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THE TECHNICAL ASSISTANCE SPECIAL FUND AND AGRICULTURAL CREDIT GUARANTEE AND FINANCIAL SERVICES

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ABSTRACT

The objective of this study is to analyze the impact of the Technical Assistance Special Fund and Agricultural Credit Guarantee (FEGA) on the total portfolio of credits granted to the agriculture, livestock, forestry and fishing sectors, in the occupied population of the primary sector and the Trimester Indicator of State Economic Activity (ITAEE), during the 2015 to 2017 period. To fulfill the objective, three models were estimated from panel data, both of fixed effects and of variable effects; two of them analyze the impact of FEGA on the total portfolio of credits granted to the agriculture, livestock, forestry and fishing sector at the state level, two examine the impact of FEGA on the occupied population of the primary sector, and two analyze the impact of FEGA on the ITAEE. The results indicate that FEGA does not have an impact on the ITAEE in the occupied population of the primary sector and the total portfolio of the credits granted to the agriculture, livestock, forestry and fishing sector at the state level. The study concludes that the strategies that FEGA uses to facilitate financial services do not affect the agriculture, livestock, poultry sectors, agroindustry, fishing and other activities related to the rural sphere.

Keywords: credit for the rural sector, employment in the primary sector, government backing, lack of capital, rural sector.

INTRODUCTION

The agriculture and livestock sector and other rural sectors in Mexico face several challenges, such as globalization and international competition, increasing their production and modernization. Some of the main challenges of the Mexican farmland are lack of capital and access to financial services, mainly credit, which would allow producers to invest and with that, to modernize, develop, increase their production and face competition (Saavedra, 2012; Buendía *et al.,* 2016).

To illustrate the problem that granting credits to the agriculture, livestock, forestry and fishing sector represents, it should be mentioned that from July 2009 to February 2024, the sector received on average only four percent of the total portfolio of current credits granted to the private sector by commercial banking. It should be mentioned that in the same period, the manufacturing sector attained 23% of the current credits from commercial banking, followed by the construction sector with an average of 18% (Banco de México-BANXICO, 2024). These data support the problem of credit for the agriculture, livestock, forestry, and fishing sectors.

In face of the lack of capital and access to credit in the rural sectors, the government implemented various programs, plans and policies, among them PROCAMPO and Trusts

Funds for Rural Development (FIRA). These instruments seek to contribute to producers of the farming sector gaining access to financial capital (Saavedra, 2012; Buendía *et al.,* 2016).

FIRA seeks to contribute to the sectors of agriculture, livestock, poultry, agroindustry, fishing and other activities related with the rural sphere to have access to credit, discount and granting of credit guarantees so that they can invest, develop and contribute to these sectors, with more resources (De la Vega *et al*., 2014; FIRA, 2023; Saavedra, 2012; Buendía *et al*., 2016). FIRA is made up by four funds: *Fondo de Garantía y Fomento para la Agricultura, Ganadería y Avicultura* (FONDO), *Fondo Especial para Financiamientos Agropecuarios* (FEFA), *Fondo Especial de Asistencia Técnica y Garantía para Créditos Agropecuarios* (FEGA) and *Fondo de Garantía y Fomento para las Actividades Pesqueras* (FOPESCA). FEGA (Technical Assistance Special Fund and Agricultural Credit Guarantee) provides credit guarantees, subsidies and other financial services, through multiple bank institutions, such as Limited Object Financial Societies, or directly, to individuals or businesses in the agriculture, livestock, forestry, fishing and agroindustry sectors, and others from the rural sphere (Cuenta pública, 2014).

The problems of access to financial services, such as credits, are not only those from the farming sector and other activities related with the rural environment, but rather affect every sector of Mexico's economy, because banks are focused on activities that give them higher profits and which entail fewer risks, and avoid granting credits to small-scale producers or sectors that they consider high-risk (Peña and Ríos, 2013; Rivera and Bernal, 2018; Gómez *et al*., 2018). The lack of capital and financial services, such as credit, prevents the agriculture, livestock, forestry, fishing, agroindustrial sectors, and others in Mexico's rural sphere from having a higher growth and negatively impacts growth and economic development. This situation also affects negatively job creation and the improvement in the quality of employment in those sectors (Mora, 2017; Bertoni *et al*., 2019; Timbila *et al*., 2020).

