# Griffith UNIVERSITY
## Griffith Business School

# Discussion paper series



## ECONOMICS AND BUSINESS STATISTICS

# The self-reinforcing dynamics of economic insecurity and obesity

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No. 2016-01

# The Self-Reinforcing Dynamics of Economic Insecurity and Obesity[*]

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December 30, 2015

### Abstract

This paper models the dynamic effects of economic insecurity on bodyweight. Using Australian panel data, we infer an individual's level of economic insecurity as a function of exposure to various financial risks and employ regression equations to explore its effect upon current period Body Mass Index (BMI) scores. Estimates reveal that a sustained standard deviation increase in economic insecurity raises an individual's BMI at a rate of approximately 0.35 units per year. Quantile regressions are then used to estimate the sensitivity of body weight to insecurity at different percentiles of the distribution and we find that persons who are overweight and obese are much more seriously affected. This implies that shocks that make individuals more financially vulnerable can generate harmful self-sustaining cycles of risk and weight gain. We also model the dynamics of insecurity and show that it is a persistent phenomenon for persons with high levels of exposure and lower incomes and educational attainments. This finding indicates that persons of lower socioeconomic status are more likely to encounter vicious cycles of increasing insecurity and obesity, which partially explains why weight related health problems are unusually highly concentrated amongst these individuals.

Key Words: Economic Insecurity, Body Mass Index, Health Economics, Obesity

JEL Classification: I12, I30

# 1 Introduction

For many individuals economic risks are an unfortunate and inescapable part of every-day life. Some people have uncertain or unreliable jobs and hence can never be sure of their next pay check, while others lack insurance or have so little wealth that large unexpected expenses may force them into bankruptcy. Many more are at risk of poverty through mishaps such as accidents or illness, or through familial break ups from widowhood or divorce. Amongst social scientists there is now a growing recognition that exposure to these risks can be highly stressful and that this stress may be creating serious and wide-ranging public health problems.

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The goal of this paper is to study the links between economic risks and one specific health concern – unhealthy weight gain. The central hypothesis is that if economic risks are stressful, and if excessive calorie consumption is a typical response to stress, then holding all other factors equal we would expect to see greater levels of obesity in persons with more economic risk. This "rational overeating" hypothesis is well established in the literature (Dallman et al., 2005; Smith, 2009; Offer et al., 2010; Wiseman and Capehart, 2010) and has its roots in evolutionary biology. It is speculated by these authors that over time, humans have developed a tendency to seek out larger quantities of richer foods in times of duress as a way of stockpiling energy. This tendency provides advantages when common negative shocks (such as droughts, floods, conflict, predation, illness or injury) are likely to result in future malnutrition. However in the modern developed world where high calorie foods are easily accessible, and when stress is more likely to be caused by social factors unrelated to the threat of starvation, the biological impulse to respond to anxiety by eating represents a misfiring of this evolutionary trait.

Our objective is to test a form of this hypothesis, essentially the idea that exposure to economic stressors (in the form of risks to future financial wellbeing) leads to increases in bodyweight. Our work thus adds to a now substantial body of literature that examines various facets of the nexus between economic risk and health, however our angle on this issue differs from existing work in two notable ways. Firstly we observe that there are many types of potential economic pitfalls that people may face, however most of the existing research tends to focus on a small basket of very specific types of risks. For example a large body of literature highlights the negative implications of job instability, including notable papers by Cheng et al (2005), De Witte (1999), Ferrie et al. (1998a, b), Green (2009), Luechinger et al (2009), Caroli and Goddard (2013), Muenster et al. (2011) and Sverke et al. (2002). Other authors consider the health consequences of income volatility (Adda, et al., 2009; Halliday, 2007; Rohde et al., 2014; Staudigel, 2015), poverty risk (Barnes and Smith, 2009; Barnes et al., 2013; Smith et al., 2009) or a lack of access to insurance (Levy and Meltzer, 2008; McWilliams, 2009).

Given this diverse range of negative outcomes we argue it is plausible that all such hazards may be harmful. This motivates our desire to study the general concept of economic insecurity rather than any particular type of adverse event. Economic insecurity represents a reasonably new development in applied wellbeing analysis and refers to the discomfort produced by a being in a vulnerable or uncertain financial position (Osberg, 1998, Osberg and Sharpe, 2014; Hacker (2006), Bossert and D'Ambrosio (2013), Cantó and Ruiz (2014) and Western et al. (2013). It is therefore a "catch all" term that captures any type of potential economic hazard an individual faces, and as a consequence can be neatly characterized as a latent variable which may be inferred via levels of exposure to specific risks, rather than the actual risks themselves.

