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HEALTH IS WEALTH: AN EMPIRICAL NOTE ACROSS THE US STATES[*]

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ABSTRACT

An attempt is made to establish the relation between risk-health factors (encapsulated in terms of obesity) and regional convergence, with special reference to the US states. The econometric results indicate that obesity does have an impact on regional growth and convergence. A preliminary examination of these findings shows harmful effects on the process of catching-up between 'poor' and 'rich' regions. Nevertheless, considerably more research is required before this relation can be discussed with confidence.

Key words: Health risk factors; obesity; regional convergence; US states

JEL classification numbers**:** I10, R11

[*] The findings, interpretations and conclusions are those entirely of the authors and do not necessarily represent the official position, policies or views of the Ministry of Rural Development and Foods and/or the Greek Government. All remaining errors are our own.

I. INTRODUCTION

The publication of the ground breaking work of Baumol (1986) was the spark that ignited a debate on economic convergence[1]. This debate has bred, and continues to do so, dozens of empirical studies (e.g. Barro and Sala-i-Martin, 1992; Greasley and Oxley, 1996; Martin, 2001; Bassino, 2006; Alexiadis and Tsagdis, 2010). In this fast growing literature, capital accumulation and diminishing returns are acknowledged to be amongst the driving forces behind convergence across economies (countries or regions). Apart from the aforementioned factors, one can identify additional features, which can affect this phenomenon. Galor and Tsiddon (1997), for example, put particular emphasis on 'human capital'. This variable is crucially affected by the *health status* of the population. Nevertheless, the existing literature handles this issue in a rather indirect way (e.g. Barro, 1997). Introducing *explicitly* health-risk factors might elucidate certain facets, which determine the process of economic convergence.

As far as these factors is concerned, *obesity* has been identified as a growing health problem in the developed world (NHLBI, 1998) related to a number of serious diseases, e.g. coronary heart disease, type II diabetes, osteoarthritis, hypertension and stroke. Given the context outlined above, an issue that, naturally springs in mind, is the relation between obesity and convergence. It is the intention of this note to study this relation across the US states over the period 1997-2007, opening, thus, an alternative avenue in the relevant empirical literature.

The remaining of this paper is structured as follows. The framework upon which the empirical analysis will be conducted is outlined in Section II. Data related issues together with the econometric results are discussed in Section III. A forth section concludes the paper.

II. BUILDING AN EMPIRICAL FRAMEWORK

There are many acceptable approaches testing for regional convergence; ranging from simple statistical measures, such as the standard deviation, to cross-section regressions.

[1] Surveys of the field include Capolupo (1998) and Islam (2003).

The latter has become a standard piece of equipment in the economist's tool kit. Following Barro and Sala-i-Martin (1992), the notion of 'convergence' describes a situation in which a 'poor' region exhibits a tendency to grow faster than a 'rich' one. This notion is labelled as 'β-convergence'[2]. Sala-i-Martin (1996) sets up this hypothesis in terms of the following regression equation:

$$\log(y_{i,T}) = a + (1-\beta)\log(y_{i,0}) + \varepsilon_i \qquad (1)$$

where $y_{i,0}$ and $y_{i,T}$ denote per-capita income in an initial and a terminal time (T) in a region i, respectively; a and β are parameters to be estimated while ε_i is the random error-term[3].

The notion of 'β-convergence' requires that $0 < \beta < 1$, i.e. there is a negative relation between the average annual growth rate, $\log(y_{i,T} / y_{i,0})$, and the initial level of per-capita income. It is conceivable, therefore, that a faster rate of convergence is signified by a high value of β.

The test for 'β-convergence' described by equation (1) is rather limited in the sense that relates this process with a single factor. This process, however, is a complex one based on factors other than the initial level of per-capita income. Recognition of this has led to the development of an alternative notion of convergence, that of *conditional* convergence. This extends the test for *absolute* convergence in equation (1) by adding a vector of variables that control for differences across regions. Therefore, it becomes of critical importance to choose the appropriate variable(s) that will be included in this vector. As pointed out in the introduction, the primary focus of the paper is generally on health-risk factors and obesity, in particular. Once this knowledge is introduced, the test for conditional convergence appears in the following form:

$$\log(y_{i,T}) = a + (1-\beta)\log(y_{i,0}) + \gamma OB_{i,0} + \varepsilon_i \qquad (2)$$

where $OB_{i,0}$ denotes the percentage of obese individuals in the adult population[4].