The objective of this study was to analyze the impact of FEGA on the total portfolio of credits granted to the agriculture, livestock, forestry and fishing sectors in the occupied population of the primary sector and the Trimester Indicator of State Economic Activity (ITAEE) during the 2015 to 2017 period. The research hypothesis was that FEGA impacts the total portfolio of credits granted to the agriculture, livestock, forestry and fishing sectors in the occupied population of the primary sector and in the ITAEE from 2015 to 2017, which is based on the literature review presented in the next section.

THEORETICAL FRAMEWORK

The agriculture, livestock, poultry, agroindustry, fishing sectors and other activities related to the rural sphere in Mexico have had problems of lack of capital and access to financial services, mainly credit. Likewise, in these sectors, there is a constant need for capital due to the payment schemes that producers can have (Mora, 2017; Bertoni *et al.,* 2019; Timbila *et al*., 2020). It should be mentioned that agricultural producers during the production

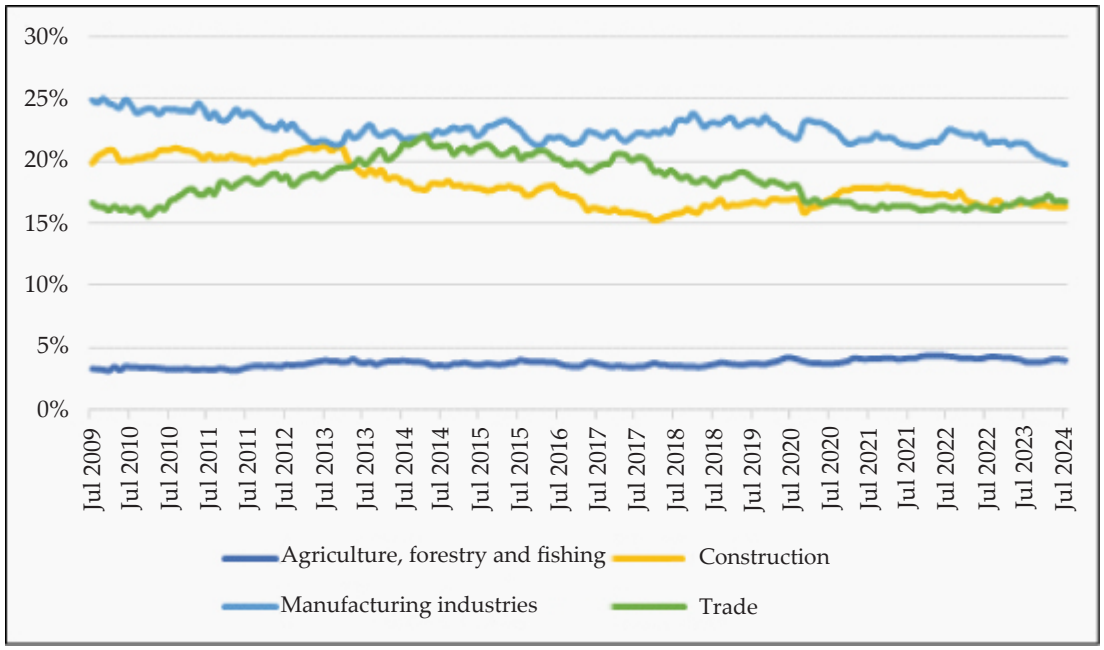
and collection period, require covering different costs –such as day workers' payroll, plant care, maintenance of machinery and infrastructure, etc.– and during this period, they tend not to have income (Cotler, 2015; Escalante *et al.*, 2013; Saavedra, 2012; Cuenta pública, 2014).

In addition, the sectors related to the rural sphere, such as agriculture, have different problems in gaining access to credit, and in order to be candidates for credit they are assessed in matters such as type of crop, land ownership, and value of the properties and assets that petitioners own. It should be highlighted that farmers who have permanent crops and large extensions of land will more easily gain access to credit, compared to seasonal producers and those with smaller land extensions (Echevarría *et al.*, 2017).

However, in general, the agriculture, livestock, poultry, agroindustry, fishing sectors and other activities related to the rural sphere in Mexico have had problems gaining access to credit, and as Figure 1 shows, it is among the sectors that have had the least current credits from July 2009 to February 2024.

Figure 1 shows that the sectors with most current credits were the manufacturing sector, followed by the construction sector (BANXICO, 2024).

In addition, the financial sector in Mexico has multiple problems that affect access to its services, aggravating the situation of the agriculture, livestock, poultry, agroindustry, fishing sectors and other activities related with the rural sphere in Mexico, in order to gain



Source: prepared by authors based on BANXICO (2024).

