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Elasticidades precio del frijol (phaseolus vulgaris l.) como indicadores de competitividad: un análisis retrospectivo

Elasticities Bean price (Phaseolus vulgaris L.) As competitive indicators: a retrospective análisis

Elasticidades-preço do feijão (Phaseolus vulgaris L.) como indicadores de competitividade: uma análise retrospectiva

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Resumen

En México, el frijol (*Phaseolus vulgaris* L.) tiene gran importancia sociocultural y económica al generar más de un millón de empleos, formar parte de tradiciones culturales y preservar la identidad alimentaria de la población; no obstante, la estructura productivo-comercial de esta leguminosa enfrenta problemáticas que justifican identificar si el precio propio del grano asociado con el de la tortilla de maíz y el de la carne de pollo o el ingreso de la población son los factores que afectaron su competitividad durante el período 1980-2004. Metodológicamente se estructura un modelo de ecuaciones simultáneas a partir de dos ecuaciones de oferta, una de demanda y dos de transmisión de precios, una identidad de producción total y una de saldo de comercio exterior. La estimación econométrica se realizó por el método de mínimos cuadrados ordinarios con el procedimiento SYSLIN del paquete SAS. Los valores de r^2 arrojados por las regresiones revelan nula correlación entre la cantidad de frijol producida en riego y el precio esperado y, correlación baja entre estas dos variables en temporal. Las elasticidades obtenidas del modelo econométrico clasifican por el lado de la demanda al frijol como un bien inferior, ya que responde a cambios en el precio de la tortilla y porque se puede convertir en un alimento sustituto de la carne de pollo y, por el lado de la oferta

se identificó que el precio del frijol producido en riego es más sensible que el de temporal, ya que, al asociarse con el maíz, la producción depende de la precipitación pluvial. Los resultados aportan información valiosa que permite conocer la respuesta de los consumidores del frijol ante cambios en el precio y la forma en cómo afecta la competitividad.

Palabras clave: oferta, demanda, precios, elasticidades, econometría.

Abstract

In Mexico, the bean (Phaseolus vulgaris L.) has great sociocultural and economic importance for generating more than a million jobs, being part of cultural traditions and preserving the dietary identity of the population; however, the productive-commercial structure of this legume faces problems that justify identifying whether the price of the grain associated with that of corn tortillas and chicken meat or the income of the population are the factors that affected its competitiveness. during the period 1980-2004. Methodologically, a simultaneous equations model is structured from two supply equations, one for demand and two for price transmission, a total production identity and a foreign trade balance identity. The r^2 values produced by the regressions reveal no correlation between the quantity of beans produced under irrigation and the expected price and a low correlation between these two variables over time. The elasticities obtained from the econometric model classify beans as an inferior good on the demand side because they respond to changes in the price of tortillas and because they can be converted into a substitute food for chicken meat, and on the production side supply, it was identified that the price of beans produced in irrigation is more sensitive than that of rainfed, since, when associated with corn, production depends on rainfall. The results provide valuable information that allows us to know the response of bean consumers to changes in price and how it affects competitiveness.

Keywords: supply, demand, prices, elasticities, econometrics.

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Resumo

No México, o feijão (Phaseolus vulgaris L.) tem grande importância sociocultural e econômica por gerar mais de um milhão de empregos, fazer parte das tradições culturais e preservar a identidade alimentar da população; No entanto, a estrutura produtivo-comercial desta leguminosa enfrenta problemas que justificam identificar se o preço do grão associado ao das tortilhas de milho e da carne de frango ou o rendimento da população são os factores que afectaram a sua competitividade durante o período 1980-2004. . Metodologicamente, um modelo de equações simultâneas é estruturado a partir de duas equações de oferta, uma para demanda e duas para transmissão de preços, uma para produção total e outra para balança comercial exterior. A estimação econométrica foi realizada pelo método dos mínimos quadrados ordinários com o procedimento SYSLIN do pacote SAS. Os valores de r2 produzidos pelas regressões não revelam nenhuma correlação entre a quantidade de feijão produzido sob irrigação e o preço esperado e uma baixa correlação entre estas duas variáveis ao longo do tempo. As elasticidades obtidas no modelo econométrico classificam o feijão como um bem inferior do lado da demanda, pois responde às variações do preço das tortilhas e porque pode ser convertido em alimento substituto da carne de frango e, por outro lado, do abastecimento identificou-se que o preço do feijão produzido na irrigação é mais sensível do que o do sequeiro, uma vez que, quando associado ao milho, a produção depende das chuvas. Os resultados fornecem informações valiosas que nos permitem conhecer a resposta dos consumidores de feijão às mudanças de preço e como isso afeta a competitividade.

Palavras-chave: oferta, demanda, preços, elasticidades, econometria.

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Introduction

As a result of changes in the global environment and economic dynamics, the bean market has been affected in production and consumption, generating new expectations in the agri-food chain. In Mexico, the legume is the second most important product of the Agri-Food Sector since it is not only essential in the population's diet, but also constitutes an integral part of its cultural identity. For the period 2006/2008, national bean production was 1,164 million tons, with an average annual yield of 0.736 t/ha (SIAP, 2008).

T his legume is planted throughout the country under various climatic and soil conditions; It is estimated that more than 60 varieties are cultivated, the most commercially important species being *Phaseolus vulgaris* L. or common bean. From the perspective of

demand, the SIAP (2008) estimated an annual average Apparent National Consumption (ANC) of 1,280 thousand tons in the period 2000/2007, with a growth rate of 5.7%.