[2] It should be mentioned that there are alternative and more plausible views on convergence. Galor (1996) puts forward the idea of convergence in groups, 'club convergence', due to differences in human capital distribution.

[3] The error-term is assumed to be of zero mean, constant variance and independent across regions.

The sign of the parameter γ indicates the impact of obesity in a region's growth rate and by extension to the process of regional convergence. To the best of our knowledge, however, the literature on obesity examines this impact in a rather *implicit* way by highlighting specific aspects of growth. For example, the potential relation between unemployment and obesity has caused a considerable debate. A number of authors, including Smith *et al*. (2007) argue that there is a positive relationship between unemployment and obesity; whereas others argue that an opposite effect is taking place (e.g. Ruhm, 2000, 2003; Morris, 2007). Decreasing food prices, due to technological change, might account for over-the-normal weight, as pointed out by Komlos *et al*. (2004). Obese workers tend to receive relatively lower wages due to lower productivity, as indicated by several studies[5].

What is perhaps less well known is the actual impact of obesity on convergence. Consequently, it is not easy to express an opinion on the sign of the parameter γ a priori. This issue is, to a certain extent, an empirical one; a task that is carried out in Section III using an explicit *spatial* context, that of the US states. Prior to this, however, an overview of the techniques that incorporate spatial effects in a regional-convergence framework is essential. The remainder of this section, therefore, introduces the hypothesis of regional convergence, conditioned upon obesity, as a proxy for health-risk factors[6].

It has been argued, particularly in the case of regions, that spatial dependence is significant in determining patterns of economic development and hence in contributing to any convergence mechanisms. Spatial dependence can be incorporated into convergence analysis, through three econometric models, namely the spatial-error, the spatial-lag and the spatial cross-regressive models (Rey and Montouri, 1999). Building upon equation (1), the first of these, assumes that any effects from spatial interaction are captured in the

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[4] Following Barro and Sala-i-Martin (1995), the conditional variables (in this case the variable measuring obesity) should be expressed in the initial time of the analysis.

[5] Examples of this line of research include Baum and Ford (2004), Cawley (2004), Greve (2008), Brunello and D' Hombres (2007), etc.

[6] It should be noted that contemporary empirical literature on regional convergence focuses on models that combine conditional variables with spatial terms (that is to say 'spatial conditional convergence' models). Examples of this line of research include Maurseth (2001), Lopez-Bazo *et al*. (2004), Funke and Niebuhr (2005), Alexiadis (2010).

error-term. Thus, the usual assumption of independent error terms is abandoned, which is not implausible given the fact that regions are typically very open economies. Following Rey and Montouri (1999), therefore, the error-term incorporating spatial dependence is shown as follows:

$$\varepsilon_i = \zeta \mathbf{W} \varepsilon_i + u_i = (\mathbf{I} - \zeta \mathbf{W})^{-1} u_i \tag{3}$$

where ζ is a scalar spatial error coefficient to be estimated, $\mathbf{W}$ is a spatial weights matrix[7], $(\mathbf{I} - \zeta \mathbf{W})^{-1}$ is a spatial transformation matrix and u_i is the new error-term[8].

It is therefore possible to introduce spatial interaction into a test for conditional convergence by substituting the error-term of equation (3), into equation (2). Thus,

$$\log(y_{i,T}) = a_{se} + (1 - \beta_{se}) \log(y_{i,0}) + \gamma_{se} OB_{i,0} + (\mathbf{I} - \zeta \mathbf{W})^{-1} u_i \tag{4}$$

An alternative approach is to introduce the spatial weights matrix directly, either by the spatial-lag or the spatial cross-regressive model. The former takes the following form:

$$\log(y_{i,T}) = a_{sl} + (1 - \beta_{sl}) \log(y_{i,0}) + \gamma_{sl} OB_{i,0} + \rho \mathbf{W} \log(y_{i,T}) + \varepsilon_{i,sl} \tag{5}$$

where ρ is a scalar autoregressive parameter to be estimated.

