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Toward a quantitative theory of food consumption choices and body weight

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ABSTRACT

We propose a calibrated dynamic model of food consumption choices and body weight to study changes in daily caloric intake, weight, and the away-from-home share of calories consumed by adult men and women in the U.S. during the period between 1971 and 2006. Calibration reveals substantial preference heterogeneity between men and women. For example, utility losses stemming from weight gains are ten times greater for women compared to men. Counterfactual experiments show that changes in food prices and household income account for half of the increase in weight of adult men, but only a small fraction of women's weight. We argue that quantitative models of food consumption choices and body weight have a unique role to play in future research in the economics of obesity.

1. Introduction

The goal of this paper is to offer a quantitative analysis of changes in food consumption choices and body weight for adult men and women in the United States during the period between 1971 and 2006. While earlier research in obesity economics (e.g., Cutler et al., 2003) conclusively demonstrated that changes in eating habits are responsible for the recent body weight gain in the U.S., especially the continued increase in daily caloric intake when calories expended remained constant, there is much less agreement over what accounts for changes in eating habits of Americans and thus weight (Cawley, 2011).[1]

Controlled experiments, on the one hand, show that lowering prices on healthy foods and hiking prices of unhealthy foods usually induce people to switch to healthier food choices (French et al., 1997, 2001; Epstein et al., 2007) but these changes in food choices do not necessarily translate to lower body weight (Schroeter et al., 2008; Fletcher et al., 2014).[2] Statistical analyses of

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[1] Cutler et al. (2003) show that declines in energy expenditures in the U.S. are too small to account for the observed changes in weight between 1965 and 1995. Most of the switch to a sedentary lifestyle ended by the 1970s while daily calorie intake and obesity rates continued to increase after the 1970s. Understanding changes in total calories consumed is thus an important issue to consider when analyzing the obesity epidemic.

[2] Schroeter et al. (2008) and Fletcher et al. (2014) show that extra sales taxes on soda or food sold at restaurants, while discouraging consumption of this type of food, do nothing to improve people's health or reduce obesity.

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observational data, on the other hand, suggest that broad-based reductions in food prices tend to lead to body weight increase (Lakdawalla and Philipson, 2009; Lakdawalla and Zheng, 2011). However, when one looks at the effect of price changes for more narrowly defined food categories, such as food away from home versus food at home, results are more mixed. For example, Chou et al. (2004) show that prices at full-service or fast-food restaurants are negatively correlated with adult body-mass index, while Anderson and Matsa (2011) and Beydoun et al. (2008) find no causal relationship between restaurant prices and obesity.

This paper offers an alternative research option to statistical analyses of observational data and controlled experiments. We propose a calibrated dynamic model rooted in micro-economic foundations to analyze the quantitative impact of rising household income and declining food prices on body weight, daily caloric intake, and the away-from-home fraction of calories consumed by American men and women since the 1970s.

We view our work as being complementary to traditional applied micro-economic research since using a structural model addresses certain shortcomings of controlled experiments and observational data studies. First, no endogeneity issues such as reverse causality arise in structural models because the underlying theory imposes explicit restrictions on the economic mechanisms through which household income and food prices affect food consumption choices and body weight.[3] Second, structural models have an advantage over controlled experiments. They provide a single and consistent framework which allows assessing linkages between food consumption choices and body weight. Controlled experiments, in contrast, study consumers' decisions over a handful of food items only and thus are not helpful in connecting eating decisions to body weight since they cannot control for the eating behavior outside the limited controlled environment. Third, calibration, which is widely used in the fields of macroeconomics and public economics, is not well known among health economists. Calibration, a technique originally proposed by Kydland and Prescott (1982), consists of using simple stylized models with a small number of parameters and then use first-order moments from microeconomic data to pin down the model parameters. Hansen and Heckman (1995) describe calibration as a two-step scheme in which the available dependent data set is divided into two parts. In the first step, *calibration*, the independent parameters of the model are adjusted to reproduce the first part of the data. Then in the second step, *verification*, the model is run and results are compared with the second part of the data. Hansen and Heckman (1995) note that calibration described as a two-step procedure has well-founded econometric foundations, as the first step corresponds to what econometricians refer as model estimation and the second part as testing.

In the spirit of the research program which uses calibration, we propose a very stylized model of food consumption choices and body weight where only a small number of parameters (seven) needs to be calibrated. We extend the work of Lakdawalla et al. (2005) and Lakdawalla and Philipson (2009) who showed that food consumption choices can be formulated as a dynamic program where body weight, the state variable, also enters the utility function.[4] In addition, we consider two types of food: food consumed away from home (FAFH) and food at home (FAH) with a constant elasticity of substitution function. Given food prices and household income, men and women of a given weight choose how many calories of both types of food to consume as well as consumption on non-food items to maximize a well-defined objective function. The law of motion for weight which affects their weight in the next period. A simple rule of thumb for food consumption choices is that the relative price of food affects what type of food people eat while real income determines total number of calories consumed and thus weight. As a result, households respond optimally to a decline in the relative price of FAFH by reducing the share of calorie intake from FAH, while rising household income leads to an increase in total calories consumed and weight.[5]

We use data moments for total calories, food shares, and weight for men and women from the 1971 National Health and Nutrition Examination Survey (NHANES I) to calibrate preferences parameters. We also derive an analytical expression linking preference parameters, including the elasticity of substitution, to empirical estimates of price and cross-price elasticity of demand for FAFH. One interesting result from the calibration is that the elasticity of substitution between FAFH and FAH is negative for both men and women. The main takeaway from the calibration, however, is that there is substantial preference heterogeneity between men and women. For

[3] For example, in our model, the weight law of motion links calorie consumption and weight in the current period to next period body weight, while first-order conditions determine the optimal allocation of resources toward food and non-food consumption given household income and relative food prices.

[4] The assumptions in Lakdawalla et al. (2005) and Lakdawalla and Philipson (2009) are new and interesting because state variables do not usually enter agents' utility in dynamic economic models. For example, in the one-sector growth model of macroeconomics, market goods are produced using physical or human capital (the state variables) as inputs. However, only the stream of market good consumption enters agent's utility, not physical or human capital (Lucas et al., 1989; Ljungqvist and Sargent, 2012). In the field of obesity economics, however, there are good reasons to believe that weight in the utility function makes sense. First, weight is a proxy for health. Today, Americans are heavier than what the medical field recommends and the obesity epidemic is associated with many of the leading causes of preventable death such as heart disease, stroke, type-II diabetes and certain types of cancer (National Institute of Health, 2005). Second, people care about the way they look and being too skinny or too fat can affect people's self-esteem above and beyond medical considerations.

[5] The assumption of perfect rationality might be too strong when it comes to food choices. People with self-control problems or time-inconsistent preferences would find it optimal to discount future health costs and choose immediate gratification from food consumption. Adapting the bounded rationality modeling strategies in Gruber and Koszegi (2004), Gruber and Koszegi (2001), or O'Donoghue and Rabin (1999) to study the impact of declining food prices on weight would be a valuable contribution to the economics of obesity literature.