Food Away from Home Expenditures in the United States as a Complex Economic System

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Abstract

In the United States, spending on food away from home (FAFH) increased 89 percent from 1997 to 2022. The trends have shown that this can be attributed to a multitude of factors, such as microeconomic factors, macroeconomic factors, socioeconomic and demographic factors, and prices of inputs. The interrelationships among these variables in the marketplace affect producer, consumer, policy and managerial decisions. The general objective of this study is to investigate the food away from home expenditures in the United States as a complex economic system using machine learning and artificial intelligence approaches to establish various causality structures. Annual data (1997-2022) on the aforementioned categories collected from the Federal Reserve Bank and USDA-ERS are used. Preliminary analysis of data showed that two variables that directly affect FAFH expenditures are average price of gas and the exchange rate of the Mexican peso to the United States dollar. We also found multiple other variables that FAFH expenditure affects such as average prices of flour, chicken, ground beef, sugar, federal funds effective rate, and the exchange rate of the Chinese Yuan to the United States Dollar.

Key words: Food away from home expenditures, complex system, machine learning, directed acyclic graphs

JEL classification: D0, D1, E0, H0, I1, I3, C4, C8

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Introduction

In the United States, spending on food away from home (FAFH) increased 89 percent from 1997 to 2022 (Zeballos and Sinclair, 2023). FAFH is characterized as anything not prepared in the home for consumption. This can be categorized as fast food, sit-down restaurants, cafeterias, and any other means by which consumers buy food for consumption outside the household. The trends have shown consumers are increasingly spending on FAFH which can be attributed to a multitude of factors. They could include microeconomic factors, macroeconomic factors, socioeconomic and demographic factors, and prices of inputs, etc. The interrelationships among these variables in the marketplace affect producer, consumer, policy and managerial decisions. This paper aims to model the complex interaction between several variables and their effect on Food Away from Home (FAFH) expenditure in the United States.

According to Parum and Dharmasena (2021), individual education, body mass index, and employment affected FAFH expenditures. These results were found through a survey of 4,826 U.S. households (FoodAPS data; National Household Food Acquisition and Purchase Survey) over seven-day periods between April 2012 - January 2013. The individual's education was on a scale measured from no education to masters or doctorate degree in the same category. This factor had a stronger effect on Food at Home consumption than FAFH consumption. The employment factor negatively affected FAFH consumption and positively affected FAH consumption.

Lin, Jung, and Huang (2021) found macroeconomic factors, which affected FAFH expenditure. Their analysis found a relationship between individual FAFH expenditure and unemployment rate, Consumer Price Index (CPI), stock index, and oil price. The time range used

by this study was from January 1997- February 2020, discounting March to December 2020 due to the COVID-19 pandemic. The unemployment rate, CPI, and stock index have a negative impact on both nominal and constant FAFH spending percentage. The oil price had a positive impact on FAFH spending percentage. This paper draws possible connections to unemployment rate and income levels of individuals, and CPI to higher overall prices, which constrained income.

Few studies in the extant literature have used a few variables at a time in investigating the factors affecting FAFH expenditures. To the best of our knowledge, this paper will be the first look at an array of factors such as prices of inputs, microeconomic factors, macroeconomic factors, and socioeconomic and demographic factors in a complex economic system to investigate complex interactions of these variables using machine learning and artificial intelligence approaches. Uncovering of these complex interactions of variables affecting FAFH expenditures in the United States will help decision makers to make prudent managerial decisions such as in implementing government food assistance programs as well as implementing macroeconomic policies to better impact the FAFH expenditures.

Objectives

The general objective of this study is to investigate the food away from home expenditures in the United States as a complex economic system using machine learning and artificial intelligence approaches to establish various causality structures.

Specific objectives are to,

(1) establish causality structures underlying FAFH expenditures as it is affected by various factors, microeconomic, macroeconomic, socioeconomic demographic and input prices,

(2) develop structural equations based on causality structures identified in objective (1),

(3) develop policy and managerial prescriptions on multitude of variables as they affect the FAFH expenditures.

