



Article

Food Autonomy within Food Sovereignty: Evidence from a Structural Model

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Abstract: Food sovereignty as a model to solve food problems is being used in political, economic, and agricultural thought, but academic literature does not offer insight into its impact and the dimension of food autonomy. We have chosen to study Ecuador, given that, in 2008, the country reformed its constitution and adopted the concept of food sovereignty as a right of the Ecuadorian people, being the first country to do so. In this article, we apply the multiple indicators and multiple causes model to uncover scientific findings with the observable data available, and estimate the phenomenon of food sovereignty, which will be called the latent variable. The article aims to determine the main indicators associated with a synthetic index of food sovereignty and one that integrates a measurement model. In order to meet the goal of this research, eight hypotheses are raised, of which four are confirmatory and four are exploratory. The exploratory hypotheses are given because the theoretical foundations contradict themselves in favor of and against the latent variable. The findings of the statistical model relate to inflation, cereal yield, agricultural-value added, prevalence of malnutrition, food export, and food import as causes and indicators that are part of food sovereignty.

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1. Introduction

In 2008, 821 million undernourished people were projected in the world, with 63% concentrated on the Asian continent and 31% on the African continent [1]. Latin America comprises 5% of undernourished people in the world, yet it can also be observed that, from 2010 to 2018, two million more people were added to this number [2]. This is of great concern to governments, academics, and control bodies. For this reason, key concepts are raised in the discussion on how to feed the world in a sufficient, sustainable, and healthy way, such as food sovereignty [3].

The concept of food sovereignty and its development through agroecology has gained strength in indigenous movements and, as such, it is used by political leaders in their speeches aiming to transform current food systems [4]. The world food system still concentrates on the vision of agribusiness, which includes food speculation, land grabbing, deterioration of the environment, and its impact on climate change [5].

Quantitative methods have not been thoroughly used in the subject of food sovereignty [4–6]; therefore, this will be one of the first studies involving multivariate analysis techniques, specifically a model of structural equations, relating the main direct effects of the hypothetical causes and control variables. From this type of analysis, a measure can be approximated to evaluate the applied public policies and infer the policies to be implemented, which would be the main focus of this article.

Ecuador is the first country to incorporate food sovereignty into its constitution [6], which justifies the design of a measurement model that analyzes the evolution of the implemented policies, originated by legal bodies that affect the economic structure, providing a unique opportunity to observe the changes in past and current food systems.

Following the initial concepts first put forward in 1996 by the NGO La Via Campesina and the World Food Summit Forum, food sovereignty has evolved by including the interests of a wide range of social groups and, at the same time, adapting to different regional and local contexts [7]. This prompted the Food and Agriculture Organization of the United Nations to incorporate food sovereignty as an alternative to achieve a world without hunger and poverty at the 32nd FAO Regional Conference for Latin America and the Caribbean, thus creating framework law on the right to food, security, and food sovereignty [8]. This framework law was approved at the XVIII Latin American and Caribbean Parliament Ordinary Assembly, from November 30 to December 1, 2012, in Panama City [9].

At present, several authors [10–14] consider the concept of food sovereignty as a political definition that

refers to the right of a country to autonomously define its agricultural and food policies, as well as its production and consumption patterns, in a socially fair and environmentally friendly way, which allows citizens and inhabitants of an area the access to sustainable food and promotes the development of the area in which they live.

Several other authors [15–19] analyze the importance of food sovereignty in peasants and mention that

it is based on revitalizing family and peasant agriculture, as well as its contribution to national food production with technologies that are not very dependent on external inputs, imported machinery and technology; the substitution of imported food and improved access to land and domestic markets.

In the same way, it is addressed that food justice escalates in the depth of the concept and makes a participatory call to the current situation of food sovereignty. This forms the integration of the so-called egalitarian and democratized food systems [20,21].

What all of these definitions have in common is a focus on food sovereignty regarding how food is produced, under what control it is carried out, and under what social and environmental conditions it is developed. This makes it imperative for the relationships of production to be openly communicated [22].