Figure 1. Commercial credits given to the agriculture, forestry and fishing sectors; construction; manufacturing industries and trade.

access to credit, such as a low level credit-granting compared to other countries, interest rates that are not very competitive, and low financial inclusion of some segments of the population (Peña and Ríos, 2013; Almeraya *et al.*, 2011; Rivera and Bernal, 2018).

In this sense, the Mexican government has attempted to solve such problems through programs, plans, policies or funds. This is where the Trusts Funds for Rural Development (FIRA) stands out, which is an institution created by the Mexican government in 1954. It has the aim of contributing to agriculture, livestock production, poultry production, agroindustry, fishing and other activities related to the rural sphere, having access to credits, discounts and granting credit guarantees, with the objective of developing the agricultural and livestock sector and having a positive impact on the producers, the economy and labor (De la Vega *et al.*, 2014; FIRA, 2023).

Likewise, FIRA works in collaboration with other financial entities, both from the public and the private sector, to broaden the reach of their services and to guarantee access to financing for those who participate in farming activities (De la Vega *et al.*, 2014; FIRA, 2023).

It should be pointed out that the Technical Assistance Special Fund and Agricultural Credit Guarantee (FEGA) was created in 1972 and is part of FIRA. FEGA has the aim of granting individuals of businesses from the agriculture, livestock, forestry, fishing, agroindustry sectors and other sectors in the rural sphere, credit guarantees, subsidies, and other financial services, through multiple banking institutions or directly (Cuenta pública, 2014; Saavedra, 2012; Buendía *et al.*, 2016). In this sense, the Mexican government has sought to support the agriculture, livestock, poultry, agroindustry, fishing sectors and other activities related to the rural sphere. An example is PROCAMPO, which was one of the largest subsidiaries of the Mexican government, although, for multiple causes, among them bad credit management, it ended its operations (Saavedra, 2012; Buendía *et al.*, 2016).

In addition, the lack of capital and of financial services such as credit, prevents the agriculture, livestock, forestry, fishing, agroindustry sectors and other sectors from the rural sphere in Mexico from having a greater growth, which negatively affects the economic development of the country and the creation and conditions of employment in the primary sector in Mexico (Padilla and Fenton, 2012; Ketterer *et al.*, 2017; Saavedra, 2016).

The relationship between credit and economic growth emerges because, when there is access to credit, producers from the different economic sectors such as those pointed out previously, can invest more, so that they can take advantage of the variations in demand and prices caused by economic growth. That is, when there is economic growth, the demand of consumers for producers of the different economic sectors increases, which causes an increase in the prices of products, making it attractive for producers to increase their production (Tercero *et al.*, 2020; López *et al.*, 2018; Martínez *et al.*, 2021).

Likewise, when producers increase their productive investments they impact the growth of the different productive sectors and the amount of labor they generate, because

employment is generated when investments are increased (Clavellina, 2013; Barriga *et al*., 2018). It should be mentioned that the funds for promotion, programs, plans or policies destined to giving resources to the different sectors of the economy through credits with favorable conditions with the objective of development, has been an object of study to determine their impact. These studies have reached various conclusions, one of them is that if they are not carefully managed, they can reach a high expired credit portfolio that will make them unsustainable in time (Castaño and Cardona, 2013).

In addition, it has been pointed out that these programs, plans or policies have an important impact on the sectors that they are directed to. However, there are those who mention that they could have a greater impact if a series of actions are implemented to improve their administration, if they were constantly evaluated or had a better implementation mechanism. There are also those who point out that there are other ways of helping the farming sector, highlighting the program for training and access to fertilizers and seeds (Castaño and Cardona, 2013). For Pedroza (2014) and Cruz and Polanco (2014), who studied the development banking system in Mexico, they indicate that these programs have a significant impact on the sectors to which they are destined, such as the farming sector, although care must be taken to manage the expired credit portfolio and the risks.

In this sense, De la Torre *et al*., (2016), Guevara *et al*., (2018) and Peña and Hoyo (2014) point out that the problem of the guarantee funds, such as FEGA, is that they are granted through private institutions, which is why there are producers who cannot gain access to such funds, because they do not comply with the requirements that private institutions demand, such as mortgage guarantees. In addition, the authors indicate that private financial institutions in Mexico consider very risky and unattractive granting loans to agriculture, livestock, poultry, agroindustry, fishing sectors and other activities related with the rural sphere, since they are long-term projects where the risk is higher than in other areas such as manufacture. In addition, Bedendo and Bruno (2012) studied the credits in the United States destined to economic sectors, indicating that access to such funds positively impacts these sectors.