The second and perhaps more important way we look to extend the extant literature is by modelling the health effects of economic insecurity in a dynamic context. An individual's bodyweight is not so much an indicator of their lifestyle at a given point in time but rather a consequence of decisions made in the past. For this reason it is expected that lagged insecurity will be a better predictor of weight than current insecurity levels, a fact which opens up options for dynamic modelling techniques. This approach is also desirable in that it removes many of the endogeneity concerns that tend to bias econometric estimates. If being overweight tends to make people more insecure then parameter estimates will absorb this reverse causality and fail to reflect a causal effect. However it is much less likely that an individual's current weight could be driving the degree of economic insecurity experienced a year in the past, due to the fact that causes normally occur before effects. Hence by only looking at variations in bodyweight attributed to economic insecurity when the latter predates the former, this approach gets around the possibility that both variables are simultaneously determined.

Although most of the recent research on economic risk and health focuses on either the US or Europe, this paper uses Australian data which makes for an interesting case study for a couple of reasons. As well as being comparable to other developed nations (suggesting that our results are likely to be at least partially generalizable to other high income countries) Australia is notable in that it did not experience a major economic contraction in the aftermath of the 2008 financial crisis. Instead over the entire span of our data the Australian macroeconomy performed well with growth averaging around 2.8% and unemployment about 5%. This makes our results interesting as we do not wish to conflate the health effects of economic insecurity, as measured in normal conditions, with those that prevail during a severe economic downturn. Indeed the fact that we find robust evidence that insecurity is damaging for health during a period of strong economic expansion suggests that it represents a particularly pervasive social problem.

The structure of the paper is as follows. Section 2 introduces the data and describes the methods used to produce our measure of economic insecurity. Section 3 details the econometric methods including regression models, intertemporal correlations and decompositions of insecurity into permanent and transitory components. Section 4 provides some interpretation and discusses the policy implications of our findings and Section 5 concludes.

## 2 Data and Measures

Data come from the HILDA (Household Income and Labour Dynamics in Australia) panel which is a high quality survey similar in design to the US based PSID or German SOEP. The survey has been following almost 20,000 individuals since 2001 and asks a wide variety of questions on both economic wellbeing and health. It covers persons of all ages and is approximately representative of the Australian population as a whole. We draw our data from six annual waves from 2006-2011 which represent the complete set of years which contain all our variables of interest.

Overweight individuals are identified using the Body Mass Index (BMI) which is a standard marker of physical health. The BMI is the ratio of an individual's weight in kilograms to the square of their height in meters, such that higher values indicate a greater likelihood of obesity. Although the index is imperfect (it is unable to distinguish the effects of build or muscle mass from body fat) it is advantaged over other methods such as caliper body fat measures through its simplicity. A second useful characteristic is that discrete classifications for the BMI exist where persons with scores under 18.5 are regarded as underweight, from 18.5-25 as normal, 25-30 as overweight and 30+ as obese. These thresholds are considered to be fairly rough and are not universally agreed upon (e.g. Burkhauser and Cawley, 2008; Duncan et al., 2009) however they provide a useful guide for interpreting the scores.

In addition to data on BMIs we also take a wide variety of control variables in order to remove extraneous sources of variation in bodyweight. These include the age, gender, income, education and marital status of the individual, as well as dummies for the geographic region where the individual lives (state dummies and a dummy indicating residence in a major city) and a host of indicators of major life events which could plausibly have an indirect effect upon weight. Our income variable is measured in disposable terms (i.e. post-government) and is the sum of all inflows for all household members. We use the square root equivalence scale to account for economies of scale within the household.

Four measures of individual-level economic risk are used. The first is a subjective assessment of an individual's security in their primary form of employment. This is a score from 1-7 which we invert such that higher values indicate a subjectively less secure job. The rationale behind this measure is straightforward – since labour income

is often used to meet household expenses an insecure job can threaten the maintenance of an individual's social position. Our second measure is similar and measures overall satisfaction with household finances. Again this is a subjective measure (this time from 0-10) which we invert such that higher scores imply less satisfaction. Although this measure will be sensitive to a number of factors only tangentially related to insecurity such as aspirations for greater wealth the measure will also capture perceptions of risk exposure. Our third measure is also subjective and relates to an individual's ability to raise short term emergency funds using a four point scale. While this variable also does not constitute a risk per se, it is indicative of the sense of vulnerability that one would experience should some form of hazard eventuate.