Food Sovereignty in Ecuador

In the 1990s in Ecuador, millions of poverty-stricken people from rural areas left agriculture, emigrating to urban centers and even to other countries in search of improving their quality of life, thus changing public policies around poverty and hunger [23]. This migration led, according to Villegas [24], to harmful and unintended consequences of agricultural modernization, which fueled social protest over hegemonic food regimes.

Ecuador began its political and economic “post-neoliberal turn”, which brought about a modernization of unconventional ideas and models in agricultural issues [25]. Ecuador became the first country to incorporate food sovereignty as a constitutional right [6]. The Ecuadorian Constitution [26], in article 281, mentions that “food sovereignty constitutes a strategic objective and an obligation of the State to guarantee that individuals, communities, peoples and indigenous groups achieve self-sufficiency in healthy and culturally appropriate food on a permanent basis” (p. 138).

Once food sovereignty was included as a constitutional right, previous agricultural and food policies were observed, analyzed, and transformed by sustainable agricultural production guided by social and environmental justice. We call these types of production agroecological systems [27]. Under this premise, the Ecuadorian government expanded the concept of food sovereignty and focused on strategies through the Food Sovereignty Regime’s Organic Law [28], which lays out the principles of application in Article 4:

“This law will be governed by the principles of solidarity, self-determination, transparency, non-discrimination, sustainability, participation, priority of national supply, gender equity in access to production factors, economic equity and social inclusion,

interculturality, efficiency and safety, with special attention to microentrepreneurs, microenterprises or micro, small and medium production” (p. 2).

Likewise, for effective compliance with the constitutional code on food sovereignty, the Ecuadorian government has signed agreements with international organizations such as the United Nations [29]. The United Nations [30] established the Sustainable Development Goals for the 2030 Agenda, whose second goal was putting an end to hunger, achieving food security and improved nutrition, and promoting sustainable agriculture. This was added, given the food and agricultural sectors’ capacity of offering key solutions for development, as a vital actor in the elimination of hunger and poverty [31].

However, at a local level, this goal is part of the 2017–2021 National Development Plan, in its second axis, with the title of “Economy at the Service of Society”, as the sixth objective to develop the productive and material conditions to achieve food sovereignty and the rural Good Living [32]. These goals should be achieved by reviewing policies and monitoring key food indicators [33].

In this context, the article aims to determine the main indicators associated with a synthetic index of food sovereignty and integrates a measurement model to then evaluate the public policies implemented.

2. Materials and Methods

This research uses a quantitative approach with a hypothetical-deductive paradigm, whose design will be correlational–explanatory–predictive. The analysis of the variables started with the theoretical foundation and review of previous studies to define the variables that conformed to the definition of food sovereignty, and then a robust statistical analysis was carried out to see the cause–effect relationship of the observable variables, latent variables, and the control variables.

The exploration options were taken from the oldest articles to the most recent, for which the research cutoff was August 2020. Additionally, literature in English, Spanish, and Italian was analyzed to include the terms “food sovereignty AND Ecuador”, “soberanía alimentaria AND Ecuador”, “soberanía AND Ecuador”, the analysis of which was incorporated into the topic, title, keywords, and summary tags.

The data were obtained from document reviews and the World Bank official website database. The analysis was done with secondary data, supported by various public and/or private institutions and their respective specializations. The sample came from the indicators of the said database from 1998 to 2017. The information was processed with the statistical program RStudio, with the lavaan and semplot packages [34].

2.1. Empirical Methodology

In this research, we used the multiple indicators and multiple causes (MIMIC) approach, which is a variant of the structural equations model (SEM). This approach is the most complete in multivariate analyses, as it is based on a well-structured behavior model [35,36]. MIMIC is suitable for the research, because it can analyze the effects of causal variables on food sovereignty, which is the latent variable, as well as the effects of food sovereignty on the indicator variables [37,38].