METHODOLOGY

The main objective of this study was to analyze the impact of FEGA on the total portfolio of credits granted to the agriculture, livestock, forestry, and fishing sectors, in the population occupied from the primary sector and in the ITAEE, during the 2015 to 2017 period. To achieve the objective set out, the following were analyzed through six panel data models, three with fixed effects and three with variable effects: the relationship between FEGA at the state level and the total portfolio of the credits given to the agriculture, livestock, forestry and fishing sectors, the occupied population of the primary sector (agriculture, livestock production, forestry, hunting and fishing) by state, and the Trimester Index of State Economic Activity (ITAEE) from 2015 to 2017.

The FEGA database by state was extracted from the website of Government Data (2023), while the Trimester Indicator of State Economic Activity (ITAEE) was taken from the

National Institute of Statistics and Geography (INEGI, 2023 a). In turn, the occupied population rate from the primary sector at the state level was obtained from the INEGI website (2023 b); and lastly, the total portfolio of credits granted to the agriculture, livestock, forestry and fishing sector at the state level was obtained from the Banco de México website (BANXICO, 2023).

The data are at the state level from the 32 federal states in Mexico; they are trimester data and cover the period of 2015 to 2017. Likewise, aggregated data were taken and they could not be separated by type of producer, such as seasonal and risk farmers. With the data mentioned and based on the theoretical framework, it will be determined whether FEGA, as entity that supports access to financial services, had an impact on the total portfolio of credits granted to the agriculture, livestock, forestry, and fishing sector at the state level. In addition, the impact of FEGA on the ITAEE will be established. Lastly, the impact of FEGA on the occupied population from the primary sector (agriculture, livestock production, forestry, hunting and fishing) at the state level was determined.

Panels data models

To estimate the six panel data, the procedure presented by Gujarati and Porter (2010) was used, and the Eviews software was employed. According to them, before estimating the panel data models, it should be established that the series of time of the variables do not have unit roots, and this is why the unit root test by Levin, Lin and Chu was carried out (Gujarati and Porter, 2010), with the four variables.

Once the Levin, Lin and Chu test was applied, the *p* value was examined with an alfa of 0.05. It should be highlighted that this test has the main characteristic of assuming a common coefficient, $a_{ij}=p$-1, where the decision criterion is that if the value is lower than $a_{ij}=p$-1=0.05, then the null hypothesis is rejected which states that there is a unit root in the variables used in the study, and therefore, the alternative hypothesis is accepted which assumes that there is not a unit root in the variables (Gujarati and Porter, 2010).

Once it has been confirmed that the variables do not have unit roots, the next step is to estimate the six panel data models that will be conducted and which are presented in Equations 1, 2, 3, 4, 5 and 6.

$$Y = \beta_1 + \beta_2 X_{it} + v_{it} + u_{it} \quad (1)$$

In Equation 1 Y represents the total portfolio of credits given to the agriculture, livestock, forestry and fishing sector at the state level; β_1 is the value of the intercept; β_2 is the vector of the parameter X_{it}; X_{it} is the amount of guarantee of FEGA for a state i in time t; v_{it} is the fixed value for a state i in a time t; u_{it} is the error of the model throughout time.

$$Y = \beta_1 + \beta_2 X_{it} + v_{it} + u_{it} \quad (2)$$

In Equation 2 Y represents the occupied population of the primary sector (agriculture, livestock production, forestry, hunting and fishing) at the state level; β_1 is the value of the intercept; β_2 is the vector of the parameter X_{it}; X_{it} is the amount of guarantee from FEGA of a state i in time t; v_{it} is the fixed value for a state i in time t; u_{it} is the error of the model throughout time.

$$Y = \beta_1 + \beta_2 X_{it} + v_{it} + u_{it} \quad (3)$$

In Equation 3 Y represents the ITAEE; β_1 is the value of the intercept; β_2 is the vector of the parameter X_{it}; X_{it} is the amount of guarantee of FEGA from a state i in time t; u_{it} is the fixed value for a state i in time t; u_{it} is the error of the model throughout time.

$$Y = \beta_1 + \beta_2 X_{it} + v_{it} + u_{it} \quad (4)$$

In Equation 4 Y represents the total portfolio of the credits granted to the agriculture, livestock, forestry and fishing sector at the state level; β_1 is the value of the intercept; β_2 is the vector of the parameter X_{it}; X_{it} is the amount of guarantee of FEMA for a state i in a time t; v_{it} is the random value for a state i in time t; u_{it} is the error of the model throughout time.