Finally, the spatial cross-regressive model is constructed as follows:

$$\log(y_{i,T}) = a_{cr} + (1 - \beta_{cr}) \log(y_{i,0}) + \gamma_{cr} OB_{i,0} + c \mathbf{W} \log(y_{i,0}) + \varepsilon_{i,cr} \tag{6}$$

Thus, the effects of any spatial interaction flow purely from the spatial pattern associated with the initial conditions in terms of per-capita income.

An interesting issue that emerges from the discussion above regards the sign of the spatial coefficients. Although in the empirical literature this is not a specific concern, nevertheless both 'positive' and 'negative' spillover effects are possible. More specifically, if growth in one region is enhanced by proximity to another successful region then a positive sign is expected for the coefficients ζ, ρ and c. On the other hand, a

[7] The elements of this matrix may be devised in various ways. A common practice is to allow them to take the value of 1 if a region is contiguous to another and 0 otherwise. In this paper a similar approach is adopted. Of course, there are more elaborated ways to construct this matrix, considering, for example, the distances between the major cities in each state. Such an approach, however, might distort the results given the size and the disaggregation level of the regional units which comprise the empirical context of this paper.

[8] $u \sim N(0, \sigma^2 I)$.

negative sign may be considered as an indication that successful regions may be growing at the expense of the surrounding regions. However, this is ultimately an empirical issue, dependent upon particular circumstances.

III. DATA AND ECONOMETRIC APPLICATION

In this paper we will use the US as a sort of laboratory for the analysis of regional convergence conditioned upon obesity. The regional groupings used are those delineated by the Bureau of Economic Analysis (BEA) and correspond to the 49 *contiguous* states of the US (excluding Alaska and Hawaii) while the time period extends from 1997 to 2007. The time-span might be considered as rather short, but Islam (1995) points out that convergence-regressions are valid also for shorter time periods. Moreover, the choice of the particular time-span can be justified on two reasons. First, complete datasets for obesity are available from 1997 and onwards and second any distorting effects due to the 2008 crisis are avoided[9]. In this paper, convergence is examined in terms of real personal per-capita income (2005=100); nominal values were obtained by the Regional Economic Information System (BEA, US Department of Commerce). The consumer price index (provided by the OECD database) is used as a deflator. The source for the data for the conditional variable ($OB_{i,0}$) is the Centre for Disease Control and Prevention (Behavioural Risk Factor Surveillance System Survey Data, U.S. Department of Health and Human Services).

At this stage it is important to comment on the estimation methods. Estimation of equation (4) is carried out by the maximum likelihood method, as OLS may result in problems of bias. Specifically, the presence of spatial interaction in the error-term leads to a non-spherical covariance matrix, which results in unbiased OLS estimators but biased estimations of a parameter's variance (Rey and Montouri, 1999). Thus, spatial autocorrelation invalidates the standard tests in OLS regressions in a way similar to heteroscedasticity. When applied to the spatial-lag model, OLS estimators are

[9] Taking into account the impact of this crisis, however, goes beyond the scope of this note and constitutes an item in the research agenda of the authors.

inconsistent due to the simultaneity introduced through the spatial dimension. Thus, the recommended estimation method is once again maximum likelihood. In contrast to the two previous models, the spatial cross-regressive model treats the spatial variable as exogenous and, hence, estimation is possible through the OLS method. The obtained results from estimating the aforementioned models are set out in Table 1.

[Table 1 around here]

Several impressions can be taken from Table 1. Each specification yields a highly significant convergence coefficient and of the correct sign to indicate convergence, at an annual rate within the range 0.3%-0.4%. Two standard tests for heteroscedasticity suggest that the non-spatial model does not suffer from this problem. Specifically, the F-statistic for the White test with no-cross terms (cross terms) is 0.2613 (0.2249), with the associated probability 0.9012 (0.9497), indicating the acceptance of the null-hypothesis of homoscedasticity. Based on this test and considering the fact that the spatial coefficients are statistically insignificant, we cannot be certain if spatial interaction contributes to convergence adjusted for obesity, at least in the case of the US states. This can be attributed, possibly, to the scale of spatial aggregation used in the empirical analysis. Using a different scale (e.g. using counties instead of states) might reveal a different picture; a task that goes beyond the scope of this note. Nevertheless, it is important to point out that each specification produces a negative and statistically significant γ coefficient, indicating an inverse relation between the initial level of obesity and the terminal level of per-capita income. But what can this possibly mean in terms of regional convergence? Bearing in mind that the percentage of obese population approximates health-risk factors, it might be argued that an unhealthy population restricts the rate of growth in a state[10]. A visual inspection of this argument is shown in Figure 1.

