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DOES ECONOMIC INSECURITY CAUSE WEIGHT GAIN AMONG CANADIAN LABOR FORCE PARTICIPANTS?

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The National Population Health Survey (NPHS) suggests that for labor force participants age 25 to 64, the prevalence of self-reported obesity in Canada has increased from 16 percent in 1998 to 23 percent in 2008. Using six cycles of NPHS data (1998–2009), I explore Canada's obesity dilemma by considering the effect of economic insecurity—measured as the probability of an individual experiencing a severe negative economic shock. As an identification strategy, a fixed effects model is employed to control for unobserved time-invariant heterogeneity and a set of instruments based on an individual's economic environment are specified in order to isolate causality. Results suggest that for males age 25 to 64, a 1 percent increase in economic insecurity is predicted to increase their body mass index (BMI) by 0.10 points. For females age 25 to 64, the association between economic insecurity and BMI is statistically insignificant at conventional confidence levels.

JEL Codes: I12, I31, I32

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1. Introduction

The colloquial term "comfort food" is generally levied upon calorically dense food eaten to reduce feelings of stress. Recent trends suggest such foods are gaining popularity (Wells and Buzby, 2008). Is it possible that social and economic pressures imply people need more "comforting" and use food to provide that feeling? In this paper, I examine the hypothesis that an increase in an individual's economic insecurity causes weight gain thereby increasing their body mass index (BMI) and risk of obesity.

Since roughly 1980, Canada has experienced a significant increase in average body weight along with an accompanied rise in obesity (Tremblay *et al*., 2002; Public Health Agency of Canada, 2010). Using measured data, the Canadian Community Health Survey suggests that approximately 25 percent of Canadian adults 18 and older were obese in 2008, up from 15 percent in 1989 (Statistics Canada, 2008a). Using self-reported data, the same survey classifies about 17 percent of adult Canadians as obese, up from about 10 percent in 1989.

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Research suggests that obesity is an epidemic that has the potential to cause serious declines in health (United States Department of Health and Human Services, 2001; Ogden *et al*., 2004). Wisman and Capehart (2010) claim that "... only tobacco use causes more preventable deaths" (p. 937). A recent report finds that even moderate obesity (i.e. a BMI level between 30 and 35), which is relatively common (about 15–20 percent of the Canadian adult population), can reduce life expectancy by up to four years (Prospective Studies Collaboration, 2009). Health consequences attributed to obesity include: type-two diabetes, cardiovascular and respiratory diseases, and even some forms of cancer (Bray, 2004; Poulain *et al*., 2006).

A hypothesis in the social science literature has begun to emerge suggesting that economic insecurity may in part explain the North American obesity concern (Smith, 2009; Offer *et al*., 2010; Wisman and Capehart, 2010). Osberg (1998) defines economic insecurity as the "inability to obtain protection against subjectively significant potential economic losses" (p. 17). Notably, economic insecurity is a forward-looking concept which encompasses issues such as the probability of a substantial income drop and/or the probability of job loss.

Why might increasing economic insecurity be causing rising obesity rates? As Smith *et al*. (2009) put it: "viewed from the perspective of behavioral biology... the reason humans and other animals evolved with the ability to store body fat is presumably because it was necessary to survive during periodic food shortages" (p. 1). For all but the last few decades of human evolution, future periods of food scarcity have been, for most of the population, quite probable. In such an environment, over-eating when anxious about the future was an adaptive response to potential future food scarcity which, over many millennia, became hard-wired into human psychology. Notably, humans possess an evolutionary acquired genotype that promotes the efficient storage of fat (Chakravarthy and Booth, 2004). Survival probability during periods of famine was much higher with the ability to efficiently store food. As a result, humans today have a heightened ability to store fat in the presence of possible famine. Although, the threat of a famine in the developed world today is negligible, humans still possess this genotype (Neel, 1962; Chakravarthy and Booth, 2004).

Accompanying the above "evolutionary response" hypothesis is the "neurotransmitter hypothesis". Blundell (1977) examines the relationship between serotonin, a neurotransmitter, and body weight. When humans eat a large quantity of food, there appears to be a sharp increase in serotonin release. Moreover, Abramson (1998) suggests that stressful events cause a decrease in serotonin levels and Asberg and Forslund (2000) find that very low levels of serotonin are a strong predictor of depressive and suicidal behavior. Wurtman and Wurtman (1989) suggest that given the spike in serotonin after the consumption of foods rich in carbohydrates, people are over-eating in order to feel better. Thus, because over-eating causes a biochemical reaction within the brain, which helps relax the body, it acts as a self-medication for stress (Dietz, 1995; Smith, 2009).

Not only is it possible that economic insecurity causes over-eating, it may also change dietary composition. Parker (2008) notes that during the recession of 2008-09, Americans turned to comfort food more than previously. Moreover, Ng and Jeffery (2003) suggests that higher levels of stress are associated with a higher

fat diet. While the authors find stress is also associated with less frequent exercise and cigarette smoking, it is important to note that these results are correlational.

Offer *et al*. (2010) suggest that, at the country level, when economic insecurity and/or inequality increase, the response is elevated stress levels among individuals which in turn leads to over-eating and weight gain. They note: (i) obesity prevalence is higher among lower income individuals, (ii) body weight has been increasing over the past 20 to 30 years, and (iii) obesity is approximately 50 percent higher in countries that tend to emphasize liberal market regimes (i.e. countries that support free-market economic behavior). At the country level, their results suggest that "economic insecurity and 'market-liberal' welfare regime are the two strongest determinants of the level of obesity" (p. 32).

Hacker (2006) notes that many of society's risks were at one time pooled and managed by over-arching institutions. However, in recent years, many risks have been shifted to the individual (e.g. the decline in number of North American firms offering health insurance and pension plans to their employees). Similarly, Wisman and Capehart (2010) suggest that increased economic insecurity has arisen from the gain in capitalism's importance in modern society. They propose that elevated levels of insecurity increase the stress level of individuals who in turn self-medicate by consuming calorically dense foods. Empirically, Smith *et al*. (2009) find that among U.S. working age men, a drop in economic security causes a rise in body weight. The authors also find an increase in insurance programs tends to prevent weight gain.