$$Y = \beta_1 + \beta_2 X_{it} + v_{it} + u_{it} \quad (5)$$

In Equation 5 Y represents the occupied population of the primary sector (agriculture, livestock production, forestry, hunting and fishing) at the state level; β_1 is the value of the intercept; β_2 is the vector of the parameter X_{it}; X_{it} is the amount of guarantee of FEGA of a state i in a time t; v_{it} is the random value for state i in a time t; u_{it} is the error of the model throughout time.

$$Y = \beta_1 + \beta_2 X_{it} + v_{it} + u_{it} \quad (6)$$

In Equation 6 Y represents the ITAEE; β_1 is the value of the intercept; β_2 is the vector of the parameter X_{it}; X_{it} is the amount of guarantee of FEGA from a state i in a time t; v_{it} is the random value for a state i in time t; u_{it} is the error of the model throughout time.

The regression models with panel data shown in Equations 1, 2 and 3 (with fixed effects) and Equations 4, 5 and 6 (with random effects) have a time period of July 2015 to December 2017 with trimester data. It should be pointed out that the difference between Equations 1, 2 and 3 and Equations 4, 5 and 6 emerges from the treatment received by the random value v_{it}; in Equations 1, 2 and 3, its effect is fixed, and in Equations 4, 5 and 6, its effect is random.

Once the Equations 1, 2, 3, 4, 5 and 6 are estimated, the value R^2 and the Durbin-Watson statistic will be analyzed, with the aim of validating the model. If the R^2 value is higher than 0.75, it is considered that the model is significant and valid, according to Gujarati and Porter (2010). Likewise, if the Durbin-Watson statistic is higher than the critical values (with K value and n), then, it is determined that there are no problems of autocorrelation in the models. Once it has been established that the models are valid and that there are no problems of autocorrelation, the next step is to examine the p value (with alfa of 0.05) of the vectors of parameter $X_{it}(\beta_2)$ of all the Equations, with the aim of examining the relationship between the variables analyzed in the six models.

If in Equations 1 and 4 the p value of the parameter $X_{it}(\beta_2)$ is lower than 0.05, it is confirmed that FEGA for a state i in a time $t(X_{it})$, affects the total portfolio of the credits granted to the agriculture, livestock, forestry and fishing sector at the state level (Y).

If in Equations 2 and 5, the p value of the parameter $X_{it}(\beta_2)$ is lower than 0.05, it is confirmed that FEGA for a state i in a time (X_{it}), impacts the occupied population of the primary sector (agriculture, livestock production, forestry, hunting and fishing) at the state level (Y).

If in Equations 3 and 6, the p value of the parameter $X_{it}(\beta_2)$ is lower than 0.05, it is confirmed that FEGA for a state i in a time (X_{it}), affects the ITAEE (Y).

Once the six models panel data have been estimated and analyzed, three Hausman tests will be carried out, following the procedure described by Gujarati and Porter (2010), to determine whether the models of fixed or random effects are the most adequate to analyze the relationships between the variables. One of the Hausman tests will compare the models of Equations 1 and 3, another the models of Equations 2 and 4, and the last will compare the models of Equations 5 and 6. In the three tests, the p value of the test statistic will be analyzed, which has an asymptotic distribution x^2 with an alfa value of 0.05.

It should be pointed out that when the p value is lower than 0.05, it can be stated that the estimators of the panel data model with fixed effects are not equal to those with random effects and, therefore, the most adequate model to analyze the relationships is that of fixed effects. Likewise, if the p value is higher than 0.05, it can be stated that the estimators of the panel data model with fixed and random effects are equal and that the most adequate model is that of random effects. Lastly, three redundancy tests of fixed effects will be carried out to strengthen the analysis.

RESULTS

Next, the results of the Levin, Lin and Chun unit root tests of the variables examined are presented (Table 1), and they are: FEGA at the state level, total portfolio of the credits granted to the agriculture, livestock, forestry and fishing sector at the state level, occupied population of the primary sector (agriculture, livestock production, forestry, hunting and fishing) at the state level, and the ITAEE.

Table 1 shows that the variables do not have unit roots, because the p values of the Levin, Lin and Chun tests of the four variables are lower than 0.5, so the null hypothesis that there

Table 1. Unit root tests.