The last measure differs fairly strongly from the first three and represents an objective (i.e. econometric) estimate of income volatility. Letting $y_{it}$ denote the income of individual $i$ in period $t$ we estimate the fixed-effects model

$$y_{it} = \alpha_i + \mathbf{x}'_{it}\boldsymbol{\beta} + \varepsilon_{it} \tag{1}$$

and extract the error component $\varepsilon_{it}$ as a measure of unpredictability in annual income. We then use the square of this value (i.e. the variance of shocks to log income) as a marker of income risk. The key concept here is that a volatile income is unreliable and hence a good proxy for insecurity, however it is mostly the unpredictable fluctuations that are likely to be harmful. By removing predictable changes in income we are able to only focus on the random shocks that represent the true sources of risk.

Once our four measures are established we note that no single variable entirely captures economic insecurity. Rather, we observe that all four are indicators that are representative of some facet of risk that is likely to be undesirable, while ignoring other potentially important sources. However as we wish to draw inferences about insecurity as an abstract phenomena there is a need to combine all four of the measures to form a general index. Noting that insecurity can be conceptualized as a latent variable that may be inferred using a conceptually diverse set of indicators, we proceed by extracting the first principle component of the basket of measures. That is, we generate the synthetic variable

$$I = \sum_{j=1}^{k} \beta_j R_j \tag{2}$$

where the terms $\beta_1, \ldots \beta_k$ are chosen to maximize the variance in $I$ subject to the restriction $\sum \beta_j^2 = 1$. This index therefore represents the primary latent variable captured to various degrees by risk indicators $R_1, \ldots R_k$. Since this synthetic index has no natural units of measurement we standardize the variable to have a mean of zero and a standard deviation of one, such that a unit increase in I can be interpreted as a standard deviation shock to the latent conceptualization of "economic insecurity".

Some descriptive statistics on our key variables of interest are given in Table 1. We report the sample sizes, means, standard deviations and ranges for (i) BMI scores, (ii) each of the four insecurity indicators, (iii) the synthetic insecurity scores after normalization, and (iv) the logarithm of annual household equivalent income.

Table 1: Descriptive Statistics – Key Variables

| Variable | # Obs | Mean | Std Dev | Min | Max |
|---|---|---|---|---|---|
| Body Mass Index (BMI) | 69,217 | 26.39 | 5.23 | 9.60 | 49.90 |
| Economic Insecurity | 29,799 | 0.00 | 1.00 | -1.68 | 4.32 |
| Job Insecurity | 43,690 | 3.93 | 1.63 | 2.00 | 8.00 |
| Financial Dissatisfaction | 69,164 | 3.48 | 2.19 | 0.00 | 10.00 |
| Emergency Funds | 68,211 | 1.72 | 1.03 | 1.00 | 4.00 |
| Residual Variance | 42,741 | 0.07 | 0.37 | 0.00 | 23.23 |
| Log Income | 68,835 | 10.59 | 0.65 | 3.40 | 13.17 |

Note: The columns give the means, standard deviations, minima and maxima of each key variable. Descriptive statistics of other variables are obtainable form the authors upon request.

The information in Table 1 highlights the size of the data set. For most of our key variables there are over 60-70 (000) observation/years, which can be roughly broken down into 10,000 observations over 6 years (on average). There are less observations on the specific insecurity indicators (42,741-69,164) and to obtain our latent variable we require that there are no missing values across all four variables. This leaves a sample of 29,799 observations for which we can impute an insecurity score. After normalization these imputed values take on the imposed mean of zero and standard deviation of one, however we note that the variable exhibits considerable right skew. A majority of individuals have slightly negative scores (with a minimum in our data of -1.68) but these are counterbalanced with some persons having scores more than four standard deviations above the mean indicating very high levels of insecurity.