Beans are and will be an important product in Mexican gastronomy, however, the trend in *per capita consumption* is decreasing: in the period 1990/2000, consumption per person per year was 15 kilograms (kg) (FIRA, 2001). and in 2003 it was located at 11. Serrano (2004) stated that despite the CNA remaining constant, it is population growth that determines the decreasing trend in *per capita consumption* because its decrease is proportional to the increase in population.

The commercial opening of the market for this crop has created pressures in the production, marketing, transformation and consumption network, so traditional tools for analyzing demand are no longer adequate. The elasticity of demand for beans no longer responds in the same way to a changing society (FIRA, 2001).

Some aspects that have restructured demand are: changes derived from society's habits (urban planning, migration and entry of women into the labor market), greater availability of substitute products as a source of protein for this legume, with lower prices and easy preparation, consumer preferences for varieties and qualities in the different regions of the country, causing segmentation and formation of market niches (FIRA, 2001).

In the case of supply , the problems that bean production faces and that are the reason for change in its structure are: high production costs; continuous change in actual product prices; lack of competitiveness of beans in relation to those produced in the United States; production of varieties that are not consistent with those demanded, causing an increase in inventories of uncommercial varieties and speculation in the prices of those that are preferential ; fluctuations in national prices caused by the increase in imports and the lack of an organization in the marketing of the product (Ayala *et al.*, 2008).

The importance of beans in the Agri-Food Sector marks the relevance of carrying out an analysis of the market for this product. Knowledge of the impact generated by each factor will improve decision-making and policy recommendations focused on improving production strategies, increasing productivity, lowering production costs and diversifying the product based on consumer preferences; and thereby increase the competitiveness of Mexican beans. Given the presented panorama, the objective of this research is to carry out a retrospective analysis and identify the factors that determine the dynamics of the bean market structure in Mexico based on the elasticities: supply price and demand, obtained from the estimation of an ordinary least squares statistical model

Materials and methods

To estimate the price elasticities of supply and price of demand for beans, an econometric model of simultaneous equations was structured and estimated through the Ordinary Least Squares (OLS) method in two stages. The model is formulated from endogenous or dependent variables because they are predetermined by another equation that converts them into random and explanatory variables of the model (Gujarati, 2000) and exogenous variables predetermined externally and independent of the error terms of the model (Maddala, 1996).

The basic assumptions were raised based on Martínez and Martínez (1995), who state that to structure a simultaneous equations model the following must be started: assumption of completeness; sample variances and covariances of structural errors with probabilistic limits corresponding to population parameters; predetermined variables generated by a stationary stochastic process with a non-singular contemporary covariance matrix; uncorrelated processes of structural errors and predetermined variables; sample variances and covariances of the reduced form errors with probabilistic limits; altered structural equation as long as it is multiplied by a non-zero number: in each structural relationship, the coefficient of one of the dependent variables must be equal to -1 or 1 (normalization rule).

Prior to the formulation of the model, dispersion graphs were drawn of the quantity of beans produced on a seasonal basis with respect to its expected price during the same agricultural cycle; The results indicated that there is no linear trend between the graphed values due to the dispersion between them. In contrast, the scatter plots for the quantity of beans produced in rainfed season in relation to the rural minimum wage and the price of fertilizers showed that there is a very small number of observations that fall within a linear trend given that the majority present a large dispersion.

To determine the correlation between dependent and independent variables, regressions were run and the following results were obtained: $r^2 = 0.72$, indicating that there is no correlation between the amount of beans produced in irrigation and the expected price of beans, the price of fertilizers, the availability of water for irrigation, the Field Support Program (PAC) and the lagging production of irrigated beans; $r^2 = 0.30$, establishes a weak correlation between the quantity of beans produced in rainfed season and the expected price of beans and corn, the rural minimum wage, the price of fertilizers, rainfall, the PAC, the lagged production of beans in time and the own price of grain; $r^2 = 0.61$, shows low correlation between the quantity of beans consumed and the consumer price of beans, tortillas and chicken meat, national disposable

income, population and the lagged quantity of beans demanded. The wholesale price of beans does not have a strong correlation with respect to the average rural price ($r^2 = 0.25$) nor does the consumer price with respect to the wholesale price ($r^2 = 0.55$).

Once the correlations were obtained, the model for bean supply was structured based on what was proposed by García *et al* . (2004), who state that the bean producer will produce taking into account the expected price of the product, the price of the associated products (in this case corn), the rural minimum wage in irrigation and seasonal farming, the price of fertilizer, the availability of water for irrigation and rainfall . In 1994, the Direct Field Support Program (PROCAMPO) was implemented to provide support to more than 3 million producers in the country; For this reason, the payment of another factor that affects the production of the legume. On the other hand, economic theory establishes that the demand for a good is determined by its price, the disposable income of individuals, the price of nearby substitute and complementary goods (Varian, 1993, p. 146), so following These aspects for the bean demand model consider the consumer prices of beans, tortilla as a complementary good, chicken meat as a substitute good, national disposable income and population. Derived from the above, two supply equations, a demand equation, two price transmission equations, a total production identity and a foreign trade balance identity are proposed. The mathematical expression of the model is the following:

$$QPFR_a = \gamma_{10} + \gamma_{11} PEFR_a + \gamma_{12} SMRR_a + \gamma_{13} PFERR_a + \gamma_{14} DAR_a + \gamma_{15} PROFR_a + \gamma_{16} QPFR_{a-1} + \gamma_{17} D1_a + e_{1a} \quad (1)$$

$$QPFT_a = \gamma_{20} + \gamma_{21} PEFTE_a + \gamma_{22} PEMTE_a + \gamma_{23} SMRTE_a + \gamma_{24} PFERTE_a + \gamma_{25} PP_a + \gamma_{26} PROFTE_a + \gamma_{27} QPFT_{a-1} + \gamma_{27} D2 + e_{2a} \quad (2)$$