Variable	*p* Value
Total portfolio of credits granted to the agriculture, livestock, forestry and fishing sector at the state level.	0.002
ITAEE	<0.001
FEGA at the state level	<0.001
Occupied population of the primary sector (agriculture, livestock production, forestry, hunting and fishing) at the state level.	<0.001

Source: prepared by the authors.

is a unit root in the variables used in the research is rejected, and therefore, the alternative hypothesis that assumes that there is not a unit root in the variables is not rejected.
Because the variables do not have unit roots, the next step is to estimate the six panel data models, three with fixed effects and three with variable effects. The results of these models are presented next (Table 2).

Table 2. Panel data models.

Variable	FEGA with the ITAEE		FEGA with the occupied population of the primary sector (agriculture, livestock production, forestry, hunting and fishing)		FEGA with the total portfolio of the credits granted to the agriculture, livestock, forestry and fishing sector at the state level	
	Panel data model with fixed effects	Panel data model with random effects	Panel data model with fixed effect	Panel data model with random effects	Panel data model with fixed effect	Panel data model with random effects
Beta value of FEGA	-0	-0	0	-0.07	-0	-0
Beta value of the constant.	112.499	112.407	21,1940	21,3042.2	1,971.541	1,962.218
Standard error of FEGA.	0	0	0.083	0.078	0.001	0
Standard error of the constant.	2.221	5.098	1,729.36	34,925.35	33.811	307.617
t-statistic of FEGA.	-0.107	-0.059	0.024	-0.889	-0.431	-0.059
t-statistic of the constant.	50.649	22.046	122.554	6.099	58.309	6.378
p value of FEGA	0.914	0.952	0.98	0.374	0.666	0.952
p value of the constant	0	0	0	0	0	0
R^2	0.366	0	0.992	0.002	0.968	0
Durbin-Watson	2.629	2.42	1.682	0.013	1.665	0.801

Source: prepared by the authors.

Table 2 shows that the R^2 of most of the models are lower than 0.75, with the exception of the models with fixed effects of FEGA with the occupied population of the primary sector at the state level and of FEGA, with the total portfolio of the credits granted to the agriculture, livestock, forestry and fishing sector at the state level, which invalidates most of the models proposed. Likewise, most of the Durbin-Watson values of the models are higher than the critical value of 1.664 (with n of 200 and k value of 1). The only exceptions are the models with random effects of FEGA with the occupied population of the primary sector at the state level and of FEGA with the total portfolio of the credits granted to the agriculture, livestock, forestry and fishing sector at the state level.

Despite the results of R^2 obtained and the Durbin-Watson test, the p values of the FEGA variable of the six models were analyzed. With the analysis of the p values, it was observed that in the six models of the panel data, the p value is higher than 0.05 (Table 2), which implies that there is no individual significance in the explanation of the three variables analyzed. That is, the FEGA does not have an impact at the state level in the ITAEE, in the occupied population of the primary sector (agriculture, livestock production, forestry, hunting and fishing), or in the total portfolio of the credits granted to the agriculture, livestock, forestry and fishing sector at the state level.

To strengthen the analysis, the results of the Hausman test are presented next (Table 3).

As Table 3 shows, the p value of the Hausman test of the panel data model of FEGA with ITAEE indicates that the estimator of the of panel data model with fixed effects is equal to the model with random effects, because the p value is higher than 0.05; therefore, the most adequate panel data model to analyze the relationships is that of random effects. However, because the panel data models with fixed effects did not have correlation problems and the models with fixed effects of FEGA with the occupied population of the primary sector at the state level and of FEGA with the total portfolio of the credits granted to the agriculture,

Table 3. Hausman test.

Model	Variable	Fixed	Random	Var (Diff.)	p value of x^2
FEGA with ITAEE	FEGA	0	-0	0	0.855
FEGA with the occupied population of the primary sector (agriculture, livestock production, forestry, hunting and fishing).	FEGA	-0.075	-0.07	-0	NA
FEGA with total portfolio of the credits granted to the agriculture, livestock, forestry, and fishing sector at the state level.	FEGA	-0	-0	0	NA

Source: prepared by the authors.

Table 4. Redundancy tests of fixed effects.

Section of the panel data	FEGA with ITAEE		FEGA with occupied population of the primary sector (agriculture, livestock production, forestry, hunting and fishing)		FEGA with total portfolio of the credits granted to the agriculture, livestock production, forestry, and fishing sector at the state level	
	Statistic	p Value	Statistic	p Value	Statistic	p Value
Crossed F section	0	0	0	0	0	0
Chi-squared crossed section	2.10	0	976.385	0	210.561	0
F period	65.39	0	1343.864	0	923.95	0
Chi-squared period	9.20	0	2.275	0.023	7.874	0
Crossed section/F period	74.91	0	20.478	0.008	65.274	0
Crossed section/ Chi-squared period	3.62	0	784.794	0	170.331	0

Source: prepared by the authors.

livestock forestry and fishing sector at the state level had high R^2, the redundancy test of fixed effects was added (Table 4) to strengthen these models.

