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Long-run overweight levels and convergence in body mass index

Roberto Duncan[a], Patricia Toledo[b,*]

[a] Department of Economics, Ohio University, Bentley Annex 349, Athens, Ohio, United States
[b] Department of Economics, Ohio University, Bentley Annex 345, Athens, Ohio, United States

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ABSTRACT

We evaluate the hypothesis of convergence to an optimal long-run body weight worldwide. We formulate a simple rational non-addiction eating model to derive a testable equation that allows us to verify the existence of a long-run body weight as well as its estimation. We use a database of body mass index (BMI) estimates across countries over four decades published by the NCD Risk Factor Collaboration. We find that BMIs converge among European countries but not in the rest of the world. Consistent with the theoretical model, our long-run estimates suggest that European nations will show an average BMI above healthy levels. In particular, females and males will show average BMIs classified as overweight levels (BMI = 28.3). Confidence intervals and sensitivity analysis suggest that males might reach long-term BMI levels associated with obesity (BMI > 30). We discuss the implications of our findings from the perspectives of health economics and economic development.

1. Introduction

After years of persistent growth, obesity has become a serious concern owing to its well-known negative effects. Obese individuals have worse labor outcomes, more health problems (diabetes, strokes, and cancer, among others), and spend more on medical treatments for obesity-related diseases.[1] In this context, it would be desirable to characterize the evolution of this disease in the future. In particular, we are interested in assessing whether the upward trend in obesity will continue or become stable at a certain level.

In this study, we approach this question by applying the economic concept of convergence to the average body mass index (BMI, kg/m^2). Convergence rates are relevant to the extent that they give information on how fast certain nations are likely to catch up to those with relatively high BMIs. If countries converge in average BMIs, then all else being equal, the initial conditions do not matter in the long term. Similar to convergence in incomes, convergence in BMIs is not a desirable outcome per se. It also depends on the steady-state level the country approaches and how far that level is from a healthy one.

In practice, convergence in BMIs might arise from convergence in diets and physical activities across nations in an increasingly globalized world (Popkin and Gordon-Larsen, 2004). The increasing similarity in diets worldwide leads to what has been called the dietary convergence phenomenon (e.g., Popkin, 1993; FAO, 2004; Hawkes, 2006; Pingali, 2006; FAO, WFP and IFAD, 2012). Such a global diet is characterized by a greater reliance on staple grains, increased consumption of meat, dairy products, edible oil, salt and sugar, and a lower intake of dietary fiber (FAO, 2004).

Theoretically, we show that, under certain conditions, the concept of convergence in BMIs can be easily derived from a simple rational non-addiction eating model. As other studies show, this model also predicts that the optimal long-run body weight could be above its healthy level (Levy, 2002; Dragone, 2009). Thus, the model allows us to derive a testable equation to evaluate convergence and, potentially, to estimate a stable long-run BMI.

Our econometric models are estimated using data from a recently publicly available database (NCD Risk Factor Collaboration, 2016) with estimates of average BMI per gender across 172 countries between 1975 and 2014. We estimate cross-sectional and dynamic panel models for the world and different subsamples including 45 European countries. Given the data features and the empirical model, we employ a consistent and efficient estimator

* Corresponding author.
E-mail addresses: duncanr1@ohio.edu (R. Duncan), toledot@ohio.edu (P. Toledo)

[1] For a review of the economic consequences of obesity, see Cawley (2015).

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for the dynamic panel following Kiviet (1995) and Bruno (2005a,b), and check the robustness of our results in different dimensions.

We find that BMIs do not converge worldwide. However, European countries converge in BMIs. We argue that this fact might be associated with common food patterns, agricultural policies, and health policies implemented by European countries. Our long-run estimates suggest that European nations will show an average BMI above the upper limit of the range of healthy levels (BMI = 25; see WHO, 2000, 2004), and both females and males will show average BMIs classified as overweight levels (BMI = 28.3). Confidence intervals and sensitivity analysis suggest that males might reach BMI levels associated with obesity in the long term (average BMIs above 30). According to our point estimates, men converge relatively faster to their steady states than do women.[2] That said, this difference is statistically insignificant across alternative model specifications.

We aim to contribute to three strands of the literature. By testing its predictions about long-run overweight levels and convergence in BMIs, our study relates to the literature on the rational eating model developed over the last two decades (see Philipson and Posner, 1999; Levy, 2002; Lakdawalla and Philipson, 2009; Dragone, 2009; Dragone and Savorelli, 2012; Buttet and Dolar, 2015). To the best of our knowledge, this is the first time the model's predictions have been tested empirically across countries.[3]