Given the above, people are likely to cope with stress by over-eating (and/or changing their dietary composition). Thus, I hypothesize that a heightened probability of an economic shock predicts an increase in an individual's body weight. Using six cycles of longitudinal National Population Health Survey (NPHS) data, I derive an economic insecurity index based on the predicted probability an individual experiences a severe negative economic shock. This economic insecurity index is then used as a predictor of body weight (measured using BMI) for working age males and females (age 25 to 64). I develop an identification strategy using a person-specific fixed effects regression model along with a set of instrumental variables to account for potential reverse causality between economic insecurity and body weight. For working age males, results suggest that a 1 percent increase in economic insecurity predicts an increase in BMI of about 0.10 points. For working age females, the relationship between economic insecurity and BMI is statistically insignificant (P-value = 0.44). These findings are robust to several different model specifications.

The remainder of the paper is laid out as follows. Section 2 presents the data for this analysis while derivation of the economic insecurity index is discussed in Section 3. Next, Section 4 defines the econometric model with the accompanying results presented in Section 5. Results are discussed in Section 6 and Section 7 concludes.

2. Data

This study uses six cycles of Statistics Canada's longitudinal NPHS data (cycles 3 to 8). This Canadian survey commenced in 1994-95 (cycle 1) with a

new cycle of data being released every two years. Notably, the last cycle of data collection occurred in 2010–11 (cycle 9) as the survey was discontinued in September 2012. In addition to health related questions, NPHS also surveys Canadian residents regarding their socio-demographic and economic backgrounds.

All NPHS data is self-reported. Therefore, it is possible that reporting errors exist. Body weight is of particular concern as Mokhad *et al*. (1999) and Niedhammer *et al*. (2000) find that adults tend to under-report their weight but not their height. One particular test of reliability is a comparison of Canadian body weight averages from surveys that rely on self-reported data (e.g. the Canadian Community Health Survey) with those that use measured data (e.g. the Canadian Health Measures Survey). Based on the 2007–08 Canadian Community Health Survey (Statistics Canada, 2008a), 33.7 percent of Canadian adults were classified as overweight and 17.4 percent were considered obese. Using the Canadian Health Measures Survey (Statistics Canada, 2008b), during 2007–09, 37 percent of Canadian adults were considered overweight and 24 percent were obese. Thus, it is apparent that self-reported data tends to underestimate body weight. However, as reported throughout the literature, regardless of the method of data collection, body weight is on the rise.

During the 1994–95 and 1996–97 surveys (cycles 1 and 2), NPHS did not ask individuals to report their actual annual household income. Instead, respondents were asked to report the interval within which their income after transfers but before taxes occurred. It was not until cycle 3 (1998–99) that the actual (or best guess) annual income variable was added. Although NPHS suggests an estimation technique for a respondent's annual income in cycles 1 and 2, such a method may not be best suited for evaluating cycle-over-cycle income deviations (a method used in this paper for derivation of the economic insecurity index). Especially at the low end of the income scale, even small deviations, which may be the artificial result of random income assignment, could produce inaccurate values in the derivation of the economic insecurity index. As a result, observations from 1994–95 and 1996–97 are dropped from the analysis.

Only respondents who are part of the labour force at the time of the survey are studied. When an individual leaves the labour force, they are more likely to experience a severe negative economic shock as defined in this paper. However, many decisions to exit the labour force are voluntary (e.g. return to school, early retirement, etc.) and thus, less likely to be economically stressful events. As a result, I exclude these individuals from the study.[1] If respondents report being part of the labour force at the time of survey during a subsequent cycle of data, they are included for that time period. Unfortunately, there is no way in identifying the labour force status of the spouse/cohabitant partner. However, by

[1]Given NPHS does not ask respondents their reason for being out of the labour force, those classified as discouraged workers will be excluded. Although this has the potential to attenuate results given such individuals are more likely to be economically insecure (i.e. experience a 25 percent or greater income shock) which may lead to weight gain, this group only represents about 10–15 percent of those out of the labour force based on Statistics Canada data (Table 2820219).

excluding respondents who are out of the labour force, I am able to remove at least some of the voluntary exits.[2]

The study begins in cycle 3 (1998–99) with a sample of respondents age 25 to 53 who are analyzed over the study period. By cycle 8 (2008–09), the youngest a respondent can be is 35 while the oldest is 64. This age restriction is based on the conventional age bracket for the study of working age adult behavior. Given their small sample size (less than 0.25 percent of the sample), those residing in the Canadian Territories are excluded from the analysis.

Data regarding regional unemployment (used in the construction of the economic insecurity index and as an instrumental variable) and the consumer price index (used in developing the food inflation ratio) are collected from Statistics Canada (Tables 2820123 and 3260021 respectively). This data is merged with the NPHS dataset based on the respondent's geographical location at the time of the survey. All other data are collected directly from NPHS.

The overall result is a longitudinal dataset consisting of six cycles of NPHS data. The earliest an observation can exist is 1998 while the latest is 2009. An individual can appear up to six times in the dataset. If an individual is missing any relevant data during a particular survey, that observation is classified as missing for that time period. However, if that individual answers all appropriate questions in the next survey, they are once again included in the analysis for that specific time period.

The total unrestricted sample size along with the sample size given age, sample restrictions, and attrition is presented in Table A1 of the Appendix across cycles of data. For working age males who meet all sample restrictions and have no relevant missing data, the sample size falls from 1,905 in cycle 3 (1998–99) to 1,095 in cycle 8 (2008–09). On average, male respondents appear 4.44 times in the sample over the course of the study period. For working age females who meet the sample restrictions and provide all relevant data, the sample size decreases from 1,630 in cycle 3 to 1,025 by cycle 8. On average, working age females appear 4.19 times during the study period.

3. The Economic Insecurity Index

Hacker and colleagues (2014) measure economic insecurity as a 25 percent or greater drop in year-over-year real household income after adjusting for wealth, medical expenses, and debt servicing. The authors use 25 percent as the threshold suggesting that, "the median American household would have considerable difficulty making ends meet if it experienced an income loss of 25 percent or larger" (p. S9). Moreover, Osberg and Sharpe (2009) outline four key aspects of

[2]A series of robustness checks which specified varying degrees of exclusion given labour force participation were tested. These encompassed excluding only those who reported being out of the labour force for the duration of the study period and including only those who reported being part of the labour force during each cycle of data. For working age males, given the above set of exclusion criteria, the effect sizes of a 1 percent increase in economic insecurity on body weight are 0.0832 and 0.1081 respectively (both statistically significant at the 5 percent level). Regardless of the exclusion criteria, results for working age females are statistically insignificant. Thus, key results appear to be robust to labour force sample restrictions.

economic insecurity; the probability of: (i) unemployment, (ii) illness and disability, (iii) divorce, and (iv) poverty in old age.