As Table 4 shows, in the three panel data models with fixed effects –FEGA with ITAEE, FEGA with occupied population of the primary sector at the state level, and FEGA with total portfolio of credits granted to the agriculture, livestock, forestry and fishing sector at the state level–, the fixed element was not redundant, because the *p* values, both *F* and *Chi* of the crossed section, period and crossed/period, are lower than 0.05 in every case, which indicates that the fixed effects in the three models must be taken into account for the analysis of the relationship between variables.

DISCUSSION

Based on the results obtained and presented in the previous section, it can be established that the panel data models with fixed effects of the occupied population of the primary sector and the total portfolio of the credits granted to the agriculture, livestock, forestry and fishing sector at the state level, are valid, due to the R^2 values and because there is no evidence of correlation on the Durbin-Watson value.

Likewise, FEGA does not have an impact on the occupied population of the primary sector and on the total portfolio of credits granted to the agriculture, livestock, forestry and fishing sector at the state level. In addition, the panel data models with fixed effects point out that FEGA also does not have an impact on the ITAEE; this is despite it having a low R^2 value, although there are no correlation problems. It should be added that the three panel data models with fixed effects were strengthened with redundancy tests of fixed effects, which showed that the fixed effect is not redundant, and therefore, it should be taken into account.

In addition, in the three panel data models with random effects, low R^2 values were obtained. Also, in the FEGA models with the occupied population of the primary sector at the state level and of FEGA with the total portfolio of credits granted to the agriculture, livestock, forestry, and fishing sector at the state level, there is evidence of correlation. However, there is no correlation of FEGA with the ITAEE. The results of the panel data models with random effects imply that FEGA does not impact the ITAEE, in the occupied population of the primary sector at the state level and in the total portfolio of the credits granted to the agriculture, livestock, forestry and fishing sector at the state level. This strengthens the findings obtained in the panel data models with fixed effects.

What has been expressed in previous paragraphs shows that FEGA has not had a significant effect on the credits granted to the primary sector; that is, FEGA has not contributed to taking financial services of credit to agriculture, livestock production, poultry production, agroindustry, fishing and other activities related to the rural sphere, which is the reason why it was created (De la Vega *et al.*, 2014; FIRA, 2023). In other words, FEGA, which is one of the strategies that FIRA has used, has not reached its objective of significantly granting credit guarantees, subsidies and other financial services through multiple banking institutions or directly, reason why evidence has not been found of its impact on the total portfolio of credits granted to the agriculture, livestock, forestry and fishing sector at the state level.

What has been suggested earlier is supported because no evidence was found of FEGA significantly impacting the occupied population of the primary sector at the state level or in the ITAEE. That is, given that FEGA does not impact the access to credits granted to the agriculture, livestock, forestry and fishing sector at the state level, it does not stimulate the growth and the generation of employment of these sectors and, therefore, it also does not impact the ITAEE and the occupied population of the primary sector at the state level. In addition, results show that FEGA has not helped to decrease the problem of access to credit in the sectors mentioned, as has been mentioned by Cotler (2015); Mora (2017); Bertoni *et al.* (2019); Timbila *et al.* (2020); Escalante *et al.* (2013); Padilla and Fenton (2012); Saavedra (2012); Buendía *et al.* (2016). The problem of access to credit in the rural sphere has caused for the sectors mentioned to lack the necessary resources to have greater growth, to invest in infrastructure, and to modernize.

It should be highlighted that the results obtained in this study do not agree with the findings by Castaño and Cardona (2013), Pedroza (2014), and Cruz and Polanco (2014), who indicate that the programs, plans or policies such as FEGA have a positive impact on the primary sector; that is, they contribute to taking financial services of credit to agriculture, livestock production, poultry production, agroindustry, fishing, and other activities related to the rural sphere. The discrepancy found in this study with other previous studies can be attributed to what De la Torre *et al.* (2016) and Peña and Hoyo (2014) point out, when they suggest that the problem of guarantee funds, such as FEGA, is that they are granted through private institutions and that some producers cannot gain access to those funds because they do not fulfill the requirements that the institutions request.