Data and Methodology

Data from the Federal Reserve Bank of St. Louis (FRED) is used in this study coupled with the United States Department of Agriculture (USDA) Economic Research Service (ERS). The data collected includes annual data from 1997 to 2022 averaged. The variables assessed include the following. Food Away from Home food expenditures for final purchaser, Federal Funds Interest Rate, Consumer Price Index All urban consumers: Food and Beverage in U.S., unemployment rate, real disposable income, price of beef, price of chicken, price of sugar, price of gas, price of white flour, producer price index for fats and oils, U.S. Dollar to Mexican Peso exchange rate, and U.S. Dollar to Chinese Yuan exchange rate. Table 1 shows the description of these variables used in the study. This study examines what factors affect FAFH consumption in the United States based on a multitude of factors. Causality structures are developed using Directed Acyclic Graphs (DAGs) (Pearl, 2009). Greedy Equivalence Search (GES) machine-learning algorithm (Chickering, 2002) is implemented to develop causality structures using DAGs (Dharmasena. Bessler, and Capps (2016). GES is a part of TETRAD software program, which searches for casual models using artificial intelligence and DAG (Glymour et al., 2014).

Using this algorithm, we established causality structures in the complex system that determines the FAFH expenditures. Summary statistics of variables considered in this study are shown in Tables 2 and 3.

Table 1. Description of Variables used in the Study

Variable	Variable Description	Units	Seasonally Adjusted
FAFH	Food Away from Home food expenditures for final purchaser	Nominal Value, in millions	Not Applicable
RDPI	Real Disposable Personal Income	Percent Change	Yes
APF	Average Price: Flour, White, All Purpose	(Cost per Pound) in U.S. city Avg. U.S. dollars	No
APGB	Average Price: Ground Beef, 100% Beef	(Cost per Pound) in U.S. city Avg. U.S. dollars	No
APC	Average Price: Chicken, Fresh, Whole	(Cost per Pound) in U.S. city Avg. U.S. dollars	No
APS	Average Price: Sugar, White, All Sizes	(Cost per Pound) in U.S. city avg. U.S. dollars	No
CPI	Consumer Price Index for all Urban Consumers: Food and Beverages	U.S. City Average, Percent Change	Yes
MPUSD	Mexican Peso to U.S. Dollar Spot Exchange Rate	Mexican Pesos to One U.S. Dollar	No
FEER	Federal Funds Effective Rate	Percent	No
APGAS	U.S. Regular All Formulations Gas Price	Dollars per Gallon	No
PPIFO	Producer Price Index by Industry: Fats and Oils Refining and Blending: Shortening and Cooking Oils	Percentage Change	No
UNRATE	Unemployment Rate	Percent	Yes
CYUSD	Chinese Yuan to U.S. Dollar Spot Exchange Rate	Yuan to One U.S. Dollar	No

Source: Developed by authors

Table 2: Summary Statistics of Variables Considered in the Study

	FAFH	RDPI	CYUSD	UNRATE	PPIFO	APGAS	FFER
Mean	540,849.44	2.55	7.27	5.71	5.36	2.40	2.06
Median	483,191.41	3.08	6.91	5.18	1.74	2.42	1.51
Min	265,067.78	-5.96	6.15	3.64	-22.51	1.03	0.08
Max	1,049,771.88	6.40	8.32	9.61	41.35	3.95	6.24
SD	215753.17	2.34	0.84	1.77	15.67	0.84	2.08
CV	2.51	1.09	8.66	3.23	0.34	2.85	0.99

Table 3: Summary Statistics of Variables Considered in the Study

	CPI	APS	APC	APF	MPUSD	APGB
Mean	2.66	0.56	1.29	0.42	13.56	2.79
Median	2.31	0.58	1.27	0.45	12.53	2.35
Min	0.35	0.42	1.00	0.29	7.92	1.40
Max	9.58	0.78	1.80	0.53	21.55	4.81
SD	1.78	0.11	0.23	0.10	4.18	1.05
CV	1.50	5.06	5.67	4.34	3.25	2.67