[Figure 1 around here]

If a high percentage of obese population is associated with a low initial level of per-capita income, then it might be argued that convergence between ‘poor’ and ‘rich’ States occurs slowly. Indeed, in the case of the US states, a visual inspection of the relevant data (Figure 2) seems to verify the previous proposition.

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[10] Subtracting log ($y_{i,0}$) from both sides of equation (2) yields an expression with the growth rate, over a given time period, as the dependent variable.

[Figure 2 around here]

IV. CONCLUDING COMMENTS

Ever since Barro and Sala-i-Martin (1992) adduced an inverse relation between the growth rate and the initial level of per capita income as evidence of catching-up between 'poor' and 'rich' economies (countries or regions), it has been surrounded by considerable controversy. Although a plethora of empirical studies have paid attention to issues of economic convergence, the impact of health-risk factors in regional convergence has so far received rather limited attention. To remedy this, we have attempted to develop a simple model of regional convergence that puts primary focus upon health-risk factors, approximated by the percentage of obese adults in total population. The starting point of this paper is the idea that, in order to make sense of the empirical results on regional convergence, we must depart from the mainstream economic framework and think in terms of a broader model that allows for convergence mechanisms other than capital accumulation, diminishing returns, etc. Applying this model across the US states, an important conclusion emerges; a negative relation between obesity and growth rate. This constitutes an obstacle to regional convergence.

Although this paper has been focused on the role of health-factors, this is by no means to imply that this approach is the only route to understanding regional convergence. While the empirical results are significant for the case of the US states in their own right, they should nevertheless be placed in perspective. Indeed, improving the model developed in this paper by adding more explanatory variables of similar nature would open up an interesting avenue for future research. Such studies might reveal different and more interesting features regarding the relation between health and regional growth/convergence.

REFERENCES

Alexiadis, S. (2010). 'Regional convergence-clubs and dynamic externalities', *Italian Journal of Regional Science*, 9 (1), pp. 41-64.

Alexiadis, S. and Tsagdis, D. (2010). 'Is cumulative growth in manufacturing productivity slowing down in the EU12 regions?', *Cambridge Journal of Economics*, 34 (6), pp. 1001-17.

Barro, R. (1997). Determinants of Economic Growth. Cambridge MA: MIT Press.

Barro, R., Sala-i-Martin, X. (1992). 'Convergence', *Journal of Political Economy*, 100 (2), pp. 223-51.

Barro, R. and Sala-i-Martin, X. (1995). Economic Growth. Cambridge MA: MIT Press.

Bassino, J-P. (2006). 'Inequality in Japan (1892-1941): Physical stature, income, and health', *Economics & Human Biology*, 4, pp. 62-88.

Baum, C. and Ford, W. (2004). 'The wage effects of obesity: A longitudinal study', *Health Economics*, 13 (9), pp. 885-99.

Baumol, W. (1986). 'Productivity growth, convergence and welfare: What the long-run data show', *American Economic Review*, 76 (5), pp. 1072-85.

Brunello, G. and D' Hombres, B. (2007). 'Does body weight affect wages? Evidence from Europe', *Economics & Human Biology*, 5 (1), pp. 1-19.

Capolupo, R. (1998). 'Convergence in recent growth theories: A survey', *Journal of Economic Studies*, 25 (6), pp. 496-537.

Cawley, J. (2004). 'The impact of obesity on wages', *Journal of Human Resources*, 39 (2), pp. 451-74.

Funke, M. and Niebuhr, A. (2005). 'Regional geographic research and development spillovers and economic growth: Evidence from West Germany', *Regional Studies*, 39 (1), pp. 143-53.

Galor, O. (1996). 'Convergence? Inferences from theoretical models', *The Economic Journal*, 106 (437), pp. 1056-69.

Galor, O. and Tsiddon, N. (1997). 'The distribution of human capital and economic growth', *Journal of Economic Growth*, 2 (1), pp. 93-124.

Greasley, D. and Oxley, L. (1996). 'Explaining the United States' industrial growth, 1860-1991: Endogenous versus exogenous models', *Bulletin of Economic Research*, 48 (1), pp. 65-82.

