Article

General equilibrium analysis applied to the economy of a rural community in Mexico

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Abstract

Agricultural households in small rural economies are characterized by being a unit of production-consumption, not following the logic of the market and presenting a heterogeneous and diversified productive structure. This research aimed to simulate some policy scenarios to analyze the effects of sectoral policies or trade reforms on the economy of a rural community of 2 500 inhabitants or less. Through the parameterization of the agricultural household model; through the social accounting matrix of the Bajitos de la Laguna community, Tecpan de Galeana municipality, Guerrero, Mexico, and in a context of general equilibrium, three policy experiments were simulated with different model closure rules: 1) 5% drop in the price of basic goods produced by peasant-type households; 2) decrease of 5% in the price of basic goods and a direct transfer to the income of producers; and 3) a transfer to the income of producers without a drop in the prices of basic goods or any other good. The results show how a policy of this type impacts the production of the goods produced in the community, the income of the households, the consumption demand of the households, the supply and demand of factors, the commercialized surplus, mainly. The results also show that the community is indeed distinguished by being a community with typically peasant features and being impacted to different degrees by sectoral or commercial policies.

Keywords: agricultural household model, general equilibrium, parameter calibration, policy experiments, social accounting matrix.

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Introduction

In 2010, 23.2% of the Mexican population resided in localities with less than 2 500 inhabitants and just over 97% of the total localities in the country corresponded to localities with less than 2 500 inhabitants (INEGI, 2013). Localities with this characteristic are generally classified as rural. In these, agriculture and to a lesser extent livestock, fishing, forestry and handicrafts constitute their productive structure and, consequently, such activities explain their economic operation, so it is interesting to understand the way in which they obtain their income, whether in species or monetary (Bracamonte, 2005; Breisinger *et al*., 2009; De Janvry and Sadoulet, 2016).

Most of the rural population living in small communities are typically in the lowest income deciles and most marginalized, therefore they have been and are the object of programs to combat poverty, whether of a productive nature or direct transfers to income.

However, the peasant-style productive units of these economies have characteristics that frequently deviate from the economic behavior of the national average of agricultural producers. A large amount of empirical research has searched for evidence on the latter characteristic, finding that indeed in small economies where a significant proportion of production is for self-consumption.

In general, there are usually high and positive price elasticities of demand, volumes of basic production (corn, beans) that decrease when there is some stimulus of price policy (that increases them), among others (De Janvry *et al.*, 1991; Löfgren and Robinson, 1999).

Various explanations have been given to this economic behavior of peasant-style productive units, which seems to contradict the postulates of conventional microeconomics, creating true paradoxes that are difficult to explain, not only of an economic nature, but of an anthropological, cultural and tradition type. Among the economic explanations for this 'non-rational' behavior is the one that postulates that the households that make up this type of small economy are, simultaneously, production and consumption units, which in extreme cases of self-consumption.

Production determines consumption decisions and vice versa (other features of peasant-style family economies that explain the aforementioned behavior are: the family unit maximizes its income, not its profit; the diversity and interdependence of productive activities, risk aversion in its production activities and heterogeneity of family units between communities (Schejtman, 1980; Nakajima, 1986; De Janvry *et al*., 1991).

The design of models to estimate the impact of an exogenous change on the economy of a rural community is based on microeconomic models that study rural communities, starting from households without considering the economic relationships that exist in the area of the town and of this with the exterior and on the other hand there are the general equilibrium microeconomic models that postulate the maximization of a utility function subject to a production function and two resource restrictions, which use the information contained in the social accounting matrix of villages, estimated through surveys, to calibrate the parameters of said model (Ferrarese and Mazzoli, 2018).

The commercial opening that began in the early eighties, the applied policies, such as the withdrawal of the State from the economy, selective subsidy policies, the elimination of parastatals, reforms of the financial sector and credit, among others, affected the small rural economies to different degrees.

Some studies show that these policies have been unfavorable to the afore mentioned communities, since the prices of the products and crops they produce have fallen, migration and unemployment have intensified, among other effects. Some others like Taylor and Adelman (2003); Taylor and Dyer (2009) affirm that these communities have a null or even a contrary response to the expected response, for example, the non-reconversion of crops considered basic and not competitive, by others that could be expected to have improved the level of income of producers.