For this paper, construction of the economic insecurity index is based on the above research. The index measures the predicted probability that an individual will experience a 25 percent or greater short fall in cycle-over-cycle household income with probability of occurrence based on a set of circumstances related to those outlined in Osberg and Sharpe (2009).[3]

3.1. *25 percent Short Fall Dummy Variable*

A dummy variable equal to unity if the respondent incurs a severe negative economic shock is derived. The shock is based on an individual's current versus previous cycle household income - measured as all sources of household income before taxes and after transfers. To account for economies of scale, this measure of income is divided by the square root of household size to produce a measure of "equivalent income". To account for inflation, equivalent household income is measured in real terms.

Given the longitudinal nature of the dataset, a respondent's current household income $(y_{i,t})$ is compared to their household income during the previous cycle of data (both in real equivalent terms). If the respondent experiences an income loss which exceeds 25 percent, they are classified as having suffered a severe negative economic shock.[4] Thus, the economic shock variable for respondent i in time period t equals unity if:

$$\frac{(y_{i,t}-y_{i,t-1})}{y_{i,t-1}} \leq -0.25;\ \ 0\ \ \textit{Otherwise}. \tag{1}$$

As a result, a dummy variable is generated where a value of unity is given to a respondent who experiences a 25 percent or greater short fall in current versus previous cycle real equivalent household income during a particular time period; zero otherwise.

3.2. *Probability of a 25 Percent Short Fall Variable*

The economic insecurity index is calculated as the predicted probability of a 25 percent or greater short fall in current versus previous cycle household income conditional on a set of explanatory variables. In deriving this index, the following pooled probit model is specified whereby the occurrence of a severe negative economic shock is regressed on a set of covariates:

[3]An alternative threshold of 10 percent was also tested with results remaining virtually unchanged. Additionally, I also measured economic insecurity based on predicted deviations from previous cycle income—thus excluding any threshold. Key results were akin to those produced using the 25 percent threshold.

[4]Due to the issues with income measurement in cycles 1 and 2 as discussed in Section 2, the 25 percent short fall variable is only calculated using data in cycles 3 through 8. Thus, the 25 percent short fall variable is not derived for cycle 3.

$$\Pr\left(S_{i,t}=1|\boldsymbol{X}_{i,t}\right)= \phi\left(\boldsymbol{UE}_{i,t}\boldsymbol{\alpha}+\boldsymbol{H}_{i,t}\boldsymbol{\beta}+\boldsymbol{M}_{i,t}\boldsymbol{\gamma}+\boldsymbol{D}_{i,t}\boldsymbol{\delta}+\boldsymbol{Y}_{i,t}\boldsymbol{\varepsilon}+u_{i,t}\right). \tag{2}$$

In the above equation, S is a dummy variable which captures the occurrence of a 25 percent or greater short fall in current versus previous cycle household income, $\boldsymbol{UE}$ is a set of variables related to the individual's probability of unemployment, $\boldsymbol{H}$ is a set of variables measuring the individual's overall health, $\boldsymbol{M}$ denotes a set of marital status variables, $\boldsymbol{D}$ is a set of variables representing the individual's social demographic information, $\boldsymbol{Y}$ denotes a set of variables measuring the macroeconomic environment, u is the error term, i indexes the individual, t indexes time, and ϕ is the cumulative distribution function of the standard normal distribution.

Given the set of parameter estimates derived using Equation (2), the probability of a 25 percent or greater short fall in current verses previous cycle household income for each respondent can be determined by applying these parameter estimates to the respondent's observed set of characteristics. Since cycle 2 data is not used in the calculation of the 25 percent short fall variable for cycle 3, it must be noted that the predicted probability of a 25 percent or greater drop in cycle-over-cycle real equivalent household income in cycle 3 is an out-of-sample prediction. The result is a measure of the probability, versus the existence, of an income shock - thus, an index of economic insecurity ranging from 0 to 100 with higher values associated with an elevated probability of a 25 percent or greater fall in household income. Consequently, this measure of economic insecurity suggests a respondent's personal and environmental characteristics predispose them to a potentially severe negative economic shock.

However, it is important to note that income is measured at the household level and in real equivalent terms. Thus, certain major events may not necessarily lead to a 25 percent or greater fall in household income. For instance, consider a substantial reduction in working hours. Although this will lead to a significant economic shock for many respondents, consider those in dual income families. In such circumstances, income is pooled and a reduction in one income earner's hours may not be as influential to total household income - especially if the respondent is not the dominant income earner. Additionally, the spouse may choose to take on additional hours of work in order to, at least partially, offset the income loss. As a result, it is not automatic that a reduction in work hours will lead to a 25 percent or greater short fall.

The same is true in the case of divorce. If two income earners separate, both the numerator (i.e. real household income) and denominator (i.e. square root of household size) of the real equivalent income measure would be reduced. If there is a reduction in both, it is not assured that a 25 percent or greater short fall will ensue for the respondent in question.

Thus, it is important to keep in mind that such events do not automatically cause a 25 percent or greater short fall in current versus previous cycle household income. Specifically, changes in household size or labour adjustments made by household members in light of certain events may prevent the onset of a severe negative economic shock. However, these events are very likely to influence the odds of a 25 percent or greater short fall and hence form a set of explanatory variables used in modeling economic insecurity as discussed below.