Greve, J. (2008). 'Obesity and labour market outcomes in Denmark', *Economics & Human Biology*, 6 (3), pp. 350-62.

Islam, N. (1995). 'Growth empirics: A panel-data approach', *Quarterly Journal of Economics*, 110, pp. 1127-70.

Islam, N. (2003). 'What have we learnt from the convergence debate?', *Journal of Economic Surveys*, 17 (3), pp. 309-62.

Komlos, J., Smith, P., Bogin, B. (2004). 'Obesity and the rate of time preferences: Is there a connection?', *Journal of Biosocial Science*, 36 (2), pp. 209-19.

Lopez-Bazo, E., Vaya, E., Artis, M. (2004). 'Regional externalities and growth: Evidence from European regions', *Journal of Regional Science*, 44 (1), pp. 43-73.

Martin, R. (2001). 'EMU versus the regions? Regional convergence and divergence in Euroland', *Journal of Economic Geography*, 1 (1), pp. 51-80.

Maurseth, P. (2001). 'Convergence, geography and technology', *Structural Change and Economic Dynamics*, 12 (3), pp. 247-76.

Morris, S. (2007). 'The impact of obesity on employment', *Labour Economics*, 14 (3), pp. 413-33.

NHLBI (National Heart, Lung and Blood Institute) (1998). Clinical guidelines on the identification, evaluation and treatment of overweight and obesity in adults. NIH Publication Number 98-4083, National Institutes of Health, New York.

Rey, S. and Montouri, B. (1999). 'US regional income convergence: A spatial econometric perspective', *Regional Studies*, 33 (2), pp. 143-56.

Ruhm, J.C. (2000). 'Are recessions good for your health?', *The Quarterly Journal of Economics*, 115 (2), pp. 617-50.

Ruhm, J.C. (2003). 'Good times make you sick', *Journal of Health Economics*, 22 (4), pp. 637-58.

Sala-i-Martin, X. (1996). 'Regional cohesion: Evidence and theories of regional growth and convergence', *European Economic Review*, 40 (6), pp. 1325-52.

Smith, T., Stoddard, C., Barnes, M. (2007). 'Why the poor get fat: weight gain and economic insecurity', Working Paper Series WP 2007-16, Washington State University.

TABLE 1

Regional convergence and obesity, 49 US states, 1997-2007

Equation	**(2)**	**(4)**	**(5)**	**(6)**
Estimation Method	OLS	ML	ML	OLS
Dependent Variable: log ($y_{i,2007}$)				
Constant Term	0.8386 (0.7061)	0.6783 (0.7669)	0.8732 (0.6510)	0.8723 (0.7258)
Coefficient of log ($y_{i,1997}$)	0.9541*** (0.0657)	0.9675*** (0.0709)	0.9514*** (0.0586)	0.9514*** (0.0673)
Coefficient of $OB_{i,1997}$	-1.0526** (0.4212)	-0.9217** (0.4690)	-1.0544* (0.5447)	-1.0544** (0.4256)
ζ		-0.0974 (0.1373)		
ρ			-0.0001 (0.0007)	
c				-0.0001 (0.0005)
Adjusted R^2	0.8533			0.8502
LIK	68.2842	68.9129	68.3204	68.3186
AIC	-2.6647	-2.6087	-2.5845	-2.6252
SBC	-2.5488	-2.4156	-2.3915	-2.4708

Notes: Figures in parentheses are standard errors. ***, ** and * indicate statistical significance at 99%, 95% and 90%, respectively. LIK, AIC and SBC denote the Log-Likelihood, the Akaike and the Schwartz-Bayesian information criteria, respectively. OLS and ML stand for the Ordinary Least Squares and Maximum Likelihood estimation method, respectively.