# 3   Methods

**How Does Economic Insecurity Affect Bodyweight?**

In order to estimate the effect of economic insecurity on an individual's weight we employ regression models where BMI is used as the dependent variable and I is included as an independent variable, alongside a number of standard controls. Ideally we would like to employ a panel data model such as a Fixed Effects estimator, which could control for time invariant heterogeneity on cross-sectional units. However as BMI is a variable that tends to change slowly, and at a lag to social stressors, this method will not perform well in panels such as ours where the time dimension is limited. Instead we perform standard cross-sectional regressions with year fixed-effects, and circumvent endogeneity issues by using a lagged term for insecurity rather than its current value. This way we are allowing an individual's Body Mass Index one year to change in response to a shock to economic insecurity. This is a standard technique which precludes the possibility of reverse causality existing between the dependent and independent variables. The model is therefore

$$BMI_{it} = \sum_{t=1}^{T} \gamma_t D_t + \mathbf{x}'_{it}\boldsymbol{\beta} + \phi I_{it-1} + \varepsilon_{it} \tag{3}$$

where $\gamma_t$ represents the year fixed-effects on annual dummies $D$, $\mathbf{x}'_{it}$ represents a vector of control variables, $\boldsymbol{\beta}$ and $\phi$ are slope parameters to be estimated and $\varepsilon_{it}$ an error term. To account for (i) heteroskedasticity and (ii) longitudinal correlations in $\varepsilon_{it}$ we use cluster robust covariance where clustering is defined at the individual level.

Table 2 gives the results over four separate regression equations where we vary the set of controls to test for robustness. The first column simply gives the relationship between BMI and insecurity where we allow for a constant term and the year fixed effects terms. Given that this estimate has the potential to be confounded by a number of different factors we systematically introduce additional covariates in the next three rows, while focussing on the behaviour of the parameter estimate $\hat{\phi}$. EQ (2) employs a parsimonious set of standard controls for BMI including the age of the individual, the square of age (to account for non-linearities over the lifecycle) the log of equivalized household income, and dummies for gender, marital status and the highest level of educational attainment. EQ (3) adds to this by including a number of dummies for life events that have the capacity to generate stress (and hence promote weight loss/gain) including becoming married or separated within the last 12 months, experiencing the death of a spouse or child (SC), relative (RL) or friend (FR). We also include a further dummy for being a victim of physical violence within the last year. Lastly EQ (4) builds further by controlling for geography by using dummies indicating whether or not the individual lives in a major city, and the state where they reside. Controlling for these factors is important as it is plausible that individuals who live in less dense areas may be more physically active (and hence have lower BMIs) while social attitudes to diets and exercise may change from one geographic region to the next.

Table 2: Estimates of the Effect of Insecurity on BMI

| Variable | EQ (1) | EQ (2) | EQ (3) | EQ (4) |
|---|---|---|---|---|
| Insecurity (I) | 0.196*** | 0.356*** | 0.353*** | 0.355*** |
| Log Income | | 0.098 | 0.085 | 0.091 |
| Age | | 0.323*** | 0.326*** | 0.325*** |
| Age Squared | | -0.003*** | -0.003*** | -0.003*** |
| Female | | -0.683*** | -0.688*** | -0.687*** |
| Married | | -0.081** | -0.067** | -0.068* |
| Educ Less HS | | -0.133 | -0.135 | -0.211 |
| Educ Diploma | | -0.229 | -0.234 | -0.298 |
| Educ Bachelor | | -1.077 | -1.081 | -1.146 |
| Educ Advanced | | -1.110 | -1.114 | -1.178 |
| Life Event - Married | | | 0.309 | 0.319 |
| Life Event - Separated | | | -0.598*** | -0.604*** |
| Life Event - Death SC | | | 1.031* | 1.034* |
| Life Event - Death RL | | | 0.261** | 0.250** |
| Life Event - Death FR | | | 0.242* | 0.246* |
| Life Event - Violence | | | -0.315 | -0.317 |
| Major City | | | | 0.059 |
| State Vic | | | | 0.022 |
| State QLD | | | | 0.060 |
| State SA | | | | 0.445* |
| State WA | | | | 0.347 |
| State TAS | | | | 0.646* |
| State NT | | | | -0.391 |
| State ACT | | | | 0.179 |
| Year 2008 | 26.517*** | 18.837*** | 18.862*** | 18.741*** |
| Year 2009 | 26.650*** | 18.989*** | 19.017*** | 18.896*** |
| Year 2010 | 26.807*** | 19.161*** | 19.199*** | 19.079*** |
| Year 2011 | 26.834*** | 19.149*** | 19.191*** | 19.071*** |
| Sample Size (N) | 22728 | 22645 | 22405 | 29368 |
| R Squared | 0.002 | 0.060 | 0.061 | 0.062 |
| F | 11.47 | 50.54 | 35.96 | 25.58 |
| No of Clusters | 8280 | 8262 | 8221 | 9271 |

