DYNAMICS OF MACROECONOMIC SHOCKS ON SUPPLEMENTAL NUTRITION ASSISTANCE PROGRAM IN THE UNITED STATES

An Undergraduate Research Scholars Thesis

by

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ABSTRACT

Dynamics of Macroeconomic Shocks on the Supplemental Nutrition Assistance Program in the United States

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Monthly national U.S. data for the period 1997-2012 associated with macroeconomic shocks and participation in food assistance programs were used to model dynamics using artificial intelligence and directed acyclic graphs. Using this approach, contemporaneous causal flows of macroeconomic shocks and participation in food assistance programs were modeled. We find that participation in SNAP program is directly caused by unemployment rate, oil price, number of housing starts and financial stress. With a more accurate set of predictions associated with participation rates in food assistance programs based on macroeconomic drivers or shocks, policy makers will be in better position to assess program costs and to minimize errors in the budgetary process.

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CHAPTER I

INTRODUCTION

The United States Department of Agriculture (USDA) administers various food and nutrition assistance programs that provide children and low-income people access to food, a healthful diet, and nutrition education. Approximately one in four Americans participate in the Supplemental Nutrition Assistance Program (SNAP), the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), and the National School Lunch Program (NSLP) (FNS, 2011a). These programs serve as an economic safety net buffering the effects of low income and lack-of-asset households and protecting target populations against income losses and unexpected expenses. Judging from the dramatic rise in caseloads of these programs, in recent times, the role as a safety net has certainly expanded and may have changed during and after the recent U.S. economic recession. Therefore for policy makers, it is vital to have an up-to-date understanding on the plethora of macroeconomic variables (or shocks) in affecting eligibility and participation in food assistance programs.

Over the past few years, notable changes are evident in the unemployment rate; the level and volatility of disposable personal income; the number of divorces or separations (sociological stress); the number of housing starts; the value of homes and the value of homes versus the value of mortgages; the level of oil prices and other commodity prices; the number of personal bankruptcies; the personal savings rate; stress in financial markets; and the debt-to-income ratio. To illustrate, in the 2008-2010 recession period the unemployment rate was in the range of 8 to 9 percent, up from 4 to 5 percent just several years prior. During the time following the 2008-2010

economic recession the number of housing starts, a leading economic indicator, was at a historically low level dating back to 1960. Also during this time period roughly one of four households is underwater, that is, the value of their home is less than the amount owed on their mortgage. In 2011, oil prices were at slightly more than $100 per barrel, well above historic norms except for the period from March 2008 to September 2008. Moreover, the U.S. economy has recently experienced financial stress, that is, interruption to the normal functioning of financial markets (Hakkio and Keeton, 2009). Increases in financial stress ultimately lead businesses and households to cut back on their spending, which results in a decline in economic activity.

The Supplemental Nutrition Assistance Program (SNAP, formerly known as the Food Stamp Program) is the oldest food and nutrition assistance program of the federal government targeting low-income Americans. The number of participants in the SNAP declined through the 1990s. This decline was attributed to the Personal Responsibility and Work Opportunities Reconciliation Act of 1996 (PRWORA) as well as falling unemployment levels. In subsequent years, participation in the SNAP increased from about 17.2 million to 26 million people per month in 2006. It reached all-time high of 29 million people per month in year 2008. The economic slowdown during great recession of 2008-2009 coupled with rising unemployment levels were blamed for this rise in SNAP participation during that time (FNS, 2011a). Macroeconomic shocks are economic, financial, and sociological stressors. At times, these macroeconomic shocks lead to declines in economic activity. Consequently, during these instances, the number of participants in USDA food assistance programs is likely to rise. Leete and Bania (2010) investigated the relationship between income shocks and food insufficiency for

U.S. households. Using data from the Survey of Income and Program Participation (SIPP) of U.S. households, they found that both the level of income and negative income shocks affected the probability of food insufficiency, while positive income shocks did not.

In the United States, welfare reform enacted in 1996 limited cash assistance as an entitlement, imposed increased work requirements on recipients of cash assistance, eliminated eligibility of the SNAP for some populations, and limited SNAP benefit levels for others. Ziliak et al. (2003), Currie and Grogger (2001), and Kornfeld (2002) documented that these changes were driven in part by macroeconomic conditions as well as by changes in policies associated with welfare reform.