3.3. *Probability of Short Fall Explanatory Variables*

As noted above, a set of explanatory variables thought to be associated with the occurrence of a 25 percent or greater fall in household income are specified based on research by Osberg and Sharpe (2009). Given the sample for this study is restricted to those between age 25 and 64, the fourth avenue, poverty in old age, is excluded. Using this set of criteria as a guideline, the following variables are included in the model.[5]

First, a set of explanatory variables associated with unemployment and socio-economic status are incorporated as determinants of a severe economic shock. The first variable is average long run real equivalent household income measured in natural log form. Given the longitudinal nature of the NPHS dataset, long run real equivalent household income is calculated as the average of the respondent's reported annual household income in real equivalent terms over the duration of the study period. The second variable measures the respondent's education using a set of dummy variables (less than high school, high school completion, some postsecondary and postsecondary completion). The next variable, occupation, evaluates the primary job of the respondent at the time of the survey. This variable is based on the National Occupation Classification system established by Human Resources and Skills Development Canada and Statistics Canada with higher values being associated with employment that requires, on average, relatively higher skill. A dummy variable measuring whether or not the individual has multiple jobs at the time of the survey is also incorporated. This variable is included given many individuals will take on additional work in light of events that reduce the household's income (e.g. spousal job loss, a pay cut, etc.). Lastly, the change in average weekly hours of work from previous to current cycle of data is included in the model.

A "health utility index" is incorporated in the model measuring the individual's self-reported overall health. The index is based on self-reported assessments of eight attributes—vision, hearing, speech, mobility (ability to get around), dexterity, cognitive ability and pain. The index ranges from -0.36 to 1 with higher values associated with better health. Based on societal views concerning health status, perfect health is rated 1 and death is rated 0. Values below 0 are perceived to be worse than death. The expectation is that individuals with a low health utility index will be associated with a higher likelihood of experiencing a severe negative economic shock given their difficulty in maintaining a consistent work schedule and the potential for large medical expenses.[6]

[5]Given the degree of subjectiveness in determining a set of covariates, several models were tested. For example, a measure of job insecurity was included in one model as a proxy for the probability of unemployment. In all cases, key results remained relatively stable with a 1 percent rise in economic insecurity predicting a statistically significant 0.06–0.13 point increase in BMI for males. The female BMI result from an increase in economic insecurity was statistically insignificant in all cases.

[6]Although Canada's healthcare system provides universal access, some items such as pharmaceutical drugs are not covered under the plan with the burden being placed on the individual. However, as noted by Himmelstein *et al*. (2009), just over 62 percent of bankruptcy filings in the United States during 2007 were medical related. In comparison, Ziegel (2001) suggests only 7 to 14 percent of bankruptcies in Canada are health related. Thus, the incidence of medical related bankruptcy in Canada is relatively low.

I include a set of variables based on the individual's marital status at the time of the survey. With the reference category being the respondent is married, three dummy variables are included: i) the respondent is single, ii) the respondent is divorced, and iii) the respondent is a widow.

A set of age variables (linear and quadratic) are included as increases in age likely bring about more seniority and employment experience which is expected to reduce the probability of 25 percent or greater fall in household income. Time (measured in years) is also controlled for to account for temporal unobserved factors. In addition, a set of socio-demographic variables are included in the model which control for race (visible minority or otherwise), whether the respondent is native-born or an immigrant, and geographic location at the time of the survey (region of residence). An index measuring social support is also included. Those with strong social support networks are likely better able to shield themselves from severe negative economic shocks. Social support is measured using a scale that identifies "information or emotional support" based on research by Sherbourne and Stewart (1991). The scale ranges from 0 to 32 with higher values representing higher levels of social support.[7]

Lastly, a set of macroeconomic variables are also included. Regardless of personal characteristics, business cycle fluctuations may impact an individual's financial situation. Using NPHS data, average real equivalent household income in each economic region in Canada is calculated and then matched with the respondent's year of interview and place of residence at that time.[8] This variable is specified in natural log form. In addition, annual unemployment rates are collected from Statistics Canada at the economic region level. These rates are matched with the respondent's year of interview and place of residence. I then derive a variable measuring current unemployment rate deviation from the long run average for each respondent - defined as the average unemployment rate in regions where the respondent resided during the study period.

3.4. *Results*

The regression model evaluates Equation (2) using a pooled probit specification consisting of five cycles of NPHS data (cycles 4–8). Longitudinal weights provided by NPHS are used to account for the stratified sampling design and attrition. Separate regressions are run for males and females. As noted above, the parameter estimates from Equation (2) are applied to each respondent's observed characteristics in determining their predicted probability of a 25 percent or greater short fall in current versus previous cycle real equivalent household income during each cycle of data. Results can be found in Table A2 of the Appendix.

[7]The scale is based on the summation of 8 questions, each with a 5 point scale (0 for "none of the time" to 4 indicating "all of the time"). The questions relate to the respondent having someone to: (i) listen to (ii) help them in a crisis, (iii) provide information, (iv) provide advice, (v) provide suggestions, (vi) share most private worries and fears, (vii) confide in, and (viii) understand their problems.

[8]Statistics Canada derives a set of 72 economic regions based on the groupings of census divisions.

4. Results

4.1. *Econometric Specification*

The association between economic insecurity and body weight (measured as BMI) is examined using the following econometric specification:

$$(3) \qquad BMI_{i,t} = \beta_0 + \beta_1 \hat{S}_{i,t} + \boldsymbol{SE}_{i,t}\boldsymbol{\gamma} + \boldsymbol{SD}_{i,t}\boldsymbol{\delta} + \boldsymbol{HR}_{i,t}\boldsymbol{\varepsilon} + \boldsymbol{T}_{i,t}\boldsymbol{\zeta} + \pi P_{i,t} + \upsilon_{i,t}.$$

In this equation, *BMI* captures the body mass index, $\hat{S}$ is the predicted economic insecurity index[9], $\boldsymbol{SE}$ is a set of socio-economic variables, $\boldsymbol{SD}$ represents a set of socio-demographic variables, $\boldsymbol{HR}$ is a set of health-related variables, $\boldsymbol{T}$ denotes a set of age and time variables, P controls for food prices, υ is the error term, i indexes the individual, and t indexes time.