The results from this study agree with what was suggested by Pedroza (2014) and Cruz and Polanco (2014), who indicate that for this type of actions to have a significant impact, they should be accompanied by other strategies, such as offering terms for access to this type of backing.

In addition, the limitation of economic resources in agriculture, livestock production, poultry production, agroindustry, fishing and other activities related with the rural sphere causes for these sectors not to have greater influence on the economy and in the generation of employment in Mexico, because producers from these sectors cannot carry out the investments that will allow them to increase their production, as has been pointed out by Cotler (2015), Mora (2017), Bertoni *et al*. (2019), Timbila *et al.* (2020), Escalante *et al*. (2013), Padilla and Fenton (2012), Ketterer *et al.* (2017), and Saavedra (2016).

Additionally, results from the study show that FEGA as a strategy to contribute to solve the problems of access to financial services and credits of the sectors mentioned has not had the expected success and that such a problem persists (Peña and Ríos, 2013; Almeraya *et al*., 2011; Rivera and Bernal, 2018; Gómez *et al*., 2018; Morales *et al*., 2013).

It should be mentioned that the problem that producers from these sectors have in order to gain access to financial services and credits is due to factors such as: the low rate of credit granting in Mexico compared to other countries, the approach of financial institutions in sectors that give them higher profits, aversion to risk, interest rates that are not very competitive, and low penetration of financial services such as credit (Peña and Ríos, 2013; Almeraya *et al.,* 2011; Rivera and Bernal, 2018; Gómez *et al*., 2018; Morales *et al*., 2013). This leads to Gutiérrez (2015), Domínguez and Marroquín (2016), Tercero *et al.* (2020), López *et al*. (2018) and Martínez *et al.* (2021) pointing out that access to credit influences growth. However, Clavellina (2013) and Barriga *et al*. (2018) mention that the sectors of agriculture, livestock production, poultry production, agroindustry, fishing and other activities related to the rural sphere do not have access to credit and, therefore, do not grow, which has a negative impact on employment, because when these sectors do not grow, no new jobs are generated and the labor conditions are also not improved.

It should be highlighted that the results obtained indicate that FEGA is not being successful in solving the problems of access to financial services and credits of the sectors to which it is directed, which has implications in the employment and economic growth of Mexico, which agrees with previous studies; this is why the programs that tend to improve and solve the problem of access to financial services and to credits must be reconsidered.

CONCLUSIONS

The objective of the study was to analyze the impact of FEGA on the total portfolio of credits granted to the agriculture, livestock, forestry and fishing sector, in the occupied population of the primary sector and in the ITAEE, during the 2015 to 2017 period. Likewise, the hypothesis was set out that FEGA impacts the total portfolio of credits granted to the agriculture, livestock, forestry and fishing sector, in the occupied population of the primary sector and in the ITAEE of that period.

To fulfill the objective and to contrast the hypothesis, three panel data with fixed effects and three with variable effects were estimated. From the six panel data, two analyzed the impact of FEGA on the level of credits granted to the agriculture, livestock, forestry and fishing sector by state, two examine the impact of FEGA in the occupied population of the primary sector at the state level, and two analyze the impact of FEGA on the ITAEE during the period of analysis at the state level.

The results suggest that FEGA has not had an impact on the level of credits granted in the sectors analyzed. Likewise, FEGA has not been impacted in the occupied population of the primary sector. In addition, FEGA also did not influence the ITAEE.

The results obtained in this study indicate that the strategies that FEGA has used to grant individuals or businesses from the agriculture, livestock, forestry, fishing, agroindustry sector and others from the rural sphere, that is, credit guarantees, subsidies and other financial services, through multiple banking institutions or directly, have not had the expected results. That is to say, FEGA has not been successful in solving problems of access to credit and to financial services in those sectors, which can be attributed to the problems of the financial sector in Mexico, such as financial exclusion and interest rates that are not very competitive.

In addition, based on the results obtained in the models used, the hypothesis set out that FEGA impacts the total portfolio of the credits granted to the agriculture, livestock, forestry and fishing sector in the occupied population of the primary sector and in the ITAEE during the period analyzed, is rejected.

It should be mentioned that, based on the literature review, for this type of actions to have a significant impact, it is necessary for them to be accompanied by mechanisms, policies, programs or plans that make it possible for producers to have access to these.

Among the limitations of this study, there is that only three years were examined and the sectors and states were not examined specifically. For future research lines, the suggestion is to use other tools from econometrics such as cointegration and to characterize each of the states and the sectors.

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