Even though the latter have been the object of exogenous support via technological packages (Key *et al*., 2000). In this framework, it is important to determine, through an exercise of simulations, how a rural economy behaves, at the village level.

The general objective of the work is to analyze the results of some counterfactual scenarios of agricultural policy for the rural economy of Bajitos de la Laguna, municipality of Tecpan de Galeana, Guerrero, using the disaggregated model of agricultural households in the context of general equilibrium and quantify the effects that it would have the elimination of a program of direct transfers to the producer's income on production, consumer demand for goods, income and labor in the studied town.

The research hypothesis is: 1) the fall in the price of self-consumption goods produced in a small rural economy and under the assumption of perfect markets will have little impact on household income, consumer demand of agricultural households, but it will significantly impact the production of basic goods, the demand for family labor and the commercialized surplus of basic goods. But it will strongly favor the commercialized surplus of goods produced by agricultural households to be commercialized; and 2) the simultaneous fall in the price of basic goods and a direct transfer to the producer's income through some government program, will cause a sharp drop in the production of basic goods, favor the production of cash crops; it will strongly favor the increase in demand for household consumption and will negatively affect the traded surplus of basic goods while favoring the traded surplus of marketable goods produced by agricultural households.

The works referring to agricultural households date back to Chayanov (1926); Nakajima (1969) but it is Barnum and Squire (1979) who presented an econometric model of household production, consumption and the behavior of labor supply for a semi-commercial home.

The basic form of the agricultural household model was presented by Singh and Strauss (1986) and applied in Taylor *et al*. (1999) and operationalized in Yunez and Taylor (1999). Adelman and Taylor (1988); Haggblade *et al*., 1991), were pioneers in the use of models like the one applied here. Ferrarese and Mazzoli (2018) have applied them more recently in Oaxaca, Mexico.

De Jamry and Sadoulet (2003) constructed a model of the behavior of peasant households with variations in terms of specific food markets and market failures, to understand the response of the peasant economy to government food policies. The conclusions indicate the characteristics that the policy measures must have to increase the elasticity of demand in the production of basic foodstuffs in the peasant economies and avoid the perverse responses that counteract said policies.

It is up to Taylor and Adelman (1996, 2008, 2003) to construct a synthesis of the modeling of rural family units, their evolution and uses. The study presents a simple general model of rural family units, estimated with information from a rural Mexican town and using the general algebraic modeling system (GAMS) computation package and they use this model to estimate the impacts on rural family units in the face of changes in agricultural policies in production and income under different market scenarios.

In the model that is developed in the present investigation, it is based on the methodology used in this investigation by Taylor and Adelman (2003) to simulate the policy scenarios that are carried out for the community of Bajitos de la Laguna, Guerrero.

Materials and methods

The materials used in the present study were the social accounting matrix of the Bajitos de la Laguna community, Tecpan de Galeana municipality, Guerrero, which was built by The College of Mexico Program in 2002 and is published in Rojas (2004). Additionally, the general algebraic modeling system (GAMS) program was used, with which the instructions of the three policy scenarios studied were run.

The matrix used was already balanced and therefore the income flows were equal to the expenses, thus complying with the social accounting rule, which establishes that a double entry system, such as the model of the matrix of social accounting, the inputs were equal to the outputs. In this way, the Bajitos de la Laguna matrix was the database used to calibrate the parameters of the household model.

The social accounting matrix proposed by Rojas (2004) was built by grouping six small population centers under the name of Bajitos de La Laguna. The Information from the social accounting matrix of the Tecpan de Galeana community, in the state of Guerrero, was built with the information gathered by the study program on economic change and sustainability of Mexican agriculture (PRECESAM), from The College of Mexico, carried out in various entities at the end of the nineties and the first five years of the first decade of this century.

The College of Mexico carried out the survey under contract with the Ministry of the Environment and Natural Resources and Fisheries (SEMARNAP) and was also part of the so-called national survey of rural households in Mexico (ENHRUM). The information was available for free use until after 2013.