4.2. *Identification Strategy*

The relationship between economic insecurity and BMI likely suffers from endogeneity due to unobserved time-invariant characteristics. Individuals possess a set of unobservable fixed personal characteristics (e.g. genes) that influence their body weight. Such characteristics are likely constant during the study period and will be included in the error term (υ). Given data on these characteristics is not available, regression results may be endogenous due to an omitted variable bias. To control for this endogeneity, I apply a person-specific fixed effects estimator whereby all time-invariant heterogeneity is removed from the model.[10,11]

It is also possible that endogeneity exists due to reverse causation. That is, an individual's body weight may affect their level of economic insecurity. For instance, obese individuals may find it more difficult to secure permanent employment given possible discrimination (Puhl and Brownell, 2001). Moreover, health issues surrounding obesity may cause the individual to miss time at work, thereby elevating their probability of incurring a severe negative economic shock (Carr and Friedman, 2005; Schmier *et al*., 2006; Agerstrom and Rooth, 2011). To the extent this is true, results using pooled ordinary least squares (OLS) will be biased. Thus, to control for reverse causality, an instrumental variables (IV) estimation strategy is developed.

Akin to Barnes and Smith (2009) and Smith *et al*. (2009), the instruments capture fluctuations in the broader economic environment. The conjecture is that an individual's level of economic insecurity is, in part, determined by the macro environment. Specifically, an individual's level of economic insecurity in any given year is a function of economic insecurity at the provincial level along with the

[9]As a robustness check, I also included a dummy variable equal to unity given the occurrence of the 25 percent or greater short fall variable. Key results remained virtually unchanged with the occurrence variable being statistically insignificant for both males and females.

[10]For each individual i, the average of each variable in Equation (3) is computed over the study period (i.e. cycles 3 through 8). Subtracting this computation from Equation (3) time demeans all variables in the regression.

[11]For both males and females, a Hausman test rejects the null hypothesis that the preferred model employs random effects in lieu of fixed effects –i.e. the idiosyncratic errors appear to be correlated with the explanatory variables.

unemployment rate at the economic region level. Thus, the average and median levels of the economic insecurity index are calculated for each province during each year of the study period. These values are then matched with each respondent's reported province of residence during each year they are surveyed. Additionally, the unemployment rate for each economic region during each year of the study period is collected from Statistics Canada (Table 2820123) and merged with the NPHS dataset based on survey year and the respondent's region of residence.

As a result of this estimating procedure, the variation in economic insecurity is directly attributable to the broader macro environment. It is unlikely that fluctuations in the macro environment would be related to the BMI of any one individual nor with unobserved personal characteristics. Thus, such fluctuations can be treated as an exogenous source of variation that can be used in estimating the economic insecurity parameter (β_1) (see section 5.3 for more detail).

4.3. *Dependent Variable Specification*

Using self-reported NPHS data, the outcome variable, BMI, is calculated as follows:[12]

$$BMI = \frac{mass\ \ (kg)}{height\ \ (m)^2} \quad . \tag{4}$$

Less than 0.3 percent of the BMI distribution fell below an index value of 10. Close inspection of these observations shows potential errors in weight measurement. In some instances, respondents reported weighing less than 23 kilograms (approximately 50 pounds). Whether these were key stroke errors, or mistakes due to the nature of self-reported data, the data are very likely incorrect. Therefore, the bottom 0.3 percent of the distribution are excluded from the analysis. Inspection of the upper range of the distribution gives no reason to suspect measurement error.

As noted by Stommel and Schoenborn (2009), respondents tend to overestimate their BMI when at the low end of the BMI scale (BMI < 22) and underestimate their BMI when at the high end of the scale (BMI > 28). Moreover, BMI has been criticized for its inability to distinguish between fat-free mass such as bone and muscle and that of actual fat (which is the objective of BMI measurement). Unfortunately, more accurate measures of fatness such as waist-to-hip ratio, waist circumference, and skinfold thickness are not available within the NPHS dataset. However, it is important to note that Heineck (2007) measures fatness using a set of advanced techniques in addition to BMI to examine the relationship between adiposity and labour market outcomes. Results using BMI versus more

[12]Pregnant women are excluded from the analysis given their BMI score is a misleading indication of obesity. Moreover, The Canadian Guidelines for Body Weight Classification in Adults recommends that BMI not be calculated for lactating women. However, NPHS does not ask females respondents if they are lactating and thus, they are included in the study. A robustness test excluded females both when reporting being pregnant and during the following cycle of data—i.e. the time during which breastfeeding may occur. Results remained virtually unchanged.

sophisticated methods of adiposity measurement tend to produce similar findings regarding labour market outcomes.

4.4. *Additional Explanatory Variables*

Socio-Economic Variables

Income is measured based on the respondent's best estimate of household income from all sources (including transfer payments) before taxes and deductions in the 12 months preceding the survey. To adjust for household size, income is measured in equivalent terms—income divided by the square root of household size. This measure is also adjusted for inflation. To capture potential non-linearities, both a linear and quadratic term are included in the model. The survey asks respondents to report their highest level of education. Based on their response, a set of dummy variables are derived which control for the respondent having: (i) less than high school completion, (ii) a high school diploma (reference category), (iii) some postsecondary education, and (iv) postsecondary completion.

Socio-Demographics

Given a respondent has only so much time, the pressure of young children in the household may reduce an individual's ability to be physically active (Bellows-Riecken and Rhodes, 2008) and/or eat nutritious meals (Laroche *et al*., 2007). Therefore, a dichotomous variable controlling for the presence of children in the household under the age of 5 is included in the model. Furthermore, a dummy variable equal to unity is included if the individual reports being married; zero otherwise. Not only is Quebec the only Francophone province in Canada but it also possesses a set of cultural and political characteristics that make it distinct from the rest of the country. As a result, I include a dummy variable equal to unity if the individual resides in Quebec; zero otherwise. Given the person-specific fixed effects estimation technique, time-constant variables cannot be included in the model. Thus, variables such as race, immigration status, and primary language spoken in the household cannot be included.

Health-Related Variables

Several papers demonstrate a link between physical exercise and body weight (Ravussin *et al*., 1988; Williamson *et al*., 1993; Sherwood *et al*., 2000; Levin and Dunn-Meynell, 2004; Slentz *et al*., 2004). This analysis includes an energy expenditure index derived by NPHS. This index measures the daily energy expenditure of a respondent during leisure time activities over the twelve months preceding the survey using the frequency and duration of physical activity. Each physical activity is adjusted to reflect its metabolic energy cost (MET value) relative to when the body is at rest. For instance, a physical activity that has a MET value of 5 would require five times the amount of energy in comparison to when the body is at rest.