Note: The four columns give coefficients from the regressions specified above. All estimates are obtained by OLS and cluster robust standard errors are employed. *, ** and *** denote significance at 10%, 5% and 1% respectively. Dummies are defined relative to a reference individual who is an unmarried male who resides in NSW and has a high school education.

The main estimates of interest are presented in the first row of Table 2. When the minimal set of control variables is used we estimate the effect of insecurity on mental health to be 0.196 units per standard deviation. This result implies that on average, an individual who experienced a level of economic insecurity one standard deviation above the sample mean in a given year would put on enough weight to increase their BMI by 0.196 points, relative to an otherwise identical person who had an average level of insecurity. It is worth noting that this estimate increases when other factors are controlled for. Turning to rows 2-4 we see that all three estimates cluster closely around a value of 0.35 BMI units per standard deviation of economic insecurity. Thus when the confounding effects of age, gender, income, education and other such factors are removed the effect size doubles, indicating that exposure to an elevated level of economic insecurity in time $t - 1$ leads to a gain in weight of this magnitude in the coming year. The robustness of this result across the three equations leads us to use the value of 0.35 units per year as our

preferred result.

To appreciate the impact of economic insecurity upon health it is necessary to consider the magnitude of this effect size. Given that 0.35 units represents a fairly small movement relative to the distribution of BMI (which has a standard deviation of 5.23 in our data) one may conclude that the health effects of insecurity are relatively small. However this argument ignores the cumulative nature of weight gain and the fact that economic insecurity may represent an ingrained, long-run phenomenon. Indeed if an individual experiences an elevated level of insecurity for many years the impact can be large. For example a person who exceeds the population average level by one standard deviation for twenty years can be expected to see their BMI increase by 7.0 units. This would be sufficient to reclassify an otherwise underweight individual (BMI of 18.5) as overweight (25.3).

For this reason it is important to consider the mobility of insecurity over time. If being in a state of economic insecurity represents a transitory problem then the scenario described above is unlikely to play out. However if insecurity represents a chronic problem for some individuals then we would expect the health impacts to build over the long term. To examine the mobility of economic insecurity over time we consider the relationship between insecurity in $t$ and $t-1$ using correlation coefficients. As the mobility in and out of secure and insecure states may change over the distribution, we stratify our estimates into four quartiles and estimate over each. The results are presented in Table 3.

Table 3: Dynamics of Insecurity – Correlation Coefficients

|  | Full Sample | 0- 25% | 25%-50% | 50%-75% | 75%-100% |
|---|---|---|---|---|---|
| Score Range | -1.684 to 4.01 | -1.684 to -0.663 | -0.663 to -0.149 | -0.149 to 0.612 | 0.612 to 4.32 |
| Correlation | 0.681*** | 0.513*** | 0.166*** | 0.160*** | 0.394*** |

Note: The first row provides the quartile of the insecurity distribution while the second row gives the scores at which these percentiles are defined. The third row gives the correlation coefficient between insecurity scores for individuals grouped by their scores in time $t-1$.

Estimates in Table 3 show that insecurity is remarkably persistent over time. The correlation between scores over a one year period is 0.681 indicating that individuals who are insecure in one year are also likely to be insecure in the next. This implies that a regression of insecurity scores on their own lag would give an $R^2$ of around 46%, and therefore almost half of the variation in insecurity at a given point in time simply reflects the distribution in the prior year. Turning to the correlation coefficients over the quartiles we see that the degree of hysteresis is strongest in the tails of the insecurity distribution. For the most secure individuals (in the bottom 25% of the distribution) the correlation between scores was 0.513 while for the most insecure 25% the correlation coefficient was 0.394. These are notably different to those in the two central quartiles who had year-to-year correlation coefficients of around 0.16. Our data is therefore characterized as (i) having a subgroup of secure individuals who tend to remain secure, (ii) a large central group with middling levels of insecurity who move in and out of secure and insecure states fairly regularly, and (iii) a subgroup of individuals with high scores who experience chronic insecurity. Thus for most people (those in quartiles 1-3) if they do experience economic insecurity it is likely to be a fairly short lived phenomenon, however for persons with high levels it is also much more persistent over time. Thus the dynamics of our insecurity measures indicates that the static distribution of scores understates the degree to which it is concentrated amongst a certain subset of the population.