$$QCF_a = \gamma_{30} + \gamma_{31} PCF_a + \gamma_{32} PCT_a + \gamma_{33} PCCP_a + \gamma_{34} IND_a + \gamma_{35} POBU_a + \gamma_{35} QCF_{a-1} + \gamma_{34} D2 + e_{3a} \quad (3)$$

$$PMF_a = \gamma_{40} + \gamma_{41} PMRF_a + e_{4a} \quad (4)$$

$$PCF_a = \gamma_{50} + \gamma_{51} PMF_a + e_{5a} \quad (5)$$

$$QPF_a = QPFR_a + QPFT_a \quad (6)$$

$$SCEF_a = QCF_a - QPF_a - SIF_a \quad (7)$$

where, $QPFR_{a}$ and $QPFT_{to}$ are the quantities of beans produced under irrigation and rainfed in year a; $QPFR_{a-1}$ and $QPFT_{a-1}$ the quantities of beans produced under irrigation and rainfed in year *a-1* ; QCF_{to} the amount of beans consumed in year a; $PEFR_{a}$, $PEFTE_{a}$ and $PEMTE_{at}$ the expected prices for irrigated beans and, for rainfed beans and corn in year a; $PFERR_{a}$ and $PFERTE_{to}$ the real prices of irrigation and seasonal fertilizer in year *a* ; PCF_{a} , PCT_{a} and $PCCP_{to}$ the real consumer prices of beans, tortillas and chicken meat in year a; PMF_{at} the wholesale price of beans in year *a*, $/t ; $PMRF_{to}$ the average rural price of beans in year *a* ; $SMRR_{a}$ and $SMRTE_{to}$ the rural minimum wages in irrigation and temporary in year *a* ; $PROFR_{a}$ and $PROFTE_{to}$ PROCAMPO payments in irrigation and temporary in year *a* ; DAR_{to} the availability of water for irrigation in year *a* ; P_{to} the average precipitation in year *a* ; $D1_{to}$ the dummy variable for irrigation production in year a; D2a Dummy variable for temporary production in year a; and D3 the differentiation of high and low prices *;* IND_{to} the national disposable income in the year *a* ; $POBU_{to}$ the urban population in the year *a* ; $SCEF_{to}$ the balance of bean foreign trade in year a; and SIF_{to} the balance of bean inventories in year *a.*

The model was estimated by the least squares method in two stages with the SYSLIN procedure of the SAS package. The statistical congruence of the model was established by means of the coefficient of determination (R^2), the significance of the coefficients was carried out with the F test , and the individual significance of each coefficient, with Student's t.

To estimate the model, annual time series for the period 1980-2004 were used. The average rural price and purchases of corn and beans were obtained from the National Popular Subsistence Company (CONASUPO, 1994) and the Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA); the rural minimum wage in irrigation and temporary of the National Commission of Minimum Wages (CONASAMI, 2005) and the Official *Gazette of the Federation* (DOF, 2005); the price of fertilizer, the availability of water for irrigation and the average annual precipitation of García (1992), of the National Agricultural Council (CNA); consumer prices of beans and tortillas from García Delgado (1994) and the Bank of Mexico (BANXICO, 1997). Similarly, the consumer price of chicken meat was obtained from Rojas (2005), the national disposable income from the Bank of Economic Information (BIE), the urban population from the National Institute of Statistics and Geography (INEGI, 2005) and the wholesale price of beans from the National Information and Market Integration System (SNIIM, 2005).

Results

The coefficients obtained from the model estimation are presented in Table 1 in their structural form. The R^2 of the equations range between 0.18 and 0.78, which means that the goodness of fit of the model is acceptable. Based on the *t test* , it was found that only $QPFR_{a-1}$ of the irrigation supply function, $QPFT_{a-1}$ and $PROFTE_{a}$ presented a value greater than unity in absolute terms, which indicates that they were not significant.

Table 1. Statistical results and estimated coefficients of the structural form.

Function	Explanatory Variables								R^2	Pr> F
QPFR	*PEFR*	*SMRR*	*PFERR*	*GIVE*	*PROFR*	$QPFR_{a-1}$	*D1*		0.78	0.003
Coef.	36.22	-2181.8	-67.19	3.62	217.24	-0.0035	69901			
Reason *t*	4.93	-2.29	-1.37	1.04	2.69	-0.023	2.18			
QPFT	*PEFTE*	*PEMTE*	*SMRTE*	*PFERTE*	*PP*	*PROFTE*	*QPFT a-1*	*D2*		
Coef.	35.13	180.05	-3836	-338.9	1198	51.64	-0.18	279206	0.51	0.129
Reason *t*	1,327	1,765	-1,145	-1,956	1,646	0.498	-0.82	2.01		
QCF	*PCF*	*PCT*	*PCCP*	*IND*	*POBU*	QCF_{a-1}	*D3*			
Coef.	-49.64	-257.4	8.93	-0.00000021	0.046	-0.37	415061		0.54	0.046
Reason t	-2.22	-2.67	1,043	-1.45	2.38	-1.91	3.45			
PMF	*PMRF*									

Coef.	0.49								0.18	0.036
Reason t	2.23									
PCF	*PMF*									
Coef.	0.75								0.3	0.005
Reason t	3.08									

Source: Own elaboration with information obtained from the estimation of the simultaneous equations model.

From the coefficients presented in reduced form in Table 2 and from the data series, the elasticities of the variables of each equation and identity of the model were estimated to identify the dynamics of the quantity produced or consumed in the face of various changes in the factors that integrate the bean market in Mexico, given that, according to Nicholson (2008), elasticity is a measure that focuses on the proportional effect that one variable has on another.