In addition, several researchers have explored aspects of the relationship between income variability and food-related programs or outcomes. Blundell and Pistaferri (2003) found a negative relationship between income variability and food expenditures using data from the Panel Study of Income Dynamics (PSID) for the years 1978-1992. Newman (2006) examined the implications of income volatility for participation in the National School Lunch Program (NSLP), and Farrell et al. (2003) considered the implications of income volatility for participation in the SNAP. Using data over the period 1994-1997 from the SIPP and the Survey of Program Dynamics, Ribar and Hamrick (2003) found that assets, indicative of the ability of households to borrow and to save, were important to weathering bouts of poverty without experiencing food insufficiency.

We will extend the literature in several ways. First, the extant literature places emphasis primarily on the level of income or the volatility of income as the key macroeconomic variable in affecting food insufficiency as well as participation in the SNAP and the NSLP. We intend to center attention on additional macroeconomic variables besides income on the number of participants in various food and nutrition programs.

The broad objective is to determine how macroeconomic shocks affect the number of participants in various food and nutrition assistance programs. Specifically, we wish to identify and to assess the key macroeconomic factors linked to participation in food assistance programs. To accomplish this objective, we will rely on the use of graphical causal structures (directed acyclic graphs) to shed light on interrelationships among various macroeconomic variables and participation in SNAP.

CHAPTER II

DATA AND METHODOLOGY

Monthly national data associated with macroeconomic shocks and with participation in food assistance programs will be used over the period from 1997 through 2012. This time frame also includes behavior before and after the recent recession. The set of macroeconomic variables (shocks) include: (1) the unemployment rate; (2) the debt-to-income ratio; (3) the number of housing starts; (4) the Kansas City Financial Stress Index; (5) the St. Louis Financial Stress Index; (6) the S&P Case-Shiller Home Price Index; (7) oil prices; (8) the number of personal bankruptcies; (9) the personal saving rate; and (10) the Conference Board Leading Economic Index. To account for the participation in USDA food assistance programs, we use the number of participants (monthly national and state-level) in the SNAP program.

Details on Data Pertaining to Selected Macroeconomic Variables

The Kansas City Financial Stress Index (KCFSI) is a monthly composite index of 11 variables reflecting stress in the U.S. financial system, compiled by the Kansas City Federal Reserve Bank. These variables fall into two broad categories: average yield spreads and behavior of asset prices. The index is calculated using a principal components procedure (Hakkio and Keeton, 2009). This series is available monthly back to January 1990. A positive value of the KCFSI indicates that financial stress is above the long-run average, while a negative value signifies that financial stress is below the long-run average. In Figure 1 below, we can see the trend of the financial stress index.