The MIMIC model consists of two parts—the structural equation (1) and the measurement equations system (2). The structural model examines the relationships between the latent variable (η) and the causes (X_q), and the measurement model links the indicators (X_p) and the latent variable (η). In the MIMIC model, food sovereignty is the latent variable (η) and is linearly determined, subject to a disturbance (ζ) by a set of observable exogenous causes such as

$$\eta = \gamma_1 x_1 + \gamma_2 x_2 + \dots + \gamma_q x_q + \zeta \quad (1)$$

The latent variable (η), determined linearly, is subject to disturbances $\varepsilon_1, \varepsilon_2, \dots, \varepsilon_p$; the set of observable indicators y_1, y_2, \dots, y_p is as follows:

$$y_1 = \lambda_1 \eta + \varepsilon_1 \quad y_2 = \lambda_2 \eta + \varepsilon_2 \quad y_p = \lambda_p \eta + \varepsilon_p \quad (2)$$

Once the empirical methodology has been explained, the next step is to confirm the hypothetical relationships between the latent variable and the cause and indicator variables; then, these relationships with their respective parameters are identified and estimated [39,40]. These results can be used to calculate the scores for the latent variable. Then, the exogenous variable with the greatest impact on food sovereignty is chosen. In this way, the ordinal scores of food sovereignty are transformed into cardinal scores in order to estimate a value with a measurable scale [41].

Figure 1 illustrates the hypothetical path diagram of the MIMIC model for the latent variable of this research, which is food sovereignty in Ecuador [42]. Additionally, the expected signs are presented in the estimated parameters.

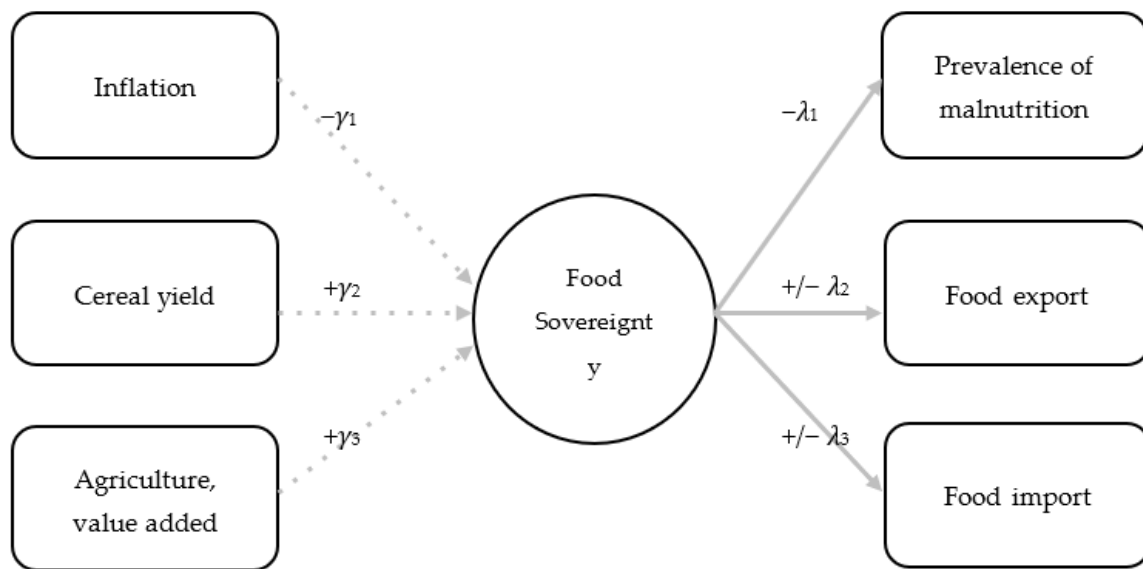


Figure 1. MIMIC path analysis food sovereignty.

2.2. Cause Variables

The main research points to consider regarding food sovereignty in Ecuador are presented, which comprise the structural part of the model.

2.2.1. Inflation and Consumer Prices

These variables measure inflation using the consumer price index, which reflects the annual percentage change in cost for the average consumer of acquiring a basket of goods and services that can be fixed or changed at specific intervals, such as annually. The formula that is generally used in all countries is Laspeyres. The international World Bank code is added to replicate this analysis in other research (FP.CPI.TOTL.ZG).