Table 2. Estimated coefficients of the reduced form.

Variables	Endogenous variables						
exogenous	*QPFR*	*QPFT*	*QCF*	*PMF*	*PCF*	*QPF*	*SCEF*
Intercept	92573.92	-253757.82	363397.87	6239.25	6110.6	-161183.9	524581.77
PEFR	36.22					36.22	-36.22
SMRR	-2181.89					-2181.89	2181.89
PFERR	-67.19					-67.19	67.19
GIVE	3.62					3.62	-3.62
PROFR	217.24					217.24	-217.24
$QPFR_{a-1}$	-0.0035					-0.0035	0.0035
D1	69901.36					69901.36	-69901.36
PEFTE		35.13				35.13	-35.13
PEMTE		180.05				180.05	-180.05
SMRTE		-3836.03				-3836.03	3836.03
PFERTE		-338.87				-338.87	338.87
PP		1198.03				1198.03	-1198.03
PROFTE		51.63				51.63	-51.63
$QPFTE_{a-1}$		-0.18				-0.18	0.18
D2		279205.82				279205.82	-279205.82
PCT			-257.35				-257.35
PCCP			8.93				8.93
IND			-2.05				2.05
POBU			0.04				0.04
QCF_{a-1}			-0.36				0.36
D3			415061.43				415061.43
PMRF			-19.04	0.49	0.37		-19.04
SIF							-1

Source: Own elaboration with information obtained from the estimation of the simultaneous equations model.

Table 3 presents the coefficients of the estimated elasticities. For price elasticity expected of the bean, values of 0.82 were obtained for irrigation production and 0.36 for rainfed production, so it is an inelastic supply ($\xi<1$) in which the degree of response of producers to changes that

are registered In the price it is less than proportional . As an example, if the expected average rural price of beans increases by 10%, this causes an increase of 8.2% in the quantity produced from irrigation and a 3.6% increase from rainfed crops.

Table 3. Estimated elasticity coefficients

Variables	β_0	Avg. value	E prom	ED=1	ED=0	And obs	E SCE
Demand							
QCF			1207696	1258044	1163535	1207696	117689
PCFR	-49.64068	13634.02	-0.56	-0.54	-0.58	-0.56	
PCTR	-257.3533	2933.38	-0.63	-0.6	-0.65	-0.63	-6.41
PCCPR	8.930772	33761.7	0.25	0.24	0.26	0.25	2.56
INDR	2.05E-07	4.05E+12	-0.69	0.66	0.71		7.06
POBU	0.045566	59646717	2.25	2.16	2.34		20.27
QCFL	-0.366422	1199662.8	-0.36	-0.35	-0.38		-3.67
D3	415061	0.52	0.18	0.17	0.19		1.83
Irrigation Offer							
QPFR			350172	349986	366926	350172	117689
PEFR	36.221541	7909.34	0.82	0.82	0.78	0.82	-2.43
SMRRR	-2181,889	61.906102	-0.39	0.82	-0.37		1.15
PFERRR	-67.19241	1393.02	-0.27	0.82	-0.26		0.80
GIVE	3.619145	25218	0.26	0.82	0.25		-0.78
PROFRR	217.24406	239.33419	0.15	0.82	0.14		-0.44
QPFRL	-0.003503	353568	0	0.82	0		0.01
D1	69901	0.8	0.16	0.82	0.15		-0.48
Temporary Offer							
QCF			768162	808815	736087	768162	117689
PEFTE	35.12938	7957.32	0.36	0.35	0.38	0.36	-2.38
PEMTE	180.04579	3051.01	0.72	0.68	0.75		-4.67
SMRTER	-3836.034	61.29699	-0.31	-0.29	-0.32		2.00
PFERTER	-338.8747	1393.02	-0.61	-0.58	-0.64		4.01
PP	1198.0333	745	1.16	1.1	1.21		-7.59
PROFTER	51.634866	752.86489	0.05	0.05	0.05		-0.33