Chou *et al*. (2004) suggest that tobacco use and obesity are substitute goods. Additionally, smoking cessation has been linked with weight gain (Williamson *et al*., 1991; Filozof *et al*., 2004). Thus, three dummy variables are specified: those who have never been a daily smoker (reference category), those who are currently daily smokers, and those who used to be daily smokers but have since quit.

A continuous variable measuring the self-reported number of alcohol drinks consumed by the respondent during an average week is included in the model. Both a linear and quadratic term are specified to capture potential non-linearities in the relationship between alcohol use and body weight. Notably, the variable does not distinguish between types of alcoholic beverages as NPHS considers one drink to be either: one and a half ounces of spirits, one glass of wine, or one bottle/can of beer.[13]

Age & Calendar Time

Age is included in the model in linear and quadratic form. To account for secular trends, the inclusion of a calendar time variable, measured in years, is also included in both linear and quadratic form.

Food Prices

If the price of food becomes cheaper relative to other consumer goods, consumer choice models suggest individuals will increase their consumption of food and vice-versa. Statistics Canada publishes annual data measuring the Consumer Price Index (CPI) at the provincial level (Table 3260021). Within this index, Statistics Canada also partitions out several items including that of food prices. As a result, I include a variable that ratios food inflation against overall inflation (measured by the percentage change in CPI). This data is matched with NPHS data based on the respondent's province of residence during each year of the study period.

5. Results

Separate analyses are run for males and females and include all sample restrictions noted above. Regression models in this section evaluate Equation (3) using a fixed effects estimation model that uses variation in the macroeconomic environment to instrument for economic insecurity. As a means of comparison, regression results using pooled OLS and fixed effects can be found in Table A3 of the Appendix. Because the model is over-identified, a Generalized Method of Moments (GMM) estimator is employed given in the presence of heteroskedasticity, a GMM estimator is more efficient than Two Stage Least Squares (Baum *et al*., 2007). Note that first stage regressions can be found in the Appendix–Table A4. The study period consists of six cycles of pooled NPHS data (1998–2009). To

[13]This serves as a slight limitation given research does suggest that certain types of alcohol are more prone to causing obesity than others. For instance, Vadstrup *et al*. (2003) find that moderate to high consumption of beer and spirits is positively associated with body weight while moderate to high consumption of wine predicts reduced body weight.

TABLE 1
Estimates Using Fixed Effects and Instrumental Variables

Dependent Variable: BMI	Males	Females
Economic Insecurity Index	0.1017**	−0.0187
	(0.03)	(0.02)
Real Equivalent Household Income (in 1000's)	0.0080**	−0.0003
	(0.00)	(0.00)
Real Equivalent Household Income (in 1000's) - Squared	−0.00003***	−0.00001
	(0.00001)	(0.00001)
Education: Less Than High School	0.4989	−1.4186*
	(1.25)	(0.62)
Education: Some Post-Secondary	−0.5031	0.6471
	(0.73)	(0.40)
Education: Post-Secondary Completion	−0.3615	0.7086
	(0.72)	(0.39)
Presence of Children Under 5 in Household	0.0456	0.0257
	(0.08)	(0.12)
Respondent is Married	0.6098***	0.3593
	(0.12)	(0.17)
Region of Residence: Quebec	−1.8602***	3.0790
	(0.53)	(3.19)
Energy Expenditure Index	−0.0559***	−0.1396***
	(0.02)	(0.03)
Respondent is a Daily Smoker	−0.7910***	−1.0460***
	(0.17)	(0.24)
Respondent is a Former Daily Smoker	−0.2795	−0.1366
	(0.15)	(0.19)
Alcohol Consumption Per Week	0.0023	0.0056
	(0.01)	(0.02)
Alcohol Consumption Per Week - Squared	−0.00001	−0.00017
	(0.00012)	(0.00023)
Age	0.2678	0.0362
	(0.13)	(0.17)
Age - Squared	−0.0032***	0.0009
	(0.0008)	(0.0010)
Calendar Time	0.1771	0.0184
	(0.12)	(0.15)
Food Inflation Ratio	0.0160	0.0044
	(0.01)	(0.02)
Number of Observations	8,480	7,520
Number of Respondents	2,140	2,025
R^2	0.1002	0.0909

Notes: *** $p < 0:001$, ** $p < 0:01$, * $p < 0:05$. Estimation technique: Instrumental variable regression with fixed effects using six cycles of NPHS data. The economic insecurity index variable is instrumented by using provincial-level mean and median values of the economic insecurity index and economic region-level unemployment rates during each year of the study period. Robust Standard errors are in parentheses. Given confidentiality rules with Statistics Canada data, observation totals are rounded to the nearest 5.

account for the stratified sampling design and attrition, longitudinal population weights provided by NPHS are applied throughout.

5.1. *Descriptive Statistics*

The sample means for each cycle of NPHS data can be found in Table A5 of the Appendix. Average BMI for males increases by just over 1 point during the

study period (26.56 to 27.73). Additionally, average BMI also increases for females over the study period going from 24.92 in cycle 3 (1998–99) to 26.50 in cycle 8 (2008–09).

For working age males, the average value of the economic insecurity index monotonically decreases across cycles of data (12.02 in cycle 3 to 7.71 in cycle 8). Given the onset of the Great Recession during the fall 2008–09, it is expected average economic insecurity should begin to rise. Restricting the sample in cycle 8 (2008–09) to only those surveyed after August 31, 2008 suggests this to be true whereby mean average economic insecurity rises to 8.27. This trend is similar for working age females where the average value of the economic insecurity index decreases from 14.66 in cycle 3 to 10.24 in cycle 7. During cycle 8 (2008–09), the average value of the index increases to a value of 11.40. This downward trend in average economic insecurity is likely due, in part, to a notable drop in unemployment in Canada during this period. Statistics Canada data (Table 2820002) suggests the unemployment rate fell over 2 percentage points from 2002 to 2008 for working age adults.

Over the study period, average real equivalent household income monotonically increases for working age males and females. Although gains in real income may appear rather large (over 3 percent per year), recall this income measure accounts for household size, which on average, decreases over the study period. Additionally, those surveyed in cycle 3 were 25 to 53 years of age. By cycle 8, these individuals are 35 to 65 years of age. Thus, given a typical age-earnings profile, we can expect these individuals to experience a rise in real income over the study period.