Given that a fundamental aspect in this type of study is the effect that technological change produces in the entire structure of these productive units and because in peasant economies it is a factor that does not register substantive changes in the short term, the use of this information does not detract from the results or conclusions obtained.

According to Singh *et al*. (1986) the household model, originally proposed by Chayanov (1926) and taken up among others by Nakajima (1986), originally considers that the production and consumption decisions of the family peasant unit are taken simultaneously, which in practical estimation this type of model becomes very difficult given the simultaneity and non-linearity of the model.

Given this difficulty, the introduction of the assumption by development microeconomics, synthesized by Bardham and Udry (1999), that, if the production and consumption decisions are made in separate markets, then the household model can be modeled as a recursive system of simultaneous equations, therefore, its estimation is possible, by estimating one of the equations first and then one by one using the least squares procedure.

Although this argument is more technical in nature to justify the use of the assumption of perfect markets, in the case of the study in question, where you have a typical rural economy, it is justified as Taylor and Adelman (2003) do: the use the assumption of perfect competition in the closing rules of the household model is justified because it is the scenario against which the other scenarios are compared, such as incomplete markets, wages as an endogenous variable, etc.

That is, it is the benchmarking of the results of the simulated scenarios, rural economies are hardly going to observe the assumptions of perfect competition and therefore they are only a reference in the analysis of market imperfections of the same, of missing markets or market failures in rural economies considered as a whole.

Normally, the economy of a rural community or town is considered to be simple, since a few production accounts are supposed to reflect its productive structure. Despite this, peasant peoples in general show a dense network of relationships that reveal robust economic diversity. Links with the exterior, the distribution patterns of the labor force, the use of factors of production, the exchanges between institutions are clear examples of the complexity that distinguishes them.

Methodologically, the modeling of the economic relations of the rural town of Bajitos de la Laguna was added in five major accounts; namely: 1) production activities; 2) factors of production; 3) institutions; 4) capital; and 5) rest of the world (those that capture the relations of the people with the rest of the region and the country).

Once the social accounting matrix of the study locality was balanced, the functional forms of the utility and production functions were selected. Leontief and Cobb-Douglas functions were used in the GAMS program. The calibration of the parameters of these two functions was performed with the existing information in the social accounting matrix.

Calibration of the general equilibrium model of a simple economy, characteristic of rural communities, refers to the derivation of the parameters of the behavioral equations of rural economic agents from the existing information in the social accounting matrix or the use of econometric estimates from pre-existing research, so that the base case is a solution of the model.

Results and discussion

This section presents the results obtained from the application of the methodology of the household models to the community of Bajitos de la Laguna, municipality of Tecpan de Galeana, Guerrero.

Policy experiments

5% drop in the price of basic goods

In this experiment it is assumed that the prices of basic goods (or a mixture thereof) produced by the family unit are reduced by 5%. The effects on the fundamental variables of the model due to the effects of the general equilibrium are analyzed.

In the case of the so-called basic goods, a series of productive activities are grouped, such as the production of corn, beans, vegetables produced in the solar, minor livestock species that are used for the own feeding of the family nucleus, exchanged or 'commercialized' between the community homes. The results of this policy experiment are shown in Table 1.

Table 1. Experiment of a 5% drop in the price of basic goods.

Impacted variables	(A)	(B)
	Perfect markets	Endogenous wages
	Model closing rule	
Production		
Basic crops	-17.55	-17.55
Commercial crops	na	na
Demand for factors		
Family labor	-21.67	-21.67
Household income	-3.01	-3.01
Consumer demand		
Basics	2.1	2.1
Commercial	3.01	3.01
Market	-3.01	-3.01
Leisure	-3.01	-3.01
Marketed surplus		
Basics	-23.32	-23.32
Commercial	17.65	0.09
Market demand		
Market consumer goods	-3.01	-3.01
Workforce	0	na

na= not apply. Compiled from GAMS outputs, Taylor (2003).

In this scenario of perfect markets, it is observed that the quantity produced of the basic ones falls sharply (17.55%). This occurs because the value of the marginal product of the factors in this sector decreases. With market-determined prices for all goods and fixed capital inputs, the effects of the change in the price of basic goods on other sectors of production are null.