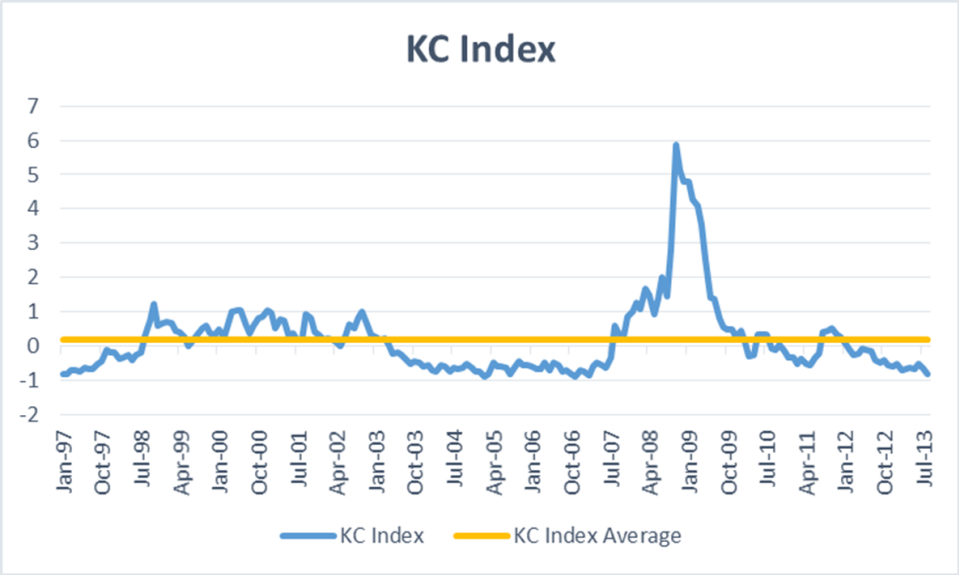

Figure 1: Trend line of the Kansas City Financial Stress Index

The St. Louis Financial Stress Index (STLFSI) is similar to the construction of the KCFSI. This index is a monthly composite index of 18 variables which deal broadly with interest rates (e.g. federal funds rate, 2-year Treasury, 10-year Treasury, and 30-year Treasury), yield spreads (e.g. 10-year Treasury minus 3-month Treasury, 3-month commercial paper minus 3-month Treasury bill, and corporate Baa-rated bond minus 10-year Treasury), and other financial indicators (e.g. Chicago Board Options Exchange Market Volatility Index, Merrill Lynch Bond Market Volatility Index and J.P. Morgan Emerging Markets Bond Index). Each of the 18 components of the STFSI captures some aspect of financial stress. This series is available weekly back to January 1994, and displayed below in Figure 2.

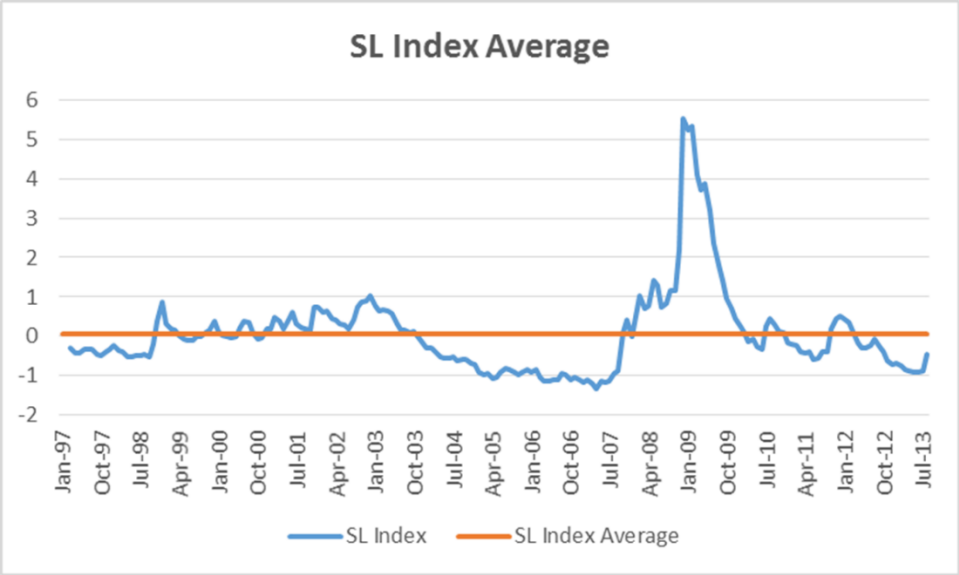

Figure 2: Trend line of the St. Louis Financial Stress Index.

The Conference Board Leading Economic Index (LEI) is a composite of ten variables which historically have turned downward before a recession and upward before an expansion. The ten variables which comprise this index are: (1) average weekly hours, manufacturing; (2) initial weekly claims for unemployment insurance; (3) manufacturers' new orders of consumer goods and materials; (4) manufacturers' new orders of non-defense capital goods; (5) building permits for new private housing units; (6) the difference (spread) between interest rates of 10-year U.S. Treasury notes and the federal funds rate; (7) the inflation-adjusted measure of the money supply as represented by M2; (8) the Institute for Supply Management (ISM) index of new orders; (9) the S&P 500 stock price index; and (10) the University of Michigan Consumer Sentiment Index, which deals with consumer expectations about the economy. This variable's trend line is very similar to the St. Louis Financial Stress Index, but moving in the opposite direction. The trend line can be seen below in Figure 3.