5.2. *Regression Results*

Males

Regression results for working age males can be found in column 2 of Table 1. The model includes 8,480 observations from 2,140 respondents and explains just over 10 percent of the within variation in BMI.

For working age males, a 1 percent increase in the economic insecurity index predicts a 0.10 point increase in BMI. Additionally, an increase in real equivalent household income is associated with an increase in BMI until reaching approximately $154,000—after which, BMI begins to decrease given a rise in income. However, given the mean of real equivalent household income for the pooled sample is about $41,300 with a standard deviation of $29,170, an increase in real equivalent household income is associated with gains in body weight for the majority of working age males in the sample.

Males who report being married are expected to have a BMI that is about 0.61 points higher than otherwise. Moreover, males who reside in Quebec are associated with a BMI that is about 1.86 points lower than those residing in the rest of the country.[14] A 1 point increase in the energy expenditure index is associated with a decrease BMI of 0.06 points. Furthermore, daily smokers are expected

[14]Clemens *et al.* (2015) report that Quebec attracts the lowest amount of total in-migration in Canada (the next lowest province, Ontario, attracts almost twice the average rate of Quebec) and is the only province to have experienced a net out-migration every year during the past 25 years, losing over half a million residents. Therefore, given the fixed effects estimator, this result is largely driven by respondents choosing to leave Quebec.

TABLE 2
Instrument Validity Texts

Weak Identification Test	Males	Females
Cragg-Donald Wald F-Statistic	241.79	214.35
Kleibergen-Paap rk Wald F-Statistic	176.11	89.53
Stock-Yogo weak ID test critical values:		
5% maximal IV relative bias	13.91	
10% maximal IV relative bias	9.08	
20% maximal IV relative bias	6.46	
30% maximal IV relative bias	5.39	
10% maximal IV size	22.30	
15% maximal IV size	12.83	
20% maximal IV size	9.54	
25% maximal IV size	7.80	
Over-identification Test of All Instruments		
Hansen J Statistic	0.865	0.570
χ^2 distribution P-value	0.65	0.75

to have a BMI that is about 0.79 points lower than non-smokers. Lastly, aging is associated with an increase in BMI until males reach the age of 42, thereafter decreasing.

Females

Regression results for working age females are found in column 3 of Table 1. The model examines 7,520 observations collected from 2,025 working age females and explains about 9 percent of the within variation in BMI.

For working age females, economic insecurity does not appear to be a predictor of BMI (P-value = 0.44). Moreover, controls for real equivalent household income are not statistically associated with BMI. However, females with less than a high school diploma are associated with a BMI value that is about 1.42 points lower than those with a high school diploma.

Relative to those who are either single, divorced, or widowed, married females are associated with an increase in BMI of about 0.36 points. Additionally, a 1 point increase in the energy expenditure index is associated with a decrease in BMI of 0.14 points. Lastly, female respondents who report being daily smokers are expected to have a BMI that is just over 1 point lower than non-smokers.

5.3. *Instrument Validity*

For the instruments to be valid, they must be sufficiently correlated with the endogenous variable - economic insecurity. Additionally, they must also be uncorrelated with the error term and thus, correctly excluded from the second stage regression. To ensure the validity of the instruments, a series of tests are performed which are presented in Table 2.

To address the first concern, the Kleibergen-Paap (2006) rk Wald F-statistic for weak identification is evaluated.[15] This test statistic is compared to the weak

[15]The Kleibergen-Paap Wald rk F-statistic is used in lieu of the Cragg-Donald (1993) Wald F-statistic given the latter is only valid under the assumption of *i.i.d.* errors.

ID test critical values derived by Stock and Yogo (2005).[16] For both males and females, this test rejects the null hypothesis of weak instruments in terms of both bias and size as Kleibergen-Paap test statistics greatly exceed Stock-Yogo thresholds. Thus, variation in a respondent's macroeconomic environment appears to have a strong association with their individual level of economic insecurity.

For the second concern, it is possible that an economic region's macroeconomic conditions could affect an individual's BMI through channels other than an individual's economic insecurity. For starters, macroeconomic shocks at the provincial level may affect a government's revenues which may in turn affect an individual's BMI through changes in provided services and/or taxation. For example, a negative shock may reduce a provincial government's ability to provide certain social services which may increase an individual's stress should they rely on such services. Moreover, certain macroeconomic shocks may affect an individual's peers which could cause the individual stress—thus, BMI may rise as a result. For instance, Helliwell and Huang (2014) find that county level unemployment is negatively associated with the well-being of employed individuals residing in that county. Although the economic insecurity index controls for deviations in the unemployment rate at the regional level, it is not a given that the onset of unemployment regarding a respondent's neighbors, friends, and family would be picked up by this statistic. Lastly, it is possible that we would observe correlation between an individual's BMI and macroeconomic conditions if regions with a higher average BMI tend to produce poorer macroeconomic conditions due to reduced productivity and/or increased absenteeism. To the extent these effects exist, key results could possess an upward bias.

The second concern is addressed using a test of over-identification developed by Hansen *et al*. (1996). Known as the Hansen *J* statistic, this test examines the null hypothesis that the instruments are uncorrelated with the error term. Rejection of the null suggests that instruments are unlikely to be exogenous which casts doubt on the validity of the estimates. However, for both males and females, the Hansen *J* statistic fails to reject the null hypothesis given standard confidence levels (P-value = 0.65 and 0.75 for males and females respectively). Given results of this test, there is greater confidence these instruments are in fact exogenous and therefore, correctly excluded from the model.

6. Discussion

In this paper I hypothesize that elevated economic insecurity causes working age individuals more stress which is likely to produce an over-eating response thus causing gains in body weight. There is currently no officially recognized measure of economic insecurity. Consequently, I derive an economic insecurity index defined as an individual's predicted probability of a 25 percent or greater short

[16]Although the Kleibergen-Paap Wald rk F-statistic relaxes the assumption of homoskedastic errors, critical values compiled by Stock and Yogo (2005) rely on this assumption. As a result, Baum *et al*. (2007) suggests caution in comparing the Kleibergen-Paap Wald rk F-statistic to the Stock-Yogo critical errors and/or using Staiger and Stock (1997) rule-of-thumb that an F-statistic must exceed a value of 10 to avoid the problem of weak identification.

fall in current versus previous cycle household income—a method consistent with the theoretical nature of economic insecurity.