QPFTEL	-0.181789	762886.92		-0.17	-0.19		1.17
D2	279206	0.36	0.08	0.12	0.14		-0.85

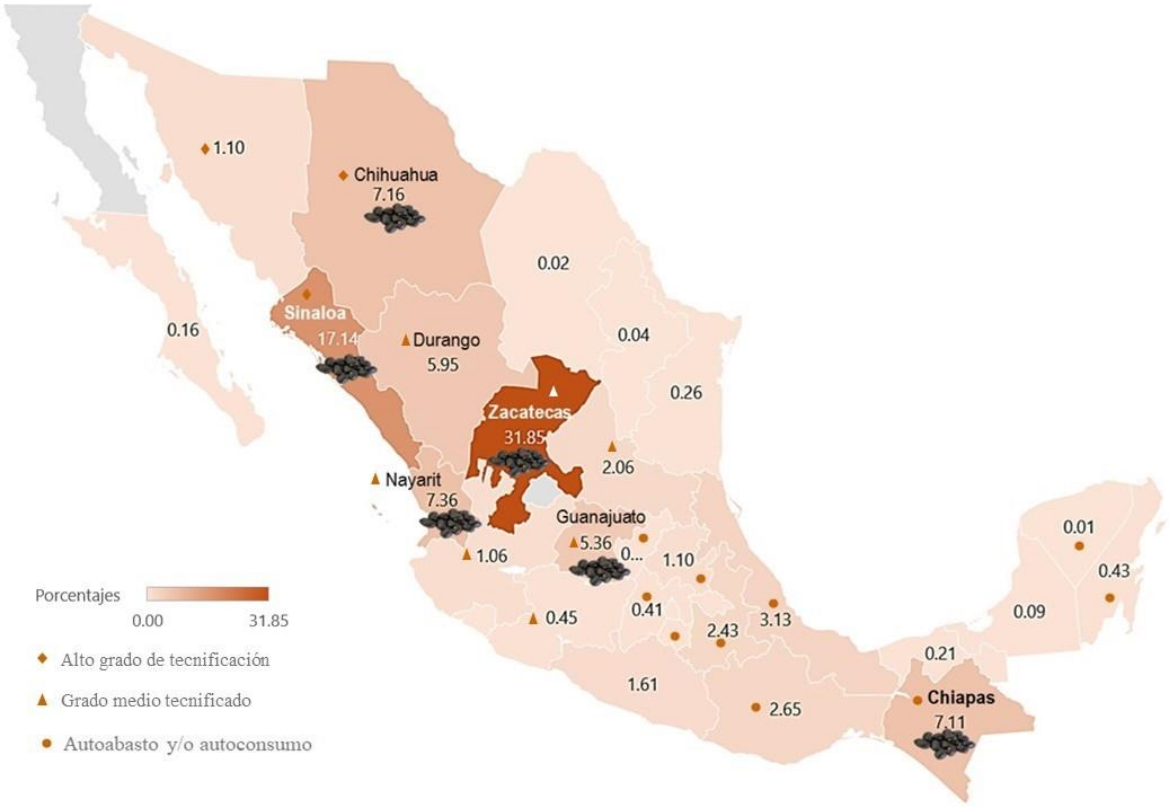
Source: Own elaboration with information obtained from the estimation of the simultaneous equations model

The greater expected price elasticity of supply in irrigation areas could be explained as Acosta and Pérez refer. (2003) by the destination of the production (the volume obtained under the irrigation system covers the market demand and the rainfed volume is intended for self-consumption, so in the second case the grain producers do not respond to the price stimuli) and by weather conditions (rainfed producers depend on rain, which is why the supply response could be lower if rainfall is not favorable).

The expected price elasticity of seasonal bean production with respect to the corn price was 0.72, which indicates the close relationship between both crops. The effect of an increase in the expected price of corn of 10% would mean an increase in production of 7.2% in bean production in rainfed areas, which reveals the importance of the effects that collateral policies have on the price of corn. corn and bean production.

For its part, the price elasticity coefficient of fertilizer was -0.26 in irrigated areas and -0.64 in rainfed areas. Fertilizers represent part of the inputs in production , according to information reported in 2009 by the Trusts Instituted in Relation to Agriculture (FIRA), only 10.2 million hectares are fertilized nationally (47.7%) and in eleven states they are fertilized. It concentrates the highest percentage of the fertilized surface (80%), among them Sinaloa, Guanajuato, Zacatecas, Chiapas and Chihuahua, which are important bean producers (see Figure 1). A subsidy for the sale of chemical fertilizers could be an agricultural policy measure. For example, by increasing the price of chemical fertilizers by 10%, the quantity of irrigated and rainfed beans produced would decrease by 2.6 and 6.4%, respectively.

Figure 1. State mapping of bean production, 2022.



Fountain. Own elaboration based on information reported by the SIAP 2008

The elasticity that relates production and the minimum wage turned out to be -0.37 in the irrigated areas and -0.32 in the rainfed areas, which indicates a low sensitivity of the producer to changes in the cost of labor, in addition, the Low response is a consequence of the increase in the use of machinery in the producing regions. Remittances have played an important role in the mechanization of plots, mainly in entities where seasonal production is important such as Zacatecas, Durango and Chihuahua. The elasticity coefficients indicate that for every 10% increase in the minimum daily wage, bean production in irrigated and rainfed areas will decrease by 3.7 and 3.2%, respectively.

For the relationship between rainfed production and rainfall, a coefficient equal to 1.21 was obtained. A 10% increase in rainfall in the months in which beans need it, would result in an increase in rainfed production of 12.1%, showing that producers' knowledge of meteorological conditions is fundamental in production decisions. produce under storm conditions. The seasonality of bean production in Mexico based on its participation in national production is as follows: January 4.16%, February 5.57%, March 8.58%, April 3.26%, May 1.68%, June 1.27%, July 0.76%, August 1.72%, September 3.01%, October 10.56%, November 39.97%, December 19.45%.

Irrigation production shows a lower sensitivity (0.26), water availability had no effect on bean production because it was not the only crop irrigated with irrigation water. In each agricultural cycle, a crop pattern is planned, hence increases in water availability imply increases in the surface area of all crops, not just beans. The elasticity that relates both variables turned out to be 0.25, which indicated that a 10% increase in availability will increase production by 2.5%.

The elasticity that relates production and PROCAMPO was 0.14 for irrigation and 0.05 for rainfed: if the payment increased by 10%, rainfed production would grow by 0.5% and 1.4% for irrigation. The low impact on production is due to the fact that it is a direct payment to the producers' income: 62.5% of the support is allocated to increasing the productive capacity of the plots and 37.5% for domestic consumption, mainly food (ASERCA, 2006). . The estimated coefficients indicate a negative relationship between the quantity produced and its lag: -0.0035 for irrigation and -0.816 for rainfed. This result indicates a downward trend in production in the long term.

For the demand for beans, the price elasticity coefficient was -0.56 (inelastic), which indicates that by increasing the consumer price by 10% the quantity demanded decreases by 5.6%; result that differs from that calculated by García (1994), who reports a value of -0.11 for the period 1965-1984. The discrepancy between the values is a result of the availability of bean substitute products (beef, pork, poultry, sheep or goats, or other types and varieties of beans); the accelerated increase in the urban population, in 1960: 50.7% of the population lived in urban locations; by 2005, this figure increased to 76.4% (INEGI, 2005); Finally, the data used for the estimation of this study are different, García (1994) considers the sales price of CONASUPO beans, while the consumer price was used in the proposed model.