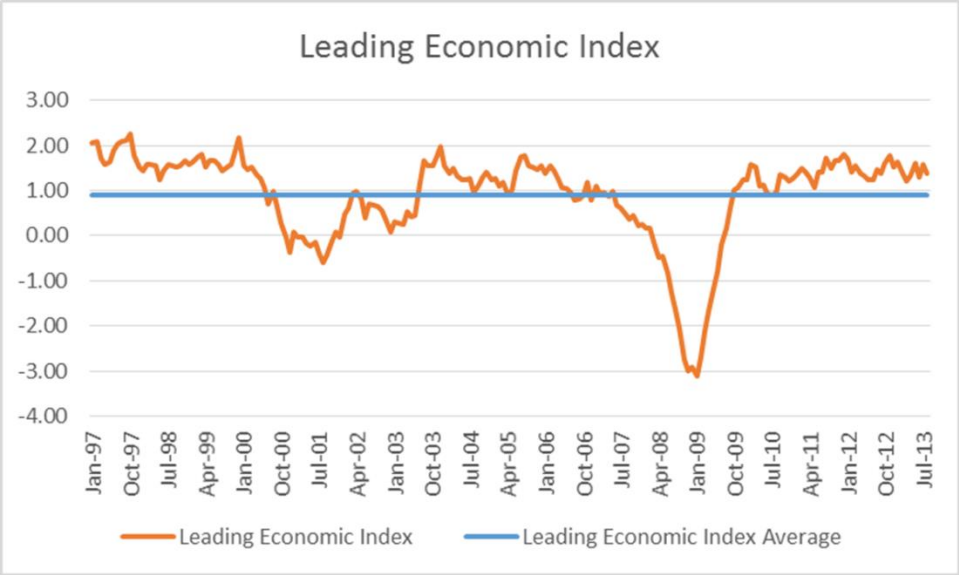

Figure 3: Leading Economic Index trend line

The West Texas Intermediate (WTI) keeps up with spot oil prices and is presented in dollars per barrel. This monthly data was sourced from Dow Jones and Company, and has been adjusted for inflation. Below in Figure 4, you can see the monthly price trend line from 1997-2013.

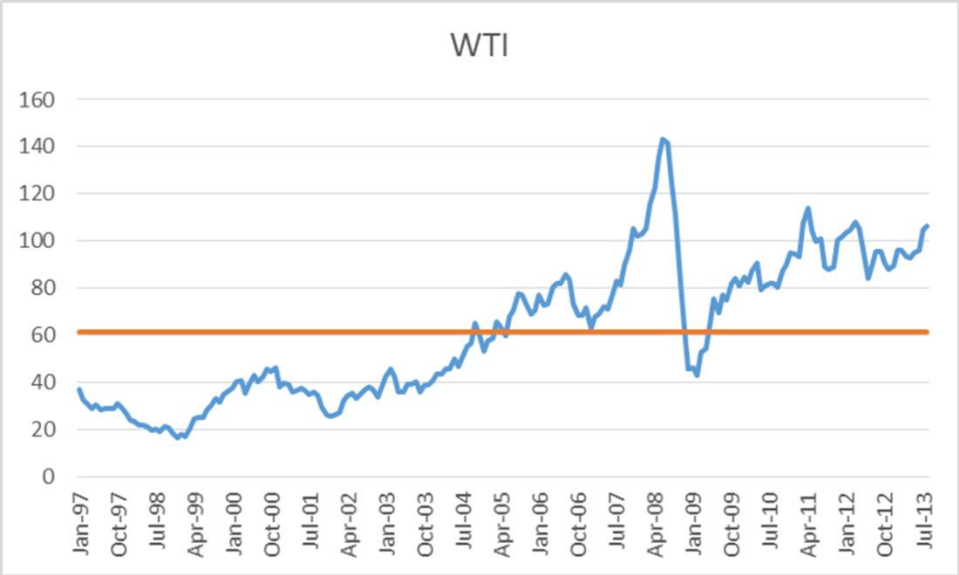

Figure 4: West Texas Intermediate oil prices

Unemployment rate is monthly data provided by the US Department of Labor: Bureau of Labor Statistics. This statistic is provided as a percentage of the unemployed individuals divided by the number of individuals in the labor force. Below in Figure 5, it is apparent that unemployment rate often moves with the cyclical business cycle at the national level, with an average unemployment rate of around 6.0% between the years 1997-2012.

