Food Security, Welfare, and Sustainability in Canada - Mathematical Conceptual Foundation

Ghana Gomaa A. Mohamed¹, PhD., PDFs

¹Dean of Students; Global Forward Academy, USA

Correspondence: President: ECO-ENA: Economics & ECO-Engineering Associate, Inc, Canada

Received: June 27, 2023 Accepted: August 30, 2023 Online Published: October 18, 2023
doi:10.5539/jmr.v15n5p73 URL: https://doi.org/10.5539/jmr.v15n5p73

Abstract

This manuscript provides a mathematical approach to measuring food security, linking it mathematically to the concept of social welfare over time to figure out the impact of food security on the transitional dynamism of social welfare. The utilized mathematical approach in this manuscript is essential as a foundation for further research on food insecurity/security, consumer behaviour, and social welfare over time. ¹

Keywords: food insecurity, food security, consumer surplus, consumer confidence, social welfare, sustainability, survey analysis, intervention analysis, time series data, Canada

1. Introduction

This manuscript depends on the definition of Health Canada of the concepts of food insecurity and food security. In addition to the definition of the FAO of food security. On the other side, it depends on Weitzman's definition of social welfare. It also depends on the Canadian Household Food Security Survey Modules (HFSSM) to measure food insecurity. This manuscript provides a mathematical approach to measuring food security, linking it mathematically to the concept of social welfare over time to figure out the impact of food security on the transitional dynamism of social welfare. The utilized mathematical approach in this manuscript is essential as a foundation for further research on food insecurity/security, consumer behaviour, and social welfare over time.

This manuscript is structured as follows. Section II, after the introduction, provides the implicit function of food insecurity. Section III explains the explanatory variables of the food security function. Section III provides a mathematical calculation to derive the data trend of food security. Section IV presents the term social welfare and its measure. Section V introduces the intervention time series model to determine food security's impact on social welfare over time. Section VI provides the implications and the conclusion of the manuscript.

2. Definitions and The Food Security Function

According to Health Canada, “food insecurity is the inability to acquire or consume an adequate diet quality or sufficient quantity of food in socially acceptable ways, or the uncertainty the one will be able to do so.”

The 1996 World Food Summit provided a broad definition of food security, I.e., “Food Security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life.” (FAO, 1996).

The Food Policy Canada defines security as “All people in Canada can access a sufficient amount of safe, nutritious, and culturally diverse food.” And added that “Canada’s food system is resilient and innovative, sustains our environment and supports our economy.” (AAFC).

The Household Food Security Survey Module (HFSSM) measures food insecurity. This tool has been included in Statistics Canada’s Canadian Community Health Survey since 2004 and in the Canadian Income Survey (CIS) since

The food insecurity function can be explained as follows.

Food Insecurity = f(financial factors, social & cultural factors, human behaviour, uncertain macro factors).

The financial factors are about the household’s disposable income and food prices. In other words, the financial factors could be represented by the consumer surplus, which can be explained on the macro level in the following section of this manuscript. Assuming that the gross consumption can be derived as a function of disposable income. Wealth could be added as one of the financial factors as well.

The social and cultural factors are cultural diversity, family kinship, community cooperation, age, gender, education, isolation, and bleakness. The social and cultural factors can be measured via a survey to determine the number of populations that suffer from negative social and cultural integration. To simplify, it can be measured by the number of immigrants in Canada every year, assuming that; immigrants take time for social and cultural integration. The data trend is available in this case.

Human behaviour toward food assistance programs is about positive behaviour toward food assistance programs or negative behaviour toward food assistance programs. “A cognitive game approach can cognitively explain this behaviour.” To neutralize, we can consider only positive behaviour toward social assistance. The consumer confidence index in Canada could measure this. The data trend is available in this case.

The uncertain macro-factors are about food supply chain blocks, crises, etc. This is considered a random term. To simplify, let’s assume that the random term is a white noise disturbance term.

The above function can then be rewritten as follows.

\[ F \text{I} = f(X_1, X_2, X_3, e). \]

Where; F\text{I} refers to food insecurity, X1 refers to the consumer surplus term, X2 refers to the social/ cultural integration term, X3 refers to the consumer confidence index, and e refers to the uncertainty.

3. How to Measure the Consumer Surplus on the Macro-Level. From Micro to Macro

The consumer surplus is measured by the difference between what they are willing to pay and what they are actually paying. From a macroeconomic perspective, we can take the CPI as a proxy of what the consumers are actually paying in the economy, while the entire area under the aggregate demand is what the consumers are willing to pay. In different words, the consumer surplus is theoretically feasible within the area located under the demand and above the price. (Mohamed & Javid (2014)).

If we consider on the macro level that the entire demand is the gross nominal private consumption, then; the consumer surplus on the macro level can be determined mathematically as follows:

\[ \text{The consumer surplus} = \ln (\text{nominal gross consumption}) - \ln (\text{CPI}); \text{ this equals the real gross consumption. Therefore, the real gross consumption in the economy can be considered a proxy of the consumer surplus. (Mohamed & Javid (2014)). The trend data of the real gross consumption is available.} \]

This entire section depends on the same author’s analysis in her paper with Saima Javid (2014); however, here, we can consider the GDP of the natural resources, not the entire GDP of the economy. The trend data is available in Canada as well. For more explanations, Px refers to the price of a good X; QDx refers to the quantity demanded of a good X, P is the price of this good and D is the demand for this good. Y is the real GDP of the natural resources, the CPI is the consumer price index, and AD is the aggregate demand.

4. How to Estimate the Trend Data of Food Security

In this section, we explain how to estimate the trend data of food security. We can do so in two steps;

Step 1: estimating the results of the Household Food Security Survey Module (HFSSM) in Canada. We then estimate the explained model in the previous section. After selecting the best-fit model, we forecast it to figure out the data trend of food insecurity. - We can control all econometric problems here. The estimated food insecurity function over time is as follows:

\[ F_{i,t} = a + bX_{1,t} + cX_{2,t} + cX_{3,t} + et. \]

Step 2: generating the data of the food insecurity from the previous model directly as follows:
Recall; $FI = f(X_1, X_2, X_3)$, considering the macro uncertainty is zero. By taking the total differentiation of this function, thus,

$$dFI = dX_1. (\partial FI / \partial X_1) + dX_2. (\partial FI / \partial X_2) + dX_3. (\partial FI / \partial X_3).$$

By minimizing food insecurity, the $FI$, as a policy, then,

$$dFI = dX_1. (\partial FI / \partial X_1) + dX_2. (\partial FI / \partial X_2) + dX_3. (\partial FI / \partial X_3) = 0.$$
References


PROOF research work on food insecurity in Canada, University of Toronto.

Copyrights

Copyright for this article is retained by the author(s), with first publication rights granted to the journal.

This is an open-access article distributed under the terms and conditions of the Creative Commons Attribution license (http://creativecommons.org/licenses/by/4.0/).