In the world there are 70 species of bean, of which 50 are found in Mexico, of which five stand out that have been domesticated: *Phaseolus vulgaris* L. (common bean), *Phaseolus coccineus* L. (ayocote bean), *Phaseolus lunatus* L. (comba bean).), *Phaseolus dumosus* (fat bean) and *Phaseolus acutifolius* Gray (tepary bean). According to INIFAP-SADER (2021), of the first national species there are more than 520 varieties throughout the territory, which are sold in the market at different prices, hence when talking about bean substitute products we must consider that the The consumer chooses the grain of his choice according to his tastes and preferences, as cited by Rodríguez-Licea *et al.* (2017). In Figure 2, different bean varieties classified based on NMX-FF-038-SCFI-2013 are presented.

Associated with the above, the relationship of nutritional complementarity between beans and corn is supported by r the value of the cross elasticity of the legume with respect to the price of the tortilla, which turned out to be -0.63. The value indicates that for every 10% increase in the price of tortillas, there is an increase of 6.3% in the amount of beans consumed. In 2007, Mexican households consumed a monthly average of 20.51 kg/household of tortillas and 2.65 kg/household of beans; Of the national expenditure on food, it is the lowest-income families that spend the most on beans (their expenditure represents 12.40% of the total), while the tortilla is a product that is consumed at very low and very high levels of the population. income (Tépach, 2007).

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Figure 2 . Bean varieties *Phaseolus Vulgaris* L. produced in Mexico.

Differentiation by type and subtype: color, shape and size

Fountain. Own elaboration

The value of the cross price elasticity of the demand for beans with respect to the price of chicken meat was 0.25. This substitution relationship indicated that with increases in the price of chicken meat by 10%, bean consumption increases by 2.5%. The value indicates that there is a stronger relationship between corn and beans than between chicken and beans because the tortilla is a complementary food to the legume.

The coefficient of income elasticity of demand (-0.70) classifies beans as an inferior and necessary good. Therefore, if the consumer's income level increases by 10%, the demand for beans decreases by 7%. Population is another determining factor of demand; the resulting sensitivity of the model indicates that, if the urban population increases by 1%, the quantity of beans demanded increases by 2.25%. The coefficient that relates current bean consumption to its lag, -0.37, indicates a downward trend in national consumption.

The reduced form of the model allows us to know the effect of the predetermined variables on the foreign trade balance of beans (imports minus exports). On the supply side, if the expected average rural price in irrigated and rainfed areas increases by 1%, the balance of foreign trade would decrease by -2.3% due to the effect of the former, and by 2.38% due to the effect of the second. For demand, each increase in the average rural price of beans by 1% would cause a decrease of 1.3% in net imports of the legume. With the aim of exemplifying the importance of exports and imports in the bean market, Figure 3 presents a diagram of the bean value chain in which the commercial circuits are linked.

The elasticities of the foreign trade balance were PEFR (-2.43), PEFTE (-2.38) and PEMTE (-4.67), this indicates that with a 1% increase in the price of corn and beans, the balance would decrease by -9.48 (the sum), or, a 1% increase in the price of beans and corn would decrease the balance by 4.81 and 4.67%, respectively. On the other hand, increases in the prices of fertilizers and minimum wage by 1% in irrigated and seasonal areas would cause an increase of 7.9% in the balance of foreign trade in beans; Of this total, 4.81% would be due to the impact of chemical fertilizers and 3.15% to the minimum wage. In contrast, if the average annual rainfall were 1% higher, the balance of bean foreign trade would decrease by 7.59%; It is insisted that the timing of the rains is essential for the effect to manifest itself. If the availability of water for irrigation increases by 1%, then the foreign trade balance decreases by 0.8%.