It is necessary to evaluate the impact of this variable, as an increase in consumer prices affects food prices [43]. The increase in food restricts the population's access to it or makes them opt for food rationing.

Hypothesis 1 (γ_1). *The better the cereal yield, the greater the size of food sovereignty in Ecuador, ceteris paribus.*

2.2.2. Cereal Yield

This variable refers to the yield of cereals, measured in kilograms per hectare of harvested land; it includes wheat, rice, corn, barley, oats, rye, millet, sorghum, buckwheat, and mixed cereals. Cereal production data relate to crops harvested for dry grains only. Cereal crops intended for hay or harvested unready for food, silage, and those used for

grazing are excluded. FAO distributes the production data for the calendar year in which most of the harvest took place. The international World Bank code is added to replicate this analysis in other research (AG.YLD.CREL.KG).

The variable has an integrating effect; from the data, it is observed that elements such as access to land, water, electricity, seeds, fertilizers, financing, and even specialized machinery all play a role in cereal yield, as without them, land could not be cultivated and crops could not be harvested [44].

Hypothesis 2 (γ_2). *The higher the inflation, the smaller the size of food sovereignty in Ecuador, ceteris paribus.*

2.2.3. Agriculture, Value Added

This variable corresponds to ISIC divisions 1–5 and includes agriculture, forestry, hunting, and fishing, as well as crop cultivation and animal husbandry. Value added is the net production of a sector after adding all the products and subtracting the intermediate inputs. It is calculated without making deductions for the depreciation of manufactured goods or for the depletion and degradation of natural resources. The international World Bank code is added to replicate this analysis in other research (NV.AGR.TOTL.ZS).

Agricultural production within a country's economy is essential to guarantee the food that the population needs for its basic nutrition, as well as to develop scale economies, building backward and forward links or generating added value [45].

Hypothesis 3 (γ_3). *The higher the production of the agricultural sector, the greater the size of food sovereignty in Ecuador, ceteris paribus.*

2.3. Indicator Variables

An increase in the latent variable can be reflected in the following indicators:

2.3.1. Prevalence of Malnutrition

This variable defines the population located below the minimum dietary energy consumption level, which shows the percentage of the population whose food intake is insufficient to meet their dietary energy requirements on a continuous basis. The international World Bank code is added to replicate this analysis in other research (SN.ITK.DEFC.ZS). The importance of food sovereignty focuses on eradicating hunger and caring for the environment [42,46].

Hypothesis 4 (λ_1). *The greater the size of food sovereignty in Ecuador, the lower the number of malnourished people, ceteris paribus.*

2.3.2. Food Export

This variable includes exports of food and live animals, beverages, oil, animal and vegetable fats, oil seeds, oil nuts, oil grains, and tobacco. Its international World Bank code is (TX.VAL.FOOD.ZS.UN).

Hypothesis 5 ($-\lambda_2$). *The greater the size of food sovereignty in Ecuador, the lower the food export levels, ceteris paribus.*

Hypothesis 6 ($+\lambda_2$). *The greater the size of food sovereignty in Ecuador, the higher the food export levels, ceteris paribus.*

2.3.3. Food Import

This variable corresponds to imports of food and live animals, beverages, oil, animal and vegetable fats, oil seeds, oil nuts, oil grains, and tobacco. It has an annual periodicity and its aggregation method is the average weight (TM.VAL.FOOD.ZS.UN).

Hypothesis 7 ($-\lambda_3$). *The greater the size of food sovereignty in Ecuador, the lower the food import levels, ceteris paribus.*

Hypothesis 8 ($+\lambda_3$). *The greater the size of food sovereignty in Ecuador, the higher the food import levels, ceteris paribus.*

With respect to hypotheses 5 and 7, they are based on the fact that food sovereignty rejects any type of control at the global level over the food system and, as a result, the liberalization of agricultural markets that affects small producers [47].

According to [48], although food sovereignty in Ecuador is institutionalized, the synergy between peasant organizations and the state is still fragile. The uncertainty of progress aimed at implementing and practicing this approach leads the state to follow the same public policies for the liberalization of agricultural markets. In other words, liberalization will remain latent in the statistics until the structure of public foreign trade policies in Ecuador gradually changes, thus establishing hypotheses 6 and 8.