Because the household economy is highly diversified, the fall in the price of basic goods affects household income, which in this case falls 3.01%. The change in the price of basic goods influences the interaction of the household with the market. With wages being set by the market, the demand for family labor falls by 21.67%.

In addition to reducing production, the lower price of basic goods stimulates consumer demand for basic goods by 2.1%. Basic traded surplus falls 23.32% (Table 1). The negative effect on demand for traded goods reflects the agricultural-non-agricultural ties in Mexico. This "jumps" the effects of the change in rural income to other sectors of the regional or country economy.

However, in this case the surplus of traded goods increases sharply (17.65%). In this scenario, it is observed that consumer goods purchased in the market fall by -3.01% while the demand for labor in the market does not change (0%).

Column (B) reports the impacts of the change in the prices of basic goods when the agricultural household lacks access to the labor market, that is, the value of family time is reflected in a 'shadow wage' that it is determined internally in the family production unit (agricultural household). The community of Bajitos de la Laguna is characterized by using mainly family labor (63%) and only a third of hired labor (37%) to carry out productive activities and produce a significant proportion of food for the consumption.

As can be seen in column (B), the simulation shows that the community is almost insensitive to the existence or not of the labor market since the results are identical to those of when the neoclassical assumption of perfect markets and reduction of the price of basic goods is assumed by 5%. In this case, the exception is the marketed surplus of commercial goods produced in the community, since in this the change is almost null (0.095).

Decrease in basic prices and a direct transfer to income

Under the population's poverty reduction strategy, an alternative to the so-called support for productive projects or food subsidies purchased in the market, a non-distorting alternative to the market is the scheme of direct transfers to the income of producers. This policy experiment simulates a drop in the price of basic goods and simultaneously a direct compensation to income, based on the cultivated area of basic in previous cycles, of the producers of the studied locality.

Table 2 shows the effect of a 5% decrease in the price of basic goods combined with a 10% transfer of the value of basic production in the year in which the information from the social accounting matrix was collected.

Table 2. Experiment of decrease in the price of basic goods by 5% and a direct transfer to income.

Impacted variables	(C)	(D)
	Perfect markets	Endogenous wages
	Model closing rule	
Production		
Basic crops	-17.55	-17.55
Commercial crops	13.11	na
Demand for factors:		
Family labor	-21.67	-21.67
Household income	6.74	6.74
Consumer demand		
Basics	12.35	12.35
Commercial	6.74	6.74
Market	6.74	6.74
Leisure	6.74	6.74
Marketed surplus		
Basics	-26.33	-26.33
Commercial	6.74	-0.19
Market demand		
Market consumer goods	6.74	6.74
Workforce	0	0

na= not apply. Compiled from GAMS outputs, Taylor (2003).

The direct effects of this policy experiment on the farm household economy are twofold. First, analogous to the previous experiment, lower basic prices induce agricultural households to shift basic production to activities other than the production of these basic crops. Second, the income transfer jumps the household budget constraint outward, increasing the demand for normal goods.

In scenarios (C) and (D), a decline in the production of basic goods plus a positive transfer of income over demand reduces the marketed surplus by a slightly greater amount than in the case of scenario (A). In the case of perfect markets, the effect on production is identical in case (C) and (A), production falls by 17.55 respectively in both scenarios.

With all exogenous home prices, there is no mechanism to create a link between income transfers and the production side of the model; that is, the model is recursive or separable. In the case of the incomplete labor market (scenario D), however, shadow wages create a link between the consumption side and the production side, transferring influences from the transfer of income to production. This can be seen by comparing the effects of production in column (B) of Table 1 with column (D) of Table 2. The payment of a direct transfer to income, by contributing to household income, increases the demand for leisure.

This helps mitigate the negative effect of the price drop on the family's wages. With a higher family income in this second scenario, the negative effects on basic production are greater and the positive effects on other production are less.

Because the household adjusts its production in response to the change in the price of basic goods, the payment of the transfer to income is offset by the adverse effects of the change in price in the perfect market scenario. The complete or total household income increases by 6.74%. However, in the case of lost markets (column D), depressed wages reduce the value (shadow) of the family's time endowment, which is reduced by 21.67%.