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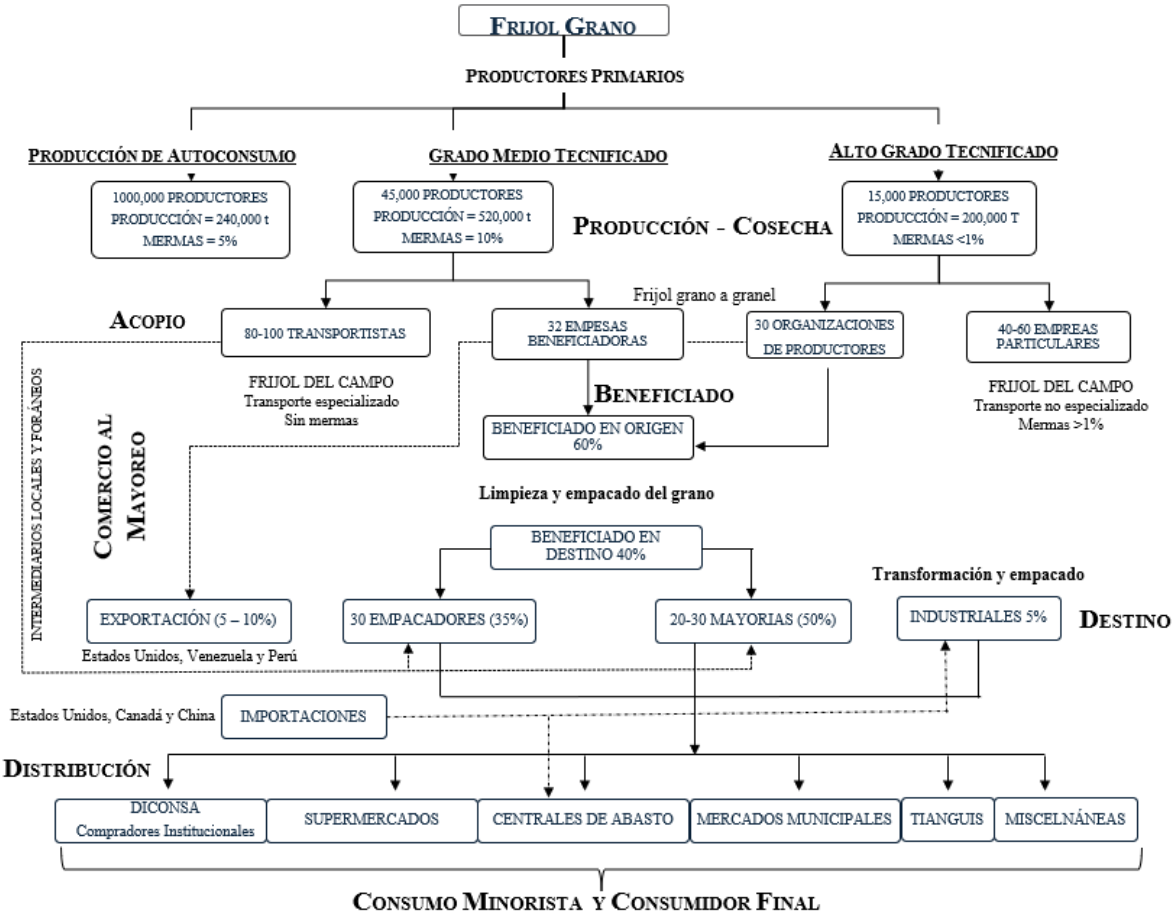
Figure 3. Bean (*Phaseolus vulgaris L.)* value chain in Mexico



Fountain. Own elaboration.

Referring to demand, we have the following: the increase in the price of corn tortilla by 1% would decrease the balance of foreign trade by 6.41% and the increase by 1% in the price of chicken meat would increase it by 2.6%; In contrast, increasing consumer income by 1% would reduce net bean imports by 7.0%.

Discussion

From the economic point of view, the price elasticities of supply, demand and income are indicators that allow identifying the competitiveness of any productive activity, given that, through these, comparative advantages can be generated on the side of the production and transformation of products. and, competitive on the market side, although in the case of beans, the consumer's behavior when purchasing the variety of their preference can lead to price differentiation at the territorial level, as cited by García-Salazar *et al.* (2012) in the analysis carried out on the importance of the spatial distribution of bean production based on the varieties demanded by the consumer, through the estimation of a multi-product model. The authors concluded that production specialization should be a function of consumer preferences for the deficit or surplus of some varieties in some markets at a local or regional level.

For their part, Rodríguez-Licea *et al.* (2010) highlighted the aspects and characteristics that affect the purchasing decision differentiated by type and variety of grain; generated information about the importance of price for the consumer when making the purchase, since they usually react to the change in price and opt for other varieties that are within the reach of their economic possibilities. From what was previously stated, it follows that price is a determinant of the competitiveness of the bean market, given that, on the supply side, it delimits the volume of production and on the demand side, consumption, coupled with the fact that, Since two-thirds of the production is generated under rainfed conditions during the spring-summer cycle, the market reference price is affected by climate change.

Conclusions

The demand for beans did not show sensitivity to changes in the price of grain, but it did turn out to be higher than that estimated by other authors for past periods. The bean behaves like an inferior good and its main consumption complement is the tortilla. A greater availability of protein substitute products at affordable prices, such as chicken meat, represents another factor influencing the consumption of legumes, as does population growth. The balance of foreign trade decreased due to increases in the average rural price of beans, the price of tortillas and disposable income; On the other hand, bean imports would be higher due to increases in the price of chicken meat. In the bean supply, differences were observed between irrigated and rainfed production; In the first, the effect that the price of grain has on the quantity of production is greater than in the second.

Future lines of research

This research focused on identifying the importance of the price elasticities of supply, demand and income on the competitiveness of the commercial productive structure of beans in Mexico; Although the results showed that price is one of the main aspects that the consumer considers when purchasing the type and variety of beans of their preference because it is associated with the income they receive, the continuation of this research could focus on identifying the importance and the impact of climate variation on the fluctuations of these economic variables, with the aim of establishing policy recommendations that help mitigate the impact of this risk factor on the production, marketing and consumption of this legume.

References

Acosta, J.A. y Pérez, P. (2003). La situación del cultivo del frijol en México: producción e investigación. Programa de frijol del Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias cnpaf.ambrapa.br/negocios/ser_doc/anais/palestras/mesa1a.pdf.

Apoyos y Servicios a la Comercialización Agropecuaria (ASERCA). (2006). Estudio sobre la Evaluación del Desempeño del Programa de Apoyos Directos al Campo: Año Agrícola 2006. http://www.aserca.gob.mx/artman/uploads/evaluacion_integral_procampo.pdf.

Ayala, A., Schwentesius, R. y Almaguer, G. (2008). La competitividad del frijol en México. *El cotidiano*, 23(147), 81-89.