Results and Implications

Preliminary analysis of data of the contemporaneous time (no lagged data) showed following results shown in Figure 1. According to Figure 1, we find two variables that directly affect FAFH expenditures. They are average price of gas and the exchange rate from the Mexican peso to the United States dollar. We also found multiple other variables that FAFH expenditure affects such as average prices of flour, chicken, ground beef, sugar, federal funds effective rate, and the exchange rate of the Chinese Yuan to the United States Dollar.
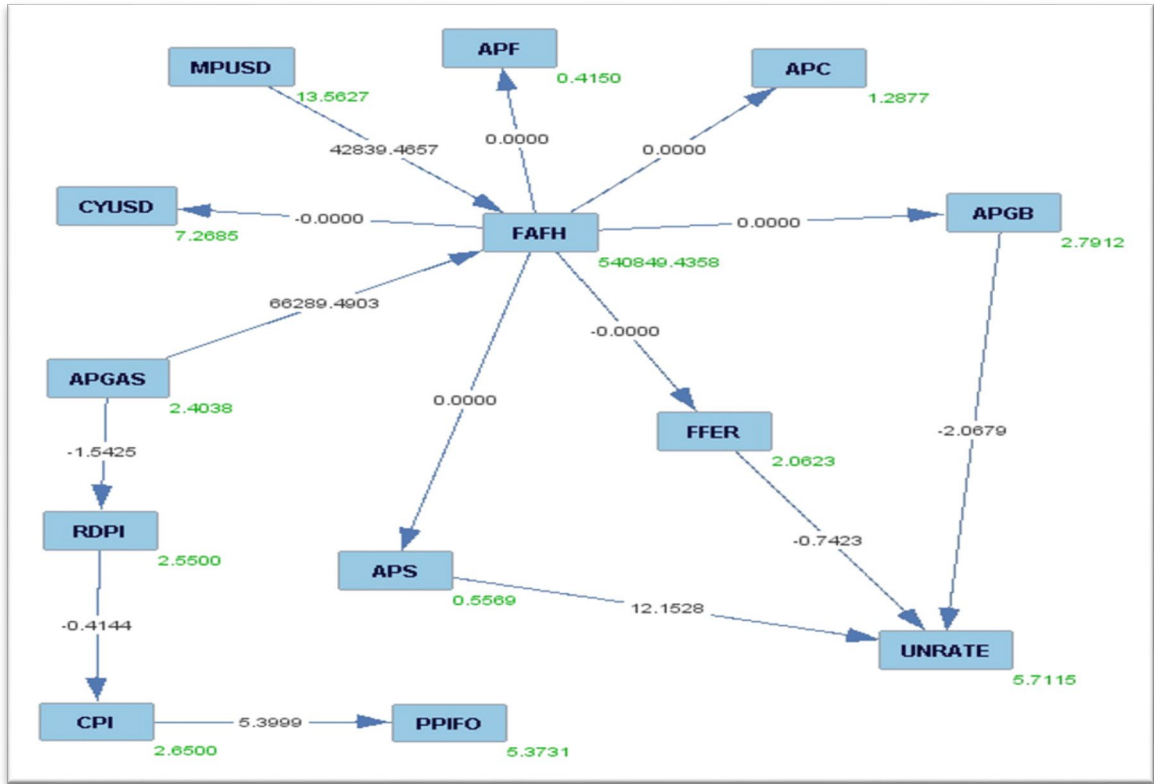
Figure 1. Directed Acyclic Graph

This preliminary analysis show that FAFH expenditures in the United States are determined in a complex economic system, where some variables are directly affecting the FAFH expenditures, while FAFH expenditures affect a few of other variables. Uncovering of these variables affecting FAFH expenditures in the United States will help decision makers to make prudent managerial decisions such as in implementing government food assistance programs as well as implementing macroeconomic policies to better impact the FAFH expenditures.

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