3. Results

This section presents the estimation of the structural component's parameters, which provides ordinal estimates of food sovereignty. In the empirical research results, 20 observations were collected by variables of causes and indicators for Ecuador (see Table 1).

Table 1. Descriptive statistics of the variables.

Cause Variables	Observations	Mean	Standard Deviation
inflation (H_1)	20	14.62	2.39
yield (H_2)	20	2898	605.23
added value (H_3)	20	10.81	2.77
Indicator variables			
malnutrition (H_4)	20	11.83	5.92
export (H_5 – H_6)	20	37.92	10.67
import (H_5 – H_6)	20	8.90	1.23

Table 1 shows that the mean is within the range of the central limits theory and its standard deviation shows normality in the treatment of the data. Additionally, the reliability of the data is denoted for the necessary mathematical convergence and guarantees the viability of the future index.

To verify the preconditions of a good MIMIC model, the data found in Table 2 show the correlations between the causal variables and the indicator variables; correlations greater than 0.50 are significant for the subsequent analysis.

Table 2. Correlation matrix of the variables.

Cause Variables	Inflation	Yield	Added Value
inflation (H_1)	1		
yield (H_2)	−0.60 **	1	
added value (H_3)	0.82 ***	−0.70 ***	1
Indicator Variables	Malnutrition	Export	Import
malnutrition (H_4)	1		
export (H_5 – H_6)	−0.55 *	1	
import (H_5 – H_6)	−0.52 *	0.82 ***	1

Note. Very significant ***, significant **, not very significant *.

Table 2 shows that the variables of added value–inflation, import–export, and added value–yield are highly correlated. Likewise, export–malnutrition, import–malnutrition, and yield–inflation are correlated at an intermediate level.

To evaluate the general model, some statistics, called the adjustment index, are estimated. Other statistical research [49–51] coincides with the intervals of good fit or acceptable fit (see Table 3).

Table 3. Model fit indices.

Fit Index	RMSEA	χ^2/df	SRMR	GFI	CFI
Good fit	$0 \leq X \leq 0.05$	$0 \leq X \leq 2$	$0 \leq X \leq 0.05$	$0.95 \leq X \leq 1$	$0.95 \leq X \leq 1$
Acceptable fit	$0.05 \leq X \leq 0.08$	$2 \leq X \leq 5$	$0.05 \leq X \leq 0.10$	$0.90 \leq X \leq 0.95$	$0.90 \leq X \leq 0.95$
Model	0.041 ***	1.03 ***	0.078 **	0.963 ***	0.996 ***

Note. Very significant ***, significant **.

The values calculated in Table 3 show that the model has a good fit, as four of the statistics are in the indicated range. Likewise, the mean square error of approximation (RMSEA) is evaluated in depth, which shows strong statistical evidence that the said statistic will remain at an interval less than 0.05, including the maximum likelihood method.

Table 3 shows that the model has internal validity and its composite reliability is acceptable for making future or evaluative predictions for control purposes. The estimated results of the cause and indicator parameters of the specified model are shown in Table 4.

Table 4. Summary of the MIMIC model.

Cause Variables	Signs	Standardized Coefficient	p-Value
inflation (H ₁)	—	0.735	0.03 ***
yield (H ₂)	+	0.639	0.00 ***
added value (H ₃)	+	1.739	0.02 ***
Variables indicadoras			
malnutrition (H ₄)	—	0.669	0.01 ***
export (H ₆)	+	0.907	0.03 ***
import (H ₈)	+	0.862	0.04 ***
R ²	0.877		

Note. Very significant ***.

Table 4 shows that the results of the model relationships are statistically significant, as the model adjusts very well to the most important determining data and its results show the theoretically expected signs. Therefore, the validity of the MIMIC model for food sovereignty is accepted in Ecuador; therefore, hypotheses 1, 2, 3, 4, 6, and 8 are verified. In the same way, hypotheses 5 and 7 are rejected, as the signs of the variables are positive and thus significant.