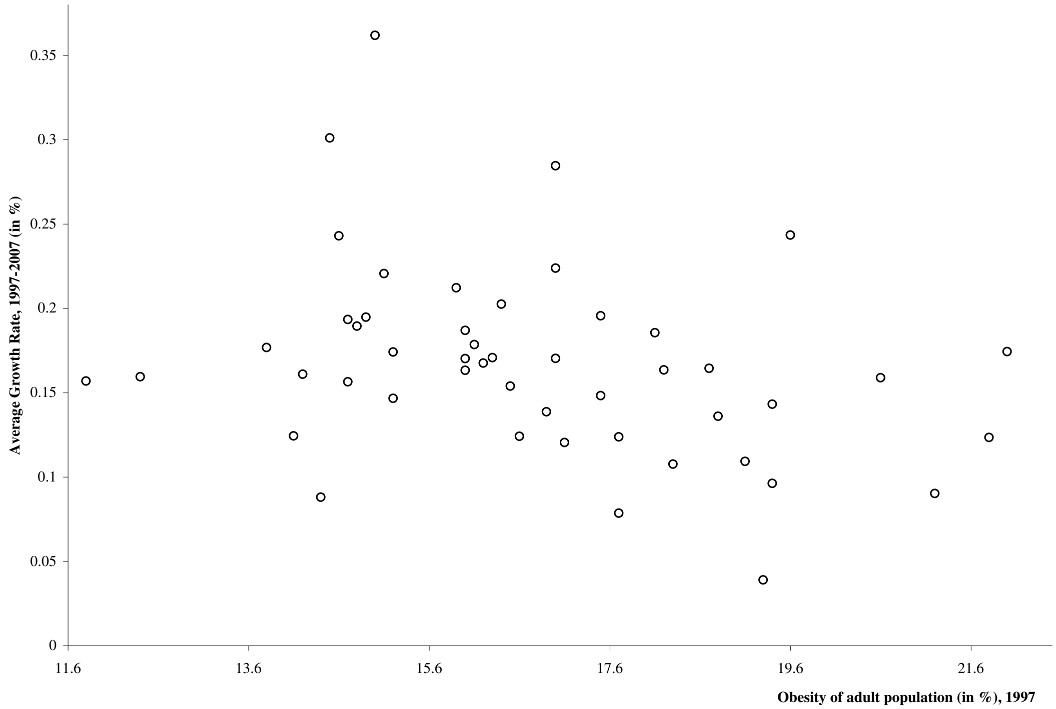

Fig. 1. The relation between obesity and growth rate, US states, 1997-2007.

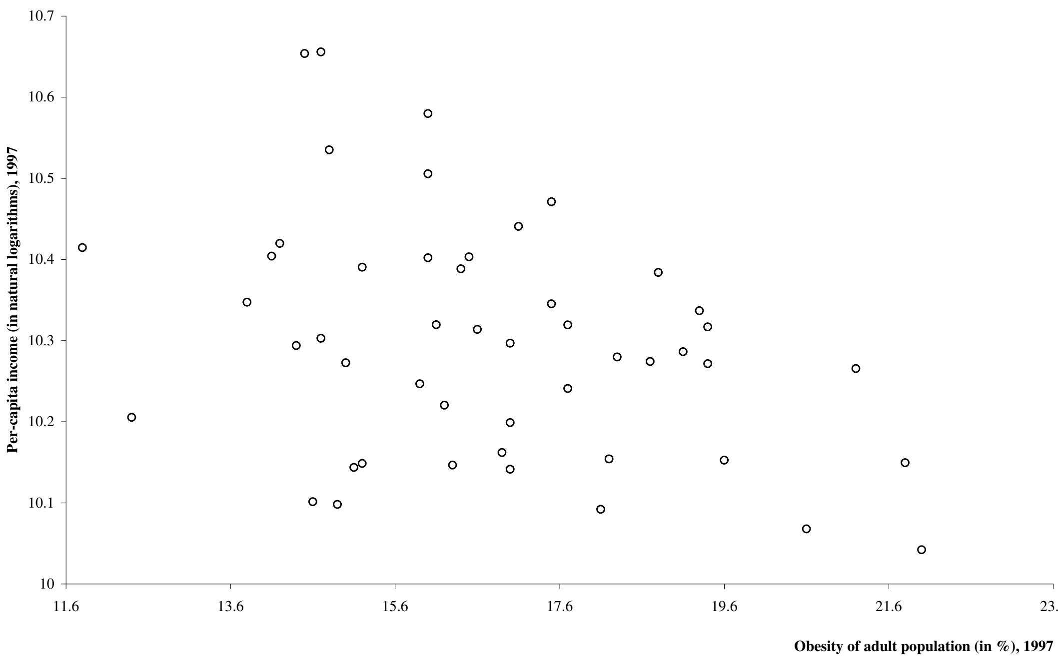

Fig. 2. Obesity and per-capita income, US states, 1997-2007.