Transfers to income without falling prices of basic goods

The third policy experiment explores the impact of direct transfer to producer income without changing the price of basic goods; that is, a rural income policy is simulated. The transfer to income is identical to that of the second counterfactual scenario. Because the price of basic goods does not change in this experiment, a closed market scenario for basic goods can also be considered in addition to the scenarios of perfect markets and non-existent labor. The results of this pure transfer experiment appear in Table 3.

Table 3. Transfers to income without falling prices of basic goods.

Impacted variables	(E)	(F)	(G)
	Perfect markets	Endogenous wages	Closed basic market
Production			
Basic crops	0	-3.96	-1.75
Commercial crops	0	0	0
Demand for factors			
Family labor	0	-3.96	-2.21
Household income	9.74	9.74	7.69
Consumer demand			
Basics	9.74	9.74	8.2
Commercial	9.74	9.74	7.69
Market	9.74	9.74	7.69
Leisure	9.74	9.74	7.69
Marketed surplus			
Basics	-2.86	-2.86	-3.08
Commercial	-0.28	-4.35	7.69
Market demand			
Market consumer goods	9.74	9.74	7.69
Workforce	4.25	na	0

na= not apply. Compiled from GAMS outputs, Taylor (2003).

In the case of the recursive version of the model (column E), transfers have no effect on the production side, but they do increase the demand for normal goods, including basic goods (9.74%). The traded surplus (by -2.86% in basic and -0.28% in traded) decreases due to a higher demand for basic.

A higher income stimulates the demand for leisure (in this case 9.74%). In order to maintain their production levels, it would be expected that households should hire more labor in the market. Although the total demand for labor, as well as production, is not affected, in the empirical verification it could be increased.

According to the theoretical model, in scenario (F), in which a direct transfer to income has been injected (10% of the value of the production of the agricultural productive activity, $2 871 in this case), it is expected that the an agricultural household cannot hire labor in the market that would increase the demand for leisure while maintaining constant production.

The production of basic goods falls 3.96% and there is no change in the production of commercial goods. In the case of scenario (G), which assumes an incomplete (absent or lost) market for basic goods, the effect of the transfer on demand does not change household wages and households reduce basic production by 1.75%. In other words, in this case, if the policy was to reduce the production of basic goods, it succeeds, just as models 'predicted' it (simulating the opening of the Mexican economy. This contrasts with many of the works of Taylor (2003) and several other authors who have found the opposite, that is, when implementing a policy of direct transfers to income (with the assumption of scenario G, rather than perfect markets).

In small communities with heterogeneous and diversified rural economies, such policies could have the opposite effect to that pursued, since agricultural households or peasant units increase their production of basic goods, rather than reduce it. In this scenario, however, with the direct transfer to income, basic production is reduced by 1.75%. The demand for household factors decreases 2.21%. Household income increases 7.69%. Household consumption demand increases basic demand 7.69%.

Finally, the marketed surplus of basic goods decreases 2.86%, while that of goods produced for the purpose of being sold or marketed increases 7.69%. In addition, the demand for goods purchased in the market, for household consumption, increases 7.69%, while the market demand for labor is not affected.

Conclusions

The conclusions derived from the three policy experiments correspond to a community with its own characteristics of an economy made up of peasant units. The community of Bajitos de la Laguna is characterized by a high use of family labor, producing for self-consumption in a significant proportion, have a diversified production structure, cattle on land, logging activities, as well as food and beverages and services trade activities. Payment to capital for the provision of machinery rental or rental services is almost non-existent.

In this context, results of the simulated policy scenarios allow us to highlight the following effects on the economy of the studied community. In the scenario of a 5% drop in the price of basic goods and under the assumption of perfect markets, the surplus sold of commercial goods sent to the market increases 17.65%, while under the assumption of endogenous wages it only increases 0.09%.

In the scenario of a 5% drop in the price of basic goods and a simultaneous direct transfer to income in the amount of 10% of the value of purely agricultural production, and under the assumption of perfect markets, the surplus sold of commercial goods grows 6.74 % while the basic surplus falls in a significant proportion (26.33%).

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