Banco de Información Económica (BIE) (2008). Series Anuales del Ingreso Nacional Disponible, reportadas por el Sistema de Consulta del Instituto Nacional de Información de Estadística y Geografía (INEGI). https://www.inegi.org.mx/app/indicadores/?tm=0

Consejo Nacional Agropecuario (CNA). (2005). *Compendio Estadístico del Sector Agroalimentario 1994-2000.* Dirección de Estudios Económicos, México, CNA. https://cna.org.mx/#

Comisión Nacional de Salarios Mínimos (CONASAMI). (2005). Salarios Mínimos Generales y Profesionales, Mexico. http://www.conasami.gob.mx/

Comisión Nacional de Mejora Regulatoria (CONAMER) (2008). Cadena Productiva de Frijol, Análisis Sectorial, México. Estudio de la Secretaría de Economía https://www.gob.mx/busqueda?utf8=%E2%9C%93#gsc.tab=0&gsc.sort=&gsc.q=Cadena%20Productiva%20de%20Frijol&gsc.page=9

Compañía Nacional de Subsistencias Populares (CONASUPO). (1997). CONASUPO en Cifras México. Programa Institucional del Gobierno Federal.

Diario Oficial de la Federación (DOF). (2005). Comisión Nacional de los Salarios Mínimos 2005, México: DOF. http://www.dof.gob.mx/publicacionesRelevantes.php

Organización de las Naciones Unidas para la Agricultura y la Alimentación (FAOSTAT). (2003). Base de datos http://faostat.fao.org/site/609/default.aspx#ancor

Fideicomisos Instituidos en Relación con la Agricultura (FIRA). (2009). El frijol en México competitividad y oportunidades de desarrollo. *Boletín informativo*, 338(316). https://www.fira.gob.mx/InvYEvalEcon/EvaluacionIF

García Delgado Adolfo (1994). Análisis espacial del comercio de frijol en México. Tesis de maestría. Colegio de Postgraduados. Montecillo, México

García, J.A., Rodríguez, G., Borja, M. y Guzmán, E. (2012). Distribución espacial de la producción de frijol en función de variedades demandadas por el consumidor. *Paradigma Económico, Revista de Economía Regional y Sectorial* 4(2): 85-99. https://paradigmaeconomico.uaemex.mx/article/view/4783/3188

García, R., Del Villar, M.F., García, J.A., Mora, J.S. y García, R.C. (2004). Modelo Econométrico para determinar los factores que afectan la carne de porcino en México. *Revista Interciencia*, 29(8), 414-420.

Gujarati, D.N. (2000). *Econometría*. Tercera edición. Edit. McGraw-Hill. México.

Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias (INIFAP) y Secretaria de Agricultura y Desarrollo Rural SADER (2021). Variedades de frijol (*Phaseolus vulgaris* L.) del INIFAP. Libro Técnico No. 2. https://vun.inifap.gob.mx/VUN_MEDIA/BibliotecaWeb/_media/_librotecnico/12277_5045_Variedades_de_Frijol_(Phaseolus_vulgaris_L.)_del_INIFAP.pdf.

Instituto Nacional de Estadística, Geografía e Informática (INEGI). 2005. Población rural y urbana. http://cuentame.inegi.gob.mx/poblacion/rur_urb.aspx?tema=P

Maddala, G. S. (1996). *Introducción a la Econometría*. Segunda edición. Edit. Prentice Hall H. México.

Martínez, M. y Martínez, A. (1995). *Ecuaciones simultáneas (una introducción).* Serie Textos de Apoyo a la Docencia. Universidad Autónoma de Chapingo. México.

Nicholson W. (2008). *Teoría Microeconómica: Principios básicos y ampliaciones*. 9ª. Edición, México: CENGAGE Learning.

Rodríguez, G., García, J. A., Rebollar, S. y Cruz, A. C. (2010). Preferencias del consumidor de frijol (*Phaseolus vulgaris* L.) en México: factores y características que influyen en la decisión de compra diferenciada por tipo y variedad. *Paradigma Económico, Revista de Economía Regional y Sectorial* 2(1): 121-145. https://paradigmaeconomico.uaemex.mx/article/view/4810.

Rojas Rojas María Magadalena (2015). Modelo Econométrico del Mercado de Huevo en México 1960-2003. Tesis de maestría del Posgrado en Socioeconomía, Estadística e Informática (PSEI). Colegio de Postgraduados. Montecillo, México.

Secretaría de Agricultura, Ganadería y Desarrollo Rural (SAGAR). (1997). *Anuario Estadístico de la Producción Agrícola de Estados Unidos Mexicanos.* www.siea.sagarpa.gob.mx.

Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación (SAGARPA) (2010).

Serrano, L. M. (2004). Análisis del Caso Frijol. Estudio de la Cadena Sistema producto Frijol. Estudio del Centro de Investigaciones Económicas, Sociales y Tecnológicas de la Agroindustria y la Agricultura Mundial (CIEESTAM) de la Universidad Autónoma de Chapingo https://www.fec-chiapas.com.mx/sistema/biblioteca_digital/analisis-del-caso-frijol--270204.pdf

Servicio de Información Agroalimentaria y Pesquera (SIAP) (2008). *Producción de frijol bajo el sistema de riego en el Sistema de Información Agroalimentaria de Consulta (SIACON).* México, SAGARPA. www.siea.sagarpa.gob.mx/sistemas/siacon.

Sistema de Información Agroalimentaria y Pesquera (SIAP). (2008). Anuario Estadístico de la Producción Agrícola. Producción de Frijol https://nube.siap.gob.mx/cierreagricola/.

Sistema Nacional de Información e Integración de Mercados (SNIIM). (2005). Precios en diversos mercados nacionales abastecedores de granos agrícolas. México. http://www.secofi-sniim.gob.mx/nuevo/.

Tépach, R. (2007). *El impacto en los hogares del país por el incremento en los precios de los artículos alimenticios que forman parte de la canasta básica*. Centro de Documentación y Formación de Análisis. México: Cámara de Diputados.

Varían, H. (1993). *Microeconomía Intermedia, un Enfoque Moderno*, España: Antoni Bosch Editor.