Second, we extend the convergence literature in development economics, which usually focused on incomes across individuals or countries, but also extended to other indicators related to health outcomes and living standards such as life expectancy and calorie intake (Ingram, 1992; Hobijn and Franses, 2001; Sab and Smith, 2002; Becker et al., 2005; Mazumdar, 2003; Neumayer, 2003; Kenny, 2005; Ram, 2005; Soares, 2007; Clark, 2011; Weil, 2014; Apergis and Georgellis, 2015). In our view, there is disagreement in the existing literature. On the one hand, a number of studies find either convergence in levels or a fall in cross-country dispersion in life expectancy and other health indicators such as calorie intake and infant survival (Ingram, 1992; Sab and Smith, 2002; Neumayer, 2003; Kenny, 2005). Along this line, Weil (2014) argues that in the last 50 years, the convergence in health has been much faster than the convergence in income. On the other hand, other works suggest a different conclusion. Hobijn and Franses (2001) find convergence in life expectancy, daily calorie supply, daily protein supply, and infant mortality rate, but only in certain groups of countries. Mazumdar (2003) shows evidence that supports divergence in life expectancy at birth, infant survival rate, calorie intake, and other indicators in a sample of 92 countries. Our contribution lies in this segment of the literature. Though we find convergence in body weights among Europeans, they converge to unhealthy levels and only European nations converge among the countries in our world sample.

Third, our work complements another branch concerned with forecasting of obesity indicators (see Kelly et al., 2008; Wang et al., 2008, 2011; Mills, 2009; Stamatakis et al., 2010; Haby et al., 2011; Finkelstein et al., 2012; Majer et al., 2013). Our evidence suggests that body weights among European nations, on average, may be reaching a stable long-run level, all else equal. In this sense, our findings back the forecasting models that predict a leveling off of European BMIs in the future over those that include linear trend components and predict unbounded growth in obesity indices.

Finally, our findings suggest different policy challenges and research agendas across world regions. In the rest of the world, where we do not observe converge in BMIs, we need to be cautious because of the heterogeneity in BMIs across economies and over time. It is necessary to identify the countries that might be approaching levels of BMI classified as overweight and those that show a sharp upward, perhaps alarming, trend in their BMI series. In that sense, it is desirable to investigate what type of policies could drive countries to converge to healthy levels of BMI. The convergence observed among heterogeneous countries as the European nations, as well as the variety of their policies, lead to the natural task of assessing what kind of public policy (health, food, agricultural, trade, etc.), if any, has been effective to prevent higher obesity and overweight levels. In any case, given the low convergence rates we find in the European sample, policies that seek to reduce obesity in the world have to be as persistent as the BMIs series. For the same reason, any serious evaluation of the effectiveness of such policies would require more than a few years.

The paper proceeds as follows. The next section briefly formulates the model's predictions and explains the economic intuition. Section 3 focuses on the main features of the data. Section 4 presents the empirical models, results, and robustness checks. Section 5 discusses our findings and conjectures some explanations. Section 6 concludes with some final remarks.

2. The model

Our basic setup considers the most important features that rational eating models in the literature have in common (see, e.g., Philipson and Posner, 1999; Levy, 2002; Dragone and Savorelli, 2012).[4] Consider a representative agent that chooses sequences of consumption and weight in order to maximize

$$U = E_0 \sum_{t=0}^{\infty} \beta^t \left[c_t \left(\bar{c} - \frac{c_t}{2} \right) - \frac{b}{2} (w_t - w^I)^2 \right] \quad (1)$$

subject to a law of motion of weight

$$w_{t+1} - w_t = \phi c_t - \delta w_t + \varepsilon_{t+1}, \quad (2)$$

an initial weight ($w_0 > 0$), non-negativity constraints, and the corresponding transversality condition. In this setup, $0 < \beta < 1$ is the subjective discount factor, c denotes food consumption, w is the individual's body weight, $0 < \delta < 1$ is the rate at which the individual burns calories and, therefore, loses weight (e.g., metabolism), ϕ is the marginal effect on weight from one unit of food consumption, $\bar{c}$ can represent the satiation consumption level (more on this below), b is a positive preference parameter, and $w^I > 0$ is the ideal body weight.[5] We include a zero-mean i.i.d. term ε_{t+1} to capture measurement errors and non-systematic unpredictable changes in weight observed every period, but that are nil on average (e.g., diet-binge cycles, change in weight owing to illness or accidents, pregnancy, etc.). We assume that the adult individual's weight is rescaled by height and normalized, for simplicity, to 1. Thus, body weight and BMI are equal in the model.

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[2] In particular, the time that it takes to eliminate half the initial gap between the BMI in 1975 and its long-run level is more than a century for women and about half of that for men.

[3] The literature on convergence in obesity is scarce. For the only studies of convergence in obesity prevalence rates across US states, see Li and Wang (2016a,b).

[4] See also Dragone (2009), Lakdawalla and Philipson (2009), Buttet and Dolar (2015), and Barbieri (2017).

[5] The ideal weight can be understood as a convex combination of a physiologically optimal weight (w^H) and a subjective or socially desirable body weight (w^S). That is, $w^I = \mu w^S + (1-\mu) w^H$, with $0 < \mu < 1$. The introduction of w^I as a weighted average helps to accommodate different setups with only w^H (as in the baseline model by Levy, 2002; Dragone, 2009; Buttet and Dolar, 2015), or with both w^H and w^S (as in Levy, 2002; Dragone and Savorelli, 2012). Given the exogeneity of w^I, the assumption is virtually innocuous for our analysis.