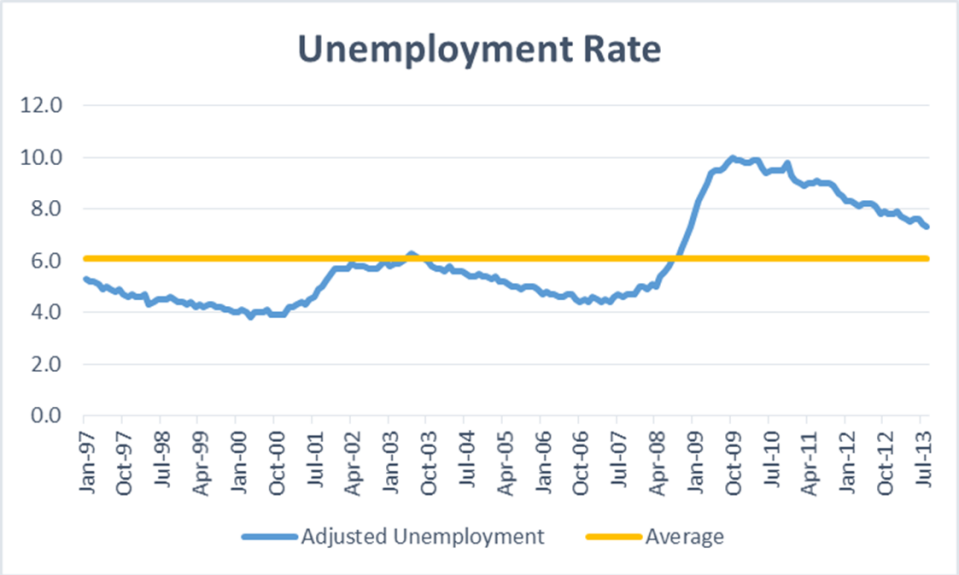

Figure 5: US Unemployment Rate

Housing Starts is a variable that represents the amount of construction sites that began in the monthly periods on the national level. The variable is represented in thousands of units and sources from the US Department of Commerce: Census Bureau. It can be seen below in Figure 6, that housing starts is a highly seasonal variable. Each year the number of housing sites that started peaked in the summer time months.