Since persistent insecurity is the phenomenon we consider most harmful it is useful to distinguish more thoroughly between transitory and ingrained risk. To do so the insecurity index is decomposed into a longitudinal average

for each individual over the five year period and the variation around the average using the formula $I_{it} = \bar{I}_t + I^*_{it}$. Here $\bar{I}_t$ represents an estimate of chronic insecurity while $I^*_{it}$ is the transitory component. To identify determinants each measure is then regressed against selected covariates and the results are presented in Table 4. The choice of covariates is restricted in this case as insecurity (unlike obesity) is likely to be primarily driven by socioeconomic conditions and hence many of the controls employed on Table 2 simply dilute the explanatory power of the models.

Table 4: Estimates of the Effect of Insecurity on BMI

| Variable | Insecurity | Chronic | Transient |
|---|---|---|---|
| Log Income | -0.492*** | -0.458*** | -0.034*** |
| Female | 0.061*** | 0.062*** | 0.000 |
| Age | -0.011*** | -0.011*** | 0.000 |
| City | 0.071*** | 0.065*** | 0.006 |
| Educ Less HS | 0.099 | 0.042 | 0.058** |
| Educ Diploma | 0.084 | 0.028 | 0.055** |
| Educ Bachelor | -0.145** | -0.202*** | 0.057** |
| Educ Advanced | -0.141** | -0.209*** | 0.067*** |
| Constant | 5.650 | 5.336*** | 0.314*** |
| No Obs | 33244 | 33244 | 33244 |
| R Squared | 0.1238 | 0.1508 | 0.001 |
| F | 515.49 | 648.05 | 5.650 |

Note: The first column represents determinates of the insecurity index as inferred from principle components in each year. The second column regresses the longitudinal average of individual insecurity scores on individual characteristics and the third column performs the same exercise for transitory variations. Note that due to the form of decomposition the coefficients in the first column will be equal to the sum of the coefficients in the latter two columns. Standard errors are obtained using White (1980) robust covariance and *, ** and *** denote significance at 10%, 5% and 1% levels.

Results from Table 4 are fairly intuitive. The first column shows that females with lower incomes and lower educational attainments are more insecure, as with persons who reside in major cities. These factors are also the major predictors for chronic insecurity and it is noted that the coefficient signs and magnitudes are similar across the two equations. Thus persons who have the hallmarks of socioeconomic disadvantage (young, low incomes, poor educational attainments) are also likely to be the most chronically insecure. Interestingly the determinants of transient insecurity are in some cases quite different. In particular more highly educated people had greater levels of transitory insecurity. This suggests that even when well-educated individuals are insecure, it tends to be limited in duration and hence is unlikely to impact greatly upon bodyweight.

It is also interesting to note that over all three regressions, variations in economic insecurity are not particularly well accounted for by our set of covariates. For the individual insecurity scores and the chronic scores the $R^2$ terms are around 12% and 15% respectively, indicating that the vast majority of variations in insecurity are left unexplained. For the transitory variations the results are even starker, with the models only accounting for a fraction of a single percentage point of the total variation. This implies that other idiosyncratic factors account for the large differentials in insecurity we observe across individuals. Since the covariates in Table 1 broadly capture an individual's socioeconomic and demographic status this suggests that insecurity is related to more subtle personal characteristics (and potentially random variation or luck) which are not easily observed.

**Does Economic Insecurity Affect All Individuals Equally?**

The models given in Table 2 assume that economic insecurity has a constant effect size on all individuals. However it is plausible that persons with different propensities to put on weight (characterized by their BMI scores) may respond differently to exposure to risk. To examine this possibility we re-estimate our models using quantile regressions which allow the effect size of our insecurity measure to change over the distribution of the dependent variable. The results are presented in Figure 1 for models 1-4, where the first two models are given in the top row, while the latter are given in the bottom row. In each case the vertical axis gives the effect of insecurity on BMI while the horizontal axis shows the quantile at which the parameter is estimated. Confidence intervals are given in greyscale while the regression parameters from the standard models depicted in Table 2 are represented with horizontal bars.

