronado et al. (2012) stated that 26% of the interviewees do not consume pork – even not being vegetarians; the main motives for this are recommendation of doctors, the wish to be healthier, and because the meat is too expensive.

In general, the research revealed specific information on the behavior of pork consumers in the VMMA, mainly through socioeconomic variables, important for the population. This creates a panorama that will help producers and industries stimulate an increase in the consumption of this product, as well as exports, since in the last decade, they have been on the decline.

Conclusions

The results showed the factors that determine the consumption of pork by the people in the Valley of Mexican Metropolitan Area. An important factor that determines the probability of consumption of this type of meat is the number of members in the family, while the preference for chicken consumption, household income, price increases, and illnesses caused by its consumption decrease pork consumption.

Household income and illnesses are important factors that determine the decision to purchase the product. The greatest marginal effect in the purchase decision is presented when illnesses increase, followed by household income, meat preferences, and the number of family members.

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