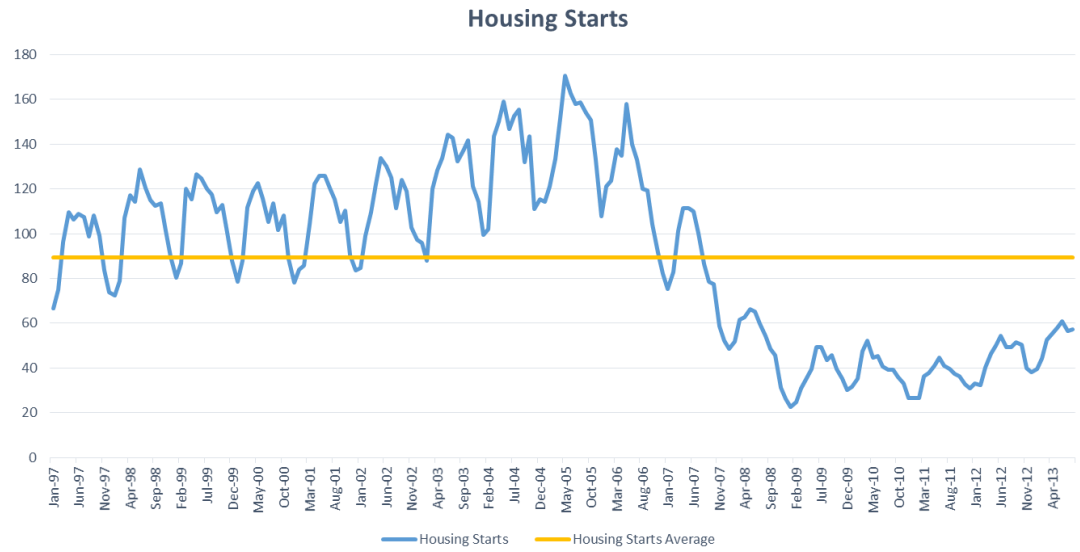

Figure 6: Housing starts in the US

Methodology

Research workers at Carnegie Mellon University have developed computer software for carrying-out causal inference using the correlation matrix associated with a set of variables. This software is labeled GES algorithm, or Greedy Equivalence Search and exists as one of several offerings under the umbrella TETRAD V. Briefly, one begins with a complete undirected graph, where every variable in a set of variables is connected to every other variable by an edge (line). Correlation and partial correlations are used to remove edges (lines) between variables if such correlations are not significantly different from zero, given a pre-determined level of significance. Edges (lines) surviving all correlation and partial correlation tests are then directed (assigned arrows "$X \rightarrow Y$ or $X \leftarrow Y$") by applying the notion of *d*-separation, which is a graphical characterization of conditional independence (Pearl, 1995).

Information on the numbers of participants in enrolled in SNAP is modeled as dependent on the shocks emanating from the macroeconomic variables considered. The GES-Algorithm found in association with the TETRAD project, is applied to achieve such identification. Applications of these algorithms have become prevalent in recent years following Swanson and Granger (1997) and Bessler and Akleman (1998).In order to generate the model using TETRAD, we had to input the data in the form of a correlation table. After finding the correlation coefficients between each variable, they were formatted in the correlation table displayed in Table 1 below. According to information shown in Table 1, there are many with strong correlations. SNAP enrollment and unemployment has a positive correlation of .85, therefore these variables move together with somewhat strong correlation. However, our model will look to find the direction that the relationship flows to better understand not only the correlation between two variables, but also direction of causality of the relationship. Some correlations are almost nonexistent, the Kansas City financial index and West Texas Intermediate oil prices have a correlation coefficient of -0.009, which is very small compared to others. Overall, SNAP enrollment has a negative relationship with housing starts and the Kansas City Index, while have a positive relationship with unemployment, S&P Case-Shiller home price index, oil prices and personal savings rate. Housing starts are negatively correlated with every variable except for home price index and Kansas City index, these two variables have very low positive correlations.

	SNAP	Unemp2	House	KC_Index	S_P	WTI	PSR
SNAP	1						
Unemp	0.85025	1					
House	-0.72724	-0.7268	1				

KC_Index	-0.06083	0.1193	-0.37297	1			
S_P	0.35043	0.15445	0.02535	-0.13141	1		
WTI	0.77439	0.53783	-0.5523	-0.00948	0.64501	1	
PSR	0.26815	0.48275	-0.45911	0.2412	-0.48912	-0.08283	1

Table 1: Correlation matrix of the variables used in the model

CHAPTER III

RESULTS

Contemporaneous causality structure associated with seven variables considered in the model is shown in Figure 7. This graphical model shows the edges or relationships that were found between each of the seven variables. Table 1 shows the parameter estimate associated with each variable, its standard error, t-statistic value and associated probability value (p-value). One must use both Directed Acyclic Graph shown in Figure 7 and associated parameter estimates shown in Table 2 in interpreting magnitude and direction of causality associated with each edge.