Figure 1: The Effect of Economic Insecurity on BMI over Quantiles – Models 1-4
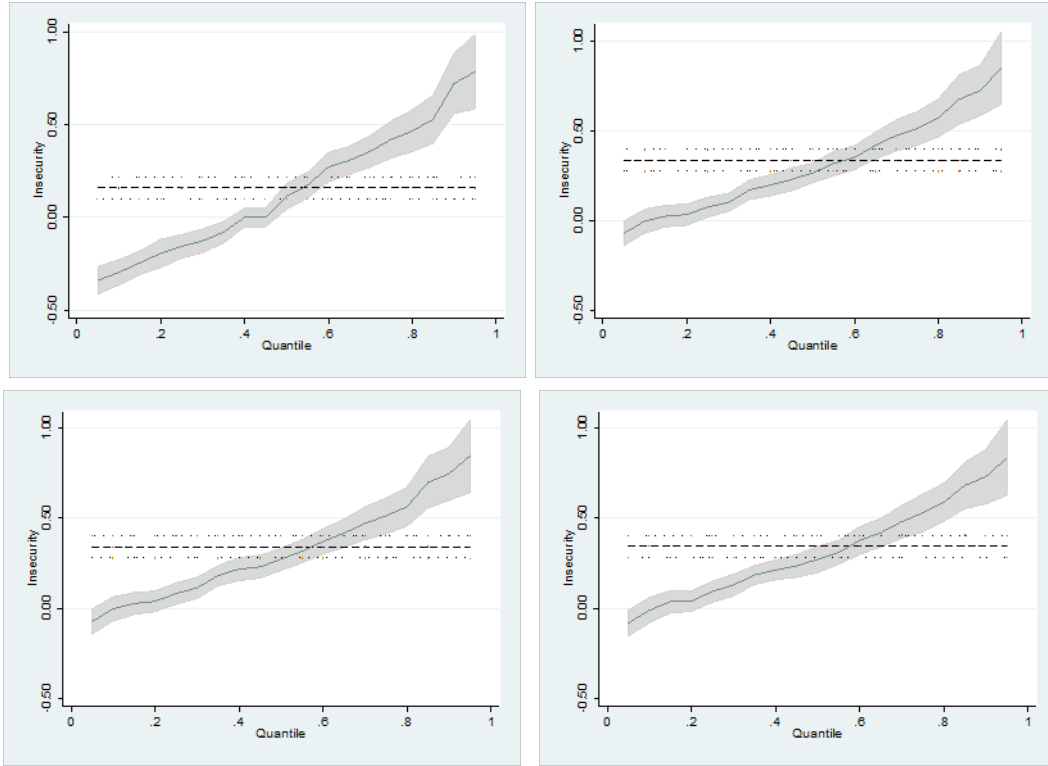


Note: The blue line gives the estimated coefficient (vertical axis) at the relevant quantile (horizontal axis) while a 95% confidence interval is shown in grey. The top left panel gives the effect size from EQ (1), the top right EQ (2), the bottom left EQ (3) and the bottom right shows the results for EQ (4). OLS Estimates and their confidence intervals are represented with horizontal bars.

Over all four models we see the effect of economic insecurity is greater in persons who already have higher BMI scores. The models that contain the more extensive sets of controls indicate that there is little effect of insecurity for persons in the bottom 20% of the distribution of BMI scores, as the coefficient is insignificantly different from zero over this range. However for the median individual (i.e. with a BMI quantile of 0.5) a standard deviation increase to insecurity raises their BMI score by around 0.4 units, while for a person at the 90th percentile the effect

size is twice this. Thus individuals who are already overweight are much more likely to gain additional weight if they are economically insecure.