Using both a person-specific fixed effects estimator and an instrumental variable approach to control for reverse causality, I find compelling evidence to support the above hypothesis for working age males. Using six cycles of NPHS longitudinal data (1998–2009), results suggest a 1 percent increase in economic insecurity predicts a 0.10 point increase in BMI for males age 25 to 64. For working age females, the association between economic insecurity and body weight is statistically insignificant (P-value = 0.44).

To put this in perspective, for a male of average height (approximately 1.75 meters), a 3.2 percentage point increase in the economic insecurity index is predicted to increase their body weight by about 1 kilogram. Moreover, based on NPHS data, the average BMI level for a male age 25 to 64 in 2008–09 was about 27.7. Should a male with this average level of BMI experience a 23 percentage point increase in economic insecurity, their BMI level is expected to increase to that of 30—the threshold for obesity.

Fortunately, for most working age Canadians the predicted probability of a 25 percent or greater short fall in real equivalent household income is relatively low with average values over the study period of about 10 and 12 percent for males and females respectively. Moreover, for both males and females, the distribution of the variable possesses a positive skew. With that said, although Statistics Canada prohibits the release of exact data points, this economic insecurity index contains individuals with predicted probability values in excess of 75 percent. As a result, it is not assured that individuals will never experience drastic increases in economic insecurity.

For instance, consider a married, Caucasian, native born individual with a high school education and mean level of long run real equivalent household income who resides in Ontario. Moreover, assume a mean level on the occupation index, no multiple jobs and no change in job hours. Age and time variables as well as the natural log of regional real equivalent household income are set to their mean values. Furthermore, assume no deviations in the regional unemployment rate. If this hypothetical individual transitions from having perfect health (health utility index = 1) to that of poor health (health utility index = 0.25), their economic insecurity value increases by over 10 percentage points (7.45 percent to 17.72 percent). If this hypothetical individual also gets divorced, the economic insecurity value is predicted to increase by another 3 percentage points to 20.88 percent. Lastly, if this hypothetical individual was to also experience a decline in hours of work from 40 to 20 hours per week, their economic insecurity index is now predicted to increase to that of 23.83 percent. Thus, a chain of unfortunate events has the potential to cause a male with a mean level of BMI to become obese.

While the result for working age males may be statistically significant, the magnitude of effect, as discussed above, is rather small. However, this study examines the contemporaneous effect of increased economic insecurity on body weight. It does not evaluate the potential enduring nature of economic insecurity. Unlike some other negative shocks that occur in life (e.g. victim of violence, divorce, or death of a loved one), the occurrence of economic insecurity can persist for

prolonged periods. Thus, it is possible that those who experience persistent economic insecurity could be subject to even greater weight gain than what is predicted in this study. As a result, future research may wish to explore the link between chronic economic insecurity and weight gain.

The effect of BMI on economic insecurity should also be explored. It is possible that factors such as discrimination may cause obese workers to face economic penalties. If this is the case, a positive feedback loop ensues given those who experience obesity related discrimination experience more economic stress and as result, are more likely to self-medicate by over-eating. The result in this case is the obese become even more obese. A simple test in which the sample is truncated to include only those who are: (i) overweight and (ii) obese suggests the effect size of a 1 percent increase in economic insecurity on BMI for working age males is 0.10 and 0.18 points respectively (female results are statistically insignificant). Future research evaluating the possibility of a feedback loop using methods such as quantile regression could shed further light on this issue.

Evaluating the effect of an economic security index which measures the predicted probability of experiencing a 25 percent or greater increase in real equivalent household income suggests a negative association with BMI for working age males (statistically insignificant for females). This index is derived in the same manner as the economic insecurity index with the difference being the dependent variable in Equation (2) now measures a positive income shock. Specifically, a 1 percent increase in this index predicts a 0.025 point decrease in BMI for working age males. This effect size is much smaller in comparison to that of the economic insecurity index. Thus, given a series of income volatile years, the net effect on BMI would likely remain positive. Therefore, future research may also consider exploring the impact of not only chronic economic insecurity but also that of income volatility and the enduring nature of weight gain.

Additionally, the difference between the male and female result regarding the effect of economic insecurity on BMI is striking. One possible explanation for this difference is that of "spheres of influence". Specifically, males may view economic insecurity as a dominant factor in their lives whereas females view this issue as only one component in the sphere of factors affecting their identity. Hence, when a male experiences an increase in the predicted probability of a negative household income shock, it causes them relatively more stress which in turn increases their likelihood of over-eating, causing subsequent weight gain.

Lastly, as noted by Phipps (2003), NPHS does not offer estimates of household wealth. This has the potential to attenuate key results. Should an individual experience an increase in economic insecurity but possess a large stock of wealth, their stress level may not increase to the same degree as it would otherwise. Therefore, a rise in BMI is less likely to ensue.

7. Conclusion

This study asks the question: does economic insecurity cause weight gain for Canadian labor force participants? An economic insecurity index is derived based on the predicted probability of a severe negative economic shock. Applying fixed

effects estimation to control for person-specific time-invariant heterogeneity and instrumental variables to account for reverse causality, results suggest that a 1 percent increase in the derived economic insecurity index predicts a 0.10 point increase in BMI for adult males. For adult females, the association between economic insecurity and BMI is statistically insignificant.

Canada has been accused over the past 20 years of reducing its social safety nets—especially for those most exposed to economic risk (Osberg, 2009). Policy makers should take note of the effect of economic insecurity on weight gain. The obesity epidemic plaguing North America was estimated to cost Canada in excess of 4 billion Canadian dollars in 2008 through increased healthcare costs and lost productivity in the workplace (Public Health Agency of Canada, 2010). Moreover, given an aging population that is producing growing health care costs, proactive policies that address preventable illnesses become ever more important. Policies that can aid in preventing weight gain and subsequent obesity should be viewed as paramount. Thus, from a policy standpoint, the effect of economic insecurity on body weight should not be overlooked.

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Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

Table A1: Sample Size by Cycle
Table A2: Probability of a 25 Percent or Greater Short Fall in Current Versus Previous Cycle Real Equivalent Household Income
Table A3: Pooled OLS and Fixed Effects Estimates
Table A4: First Stage Regression Estimates
Table A5: Descriptive Statistics – Mean Values Cycle 3