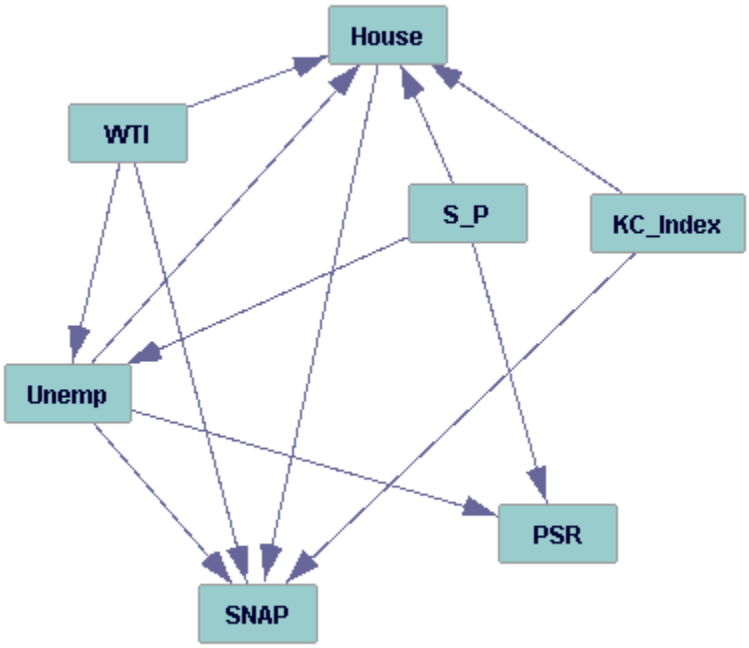

Figure 7: Directed Acyclic Graph showing the contemporaneous causality structure associated with seven variables considered

As shown in the Figure 7, number of housing starts in the U.S. economy is directly caused by unemployment rate, oil prices, S&P Case-Shiller homes price index and the Kansas City Financial Stress Index (KC_Index). Furthermore, the higher the financial stress, (measured through KC_Index), unemployment level and oil price, the lower the housing starts. On the other hand, the higher the S&P Case-Shiller home price index, the higher the housing starts. The number of housing starts, unemployment rate, the financial stress and oil prices, directly cause the SNAP participation rates. Low level of housing starts is indicative of having more participants in the SNAP program. High level of unemployment and oil price show increased number of participants in the SNAP program. Personal savings rate is directly caused by S&P Case-Shiller home price index (higher the home price index, lesser the personal savings) and unemployment rate (higher unemployment rate is associated with more savings).

There are also some areas of the model that show indirect relationships between the variables. For instance, though the home price index does not have a direct relationship with the SNAP enrollment it does have a direct effect on the unemployment rate, which has an effect on the SNAP enrollment. When looking at oil prices, though they had a direct relationship with SNAP enrollment, they also had an indirect relationship through the unemployment rate. The same situation is true when looking at the Kansas City index, though it has a direct relationship with SNAP enrollment it also has an effect on SNAP through the housing starts variable.

Table 2: Parameter estimates for each edge and their associated significance

Edge		*Coefficient*	*Standard Error*	*T- Stat*	*P-value*
House	SNAP	-0.2266	0.0415	-5.4571	0.0000
KC_Index	House	-0.2695	0.0341	-7.8967	0.0000
KC_Index	SNAP	-0.1966	0.0273	-7.2125	0.0000
S_P	House	0.4452	0.0464	9.6006	0.0000
S_P	PSR	-0.5710	0.0479	-11.9159	0.0000
S_P	Unemp	-0.3343	0.0752	-4.4448	0.0000
Unemp	House	-0.4499	0.0415	-10.8328	0.0000
Unemp	SNAP	0.4878	0.0366	13.3106	0.0000
Unemp	PSR	0.5658	0.0479	11.8085	0.0000
WTI	House	-0.6050	0.0536	-11.2971	0.0000
WTI	SNAP	0.3904	0.0300	13.0031	0.0000
WTI	Unemp	0.0752	0.0752	9.8728	0.0000

Note: The significance level used in this study is set at 95% level (p-value 0.05). We reject the null hypothesis that edges are statistically not different from zero at p-value 0.05.

CHAPTER IV

CONCLUSION

Monthly U.S. data for the period 1997-2012 associated with macroeconomic shocks and participation in food assistance programs were used to model contemporaneous causal flows of macroeconomic shocks and participation in food assistance programs using recent advances in artificial intelligence and Directed Acyclic Graphs. We find that participation in SNAP program is directly caused by unemployment rate, oil price, number of housing starts and financial stress faced by families in the United States.

With a more accurate set of predictions associated with participation rates in food assistance programs based on macroeconomic drivers or shocks, policy makers will be in better position to assess program costs and to minimize errors in the budgetary process. The model created by this research will contribute to expanding the understanding of the complex web of macroeconomic variables affecting SNAP enrollment rates in the United States. However, because of the complexity of the issue, more research will need to be done to identify the underlying causes of these relationships with a richer set of macroeconomic variables.

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