Although it is difficult to pin down precisely why the effect size may vary so much with weight we are able to form a hypothesis which is consistent with some theories on calorie consumption. Wallis and Hetherington (2009) and Weinstein et al. (1997) suggest that there is a considerable variation in the degree to which overeating is used as a mechanism for diffusing stress. If these variations in overeating are endogenously affected by weight then having a healthy BMI may effectively discourage this method of stress management. Such a feedback effect would presumably weaken with a rising BMI, implying an increasing apathy about physical health as one becomes overweight, and therefore explain the positive relationships between coefficient estimates and distributional position illustrated in Figure 1. An interesting corollary of this hypothesis is that persons with high levels of economic insecurity but BMI scores in the bottom 20% of the population would have to find different methods for dealing with risk. Assuming that they are psychologically affected in the same manner as the rest of the population, we speculate that these persons will seek alternative outlets and hence may be more likely to smoke, drink alcohol or potentially engage in healthier behaviours such as physical exercise in response.

## 4   Discussion

The models estimated above suggest three broad conclusions about the interaction between economic insecurity and bodyweight. The first is a confirmation of a finding by Offer et al. (2010) and Smith et al. (2009) that elevated levels of economic risk lead to significant increases in BMI scores. The magnitude of this estimated effect within our data is both robust and plausible – a standard deviation increase in insecurity results in a gain in BMI of 0.35 units, which is around a kilogram (2.2 pounds) per year for a person 170cm (5'6) tall.

The second and third findings are more novel and taken together imply that the relationship between risk and obesity should be understood in dynamic rather than static terms. If insecurity is only experienced intermittently (perhaps while young or while transitioning between jobs) then the health effects are unlikely to be too severe. Small increases in BMI can be easily offset in the future when an individual's economic life becomes safer. However for persons who do not find safety the health consequences will build up, and thus chronically insecure people can be expected to exhibit continual weight gain. This slow aggregation of BMI scores is consistent with observation and explains why weight gain is usually a little more prevalent in low socioeconomic status subsets of the population (Zhang and Wang, 2004; Wang and Beydoun, 2007; Sundquist, and Johansson, 1998) where there is typically less economic security (Rehm et al., 2012; Rohde et al., 2015). Further these cumulative effects will become more pronounced if there is some feedback effect from bodyweight to risk. Since persons who are already overweight are more likely to put on further weight as a response to risk, this suggests that continued economic insecurity will lead to a self-reinforcing loop of escalating bodyweight. It is important to note that this effect is not the result of a high BMI feeding directly back to increase future insecurity (although this would also be possible). Rather the feedback mechanism we uncover relates to an increasing sensitivity of BMI to risk, rather than an increasing exposure to risk.

The key message therefore is that it is persistent economic insecurity that prompts individuals to become overweight or obese, and therefore policy makers should look to identify and target these persons with appropriate interventions rather than those who are simply insecure at a given point in time. However as shown in Section 3, chronic economic

insecurity is correlated with other forms of socioeconomic disadvantage such as having a low income, a low level of education, or both a low income and a low educational attainment. Such a result makes sense if one considers a hypothesis where some individuals are simply unequipped (either via their genetics or their background) to function effectively in a competitive market for labor, or for similar reasons are unable to access an informal safety net via family or friends. It seems plausible that this form of chronic disadvantage represents a root cause which results in individuals having persistently low economic status, which in turn yields high levels of insecurity and increasing bodyweight year after year. Therefore policies that (i) reduce risk exposure, and (ii) which are targeted at low income individuals with low educational attainments may yield substantial public health benefits. However owing to the dynamic relationships we have highlighted it may take several years of insulation from risk before an individual can break out of a self-reinforcing cycle of economic insecurity and weight gain.

# 5 Conclusion

This paper has presented a number of results concerning the relationship between economic insecurity and weight gain. Economic insecurity was modelled as a latent variable determined by income volatility, job insecurity, financial dissatisfaction and a lack of access to emergency funds; and regression models were used to predict its impact upon bodyweight at a one year lag. Economic insecurity is robustly linked to increasing bodyweight and the estimates produced are of plausible magnitudes. We showed that the effects upon BMI are quite small if economic insecurity is only experienced intermittently, however for individuals who are chronically insecure the health impacts are very substantial. Our estimates indicate that at high levels, economic risk tends to also be persistent (while insecurity fluctuates much more for persons at lower levels) and that the effect upon bodyweight increases with BMI. Thus it appears that for persons with high degrees of risk exposure who are already overweight, the effects can form a self-reinforcing loop where both phenomena drive the escalation of the other. Given that both economic insecurity and obesity are generally more concentrated in persons with low socioeconomic status than for the population as a whole, affected individuals are much more likely to experience these vicious cycles.

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