4. Discussion

The estimation of the causes and effects of food sovereignty in Ecuador is an issue that has not been quantitatively researched in a territory that, since 2008, has incorporated laws and norms applied to its conceptual dimension.

The results obtained here show that hypothesis 1 was fulfilled. This means that consumer price inflation had a negative statistical effect on food sovereignty, as it was based on the notion that inflation has serious adverse effects on society [52–54], especially on food prices. This price volatility affects access to food, which causes governments to frequently resort to subsidies in the agricultural sector, in order to ease the cost of food in households with economic limitations [55–58].

Hypothesis 2 was also fulfilled, where the yield of cereal production had a positive effect on food sovereignty, accepting hypothesis 1, which was caused by technological changes, scientific research, or cheaper financing [59–62]. Similarly, some scientists have shown the relationship between performance and food security versus income and population growth in the current biofuel context [63–65].

In the same way, hypothesis 3 was contrasted, where agricultural production also had a positive effect on food sovereignty, as the data comprised all food production without industrialized processes within the gross value added [66–68]. There were also findings of bidirectional causality between agricultural value added and agricultural land use [57]. These findings raised the debate that this growth in added value is due to organic or agroecological products that further the increase in food sovereignty.

Food sovereignty reduces the prevalence of malnutrition in the population, confirming one of the main purposes of the concept, which is to eradicate hunger. By being more sovereign in its food production, society can feed its people and reduce this prevalence, validating hypothesis 4.

Additionally, the model shows that food sovereignty had a positive impact on food imports and exports, accepting hypotheses 6 and 8, which was largely due to the public policy adopted in 2014 called the Ecuadorian Fair-Trade Strategy, where the approach was to help small producers promote the sales of their products, including agro-ecological ones, in a social and solidarity economy [69–71].

Therefore, we can infer from the data and the experience that Ecuador continues to promote an economic model fueled by exports, but with a more inclusive approach. This can be explained by the need to attract foreign exchange, as the country is dollarized and needs to attract these resources through exports [31].

5. Conclusions

Food sovereignty is a phenomenon that has many dimensions and complex definitions, and addresses food law, security, and justice. Research on this phenomenon is theorized by several other prominent researchers and, as this topic progresses, it is essential to initiate more quantitative analyses that help understand and evaluate public policies.

This research confirms that inflation, cereal yields, and agricultural value added are causes of food sovereignty, and the effects of said sovereignty imply the prevalence of malnutrition, food export, and food import. The findings from this research will allow governments to plan and monitor issues related to the right to food.

Similarly, these findings contrast the draft laws and public policies that originate from the Plurinational and Intercultural Conference on Food Sovereignty (COPISA). One of these projects is agrodiversity, where an attempt is made to establish an adequate zoning for the diagnosis, monitoring, development, and dynamization of agrodiversity and seeds.

Likewise, the bill on agribusiness formulates a Sustainable Rural Agroindustry Development Program, where society and all forms of popular and solidarity economy are involved. The draft law on communes strengthens the competences and attributions that the communal government should have, as well as the communication mechanism with the corresponding parish council.

Among the main public policies that the Republic of Ecuador has created are small-scale agreements with decentralized autonomous governments, where work plans oriented to agroecology, training, and advice are established annually at a food sovereignty analysis table, and local public policies are formulated, along with their respective promotion and dissemination.

Regarding the limitations of this study, variables that were not explored in previous research could have been included, such as biodiversity and the number of agroecological zones.

Based on the discussion and conclusions, the following points are recommended for future research:

- Analyzing an econometric study between the prevalence of malnutrition, food export, and food import in the Latin American region, and updating the parameters with data after the study.
- Calibrating the dimensionless data of the model and evaluating the behavior of food sovereignty, thus validating it through a historical context.

- Calibrating the dimensionless data of the model and evaluating the behavior of food sovereignty, and validating the laws and public policies originated by COPISA.
- Comparing the results of food sovereignty calibrated with the public policies on food adopted and implemented in the Ecuadorian territory.
- Evaluating, through an econometric study, the calibrated food sovereignty and the price of oil, as a way of observing oil dependence in agriculture.

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