Economics Bulletin

Volume 31, Issue 1

A Note on Income Heterogeneity, Dietary Choice and Medical Services: Implications for Health Outcomes

Pedro Gomis-Porqueras
Department of Economics, Monash University

Junsang Lee
Korea Development Institute

Abstract

We present a theoretical framework where agents take into account the fact that their dietary choice affects their health status and hence their life expectancy. The literature that explains the relationship between income heterogeneity, health status and life expectancy has focused on the medical service channel whereby the wealthier spend more on medical services. In this note we propose an alternative mechanism -- the dietary choice channel. This channel takes into account how the quality of food directly impacts an individual's health and life expectancy. service channel whereby the wealthier spend more on medical services. In this note we propose an alternative mechanism – the dietary choice channel. This channel takes into account how the quality of food directly impacts an individual's health and life expectancy.

Citation: Pedro Gomis-Porqueras and Junsang Lee, (2011) "A Note on Income Heterogeneity, Dietary Choice and Medical Services: Implications for Health Outcomes", *Economics Bulletin*, Vol. 31 no.1 pp. 699-707.
Submitted: May 13 2010. **Published:** February 28, 2011.

1 Introduction

The literature that studies the relationship between income heterogeneity, health status and life expectancy has mainly emphasized the fact that wealthier agents can afford more medical services, thus affecting their health and life expectancy. Within this medical service channel, Suen (2005), Hall and Jones (2007) and Fengh (2009) study its consequences for health care spending and analyze its policy implications. In this paper we propose another channel commonly advocated by the medical literature – the diet channel through which consumer's dietary choice directly impacts health and life expectancy.

It is well known that: (i) agents with higher education level tend to live longer;[1] (ii) some chronic conditions and diseases (such as heart diseases, stroke, hypertension and diabetes) are more common among the poor and less educated [see Table 1]; and (iii) agents with higher education tend to report higher self-assessed health status [see Table 2].

One obvious explanation for fact (i) is the medical service channel which implies that richer agents consume more medical services raising their chances of survival in times of illness. But stylized facts (ii) and (iii) suggest that the medical services mechanism is incomplete. In particular, fact (ii) implies that richer agents also have lower morbidity in some common diseases and thus require fewer medical services. One common explanation is to note that wealthier households also consume more goods and services. Here instead, we analyze the dietary channel which we borrow from the medical literature. A dietary observable is constructed by the U.S. Department of Agriculture. The Healthy Eating Index (HEI) measures the overall quality of people's diet. This index takes into account a number of factors such as total fat consumption as a percentage of total calories intake, total cholesterol intake and total sodium intake. Nutritional research finds that people with higher income and education have better HEI than those with lower income and less education.[2] This finding motivates our work.

This note is organized as follows: Section 2 introduces the dietary choice channel that explains how the level of income impacts health and life expectancy. Section 3 combines the two channels, dietary choice and medical service channels, in a unified framework and characterizes the consumer's optimal choices. Section 4 discusses potential policy implications that may emerge from this new channel.

[1]See Lin, Rogot, Johnson, Sorlie and Arias (2003) for more on this finding.

[2]We refer to Lin (2005) for more on this issue.

2 Baseline Model

Consider a consumer's problem with no medical services. In this economy, there is a range of diets (or foods) and a homogeneous non-food consumption good.[3] Each diet is indexed by $x \in X = [\underline{x}, \bar{x}]$ with $\bar{x} > \underline{x} > 0$ and $p(x)$ represents the price of type-x diet.

At the end of each period, each consumer faces a certain probability of dying. The probability of surviving to the next period, denoted by $\Phi(x)$, is endogenously determined by the quality of diet the agent consumes.[4] Implicit in this formulation is the notion that health is only influenced by the quality of the diet. The survival probability, Φ: $\mathcal{R} \to [0, 1]$, is assumed to be strictly increasing in x and convave. Hence a diet with x=$\underline{x}$ represents the worst choice in terms of health and survival probability.

An agent in this economy derives utility from the non-food consumption while taking into account that her diet affects her life expectancy. In order to focus on the quality dimension, we assume that each agent consumes a fixed amount of food in each period and that amount is normalized to one. The consumer's problem is then given by

$$\mathcal{V} = \max_{c,x} \left[u(c) + \beta \Phi(x) V(w) \right]$$

subject to

$$c + p(x) = w; \quad c \geq 0; \quad x \in [\underline{x}, \bar{x}]$$

where c denotes non-food consumption, β is the discount factor, w be per-period income, $V : \mathcal{R}_+ \to \mathcal{R}_+$ is a value function that represents the value of remaining alive which is increasing in w. $u(c)$ has the standard preference properties.

The interior solution of this problem is given by

$$u'(c)p'(x) = \beta \Phi'(x) V(w).$$

Since both $u(c)$ and $\Phi(x)$ are strictly increasing, the previous condition implies that an interior solution exists only if $p'(x) > 0$ which is consistent with the findings of Drewnowski and Specter (2004) who report that "low quality" foods tend to be cheaper. We further assume that $p(x)$ is twice continuously differentiable.

Let us define $\tilde{u}(x, w) \equiv u(w - p(x))$ so that

$$\tilde{u}_x(x, w) = -u'(c)p'(x) < 0,$$

[3]This framework can be expanded to a fully-scaled dynamic general equilibrium model.

[4]There is ample evidence that healthier diets increase life expectancy, see for example Rao (1989).

$$\tilde{u}_{xx}(x,w) = u''(c)[p'(x)]^2 - u'(c)p''(x),$$
$$\tilde{u}_{xy}(x,w) = -u''(c)p'(x) > 0.$$

Now the first and the second order conditions for a maximum can be rewritten, respectively, as follows

$$-\tilde{u}_x(x,w) = \beta\Phi'(x)V(w) \tag{1}$$

$$\tilde{u}_{xx}(x,w) + \beta\Phi''(x)V(w) = 0. \tag{2}$$

Let $c(w)$ and $x(w)$ be the interior solution to the consumer's problem implied by equations (1), (2) and the budget constraint. By totally differentiating the first-order condition (1) with respect to x and w we have

$$-[\tilde{u}_{xw}(x,w)dw + \tilde{u}_{xx}(x,w)dx] = \beta\Phi''(x)V(w)dx + \beta\Phi'(x)V'(w)dw \tag{3}$$

$$-[\tilde{u}_{xw}(x,w) + \beta\Phi'(x)V'(w)]dw = [\tilde{u}_{xx}(x,w) + \beta\Phi''(x)V(w)]dx. \tag{4}$$

Note that equation (4) implies that

$$\frac{dx}{dw} > 0$$

which suggests that agents with higher income tend to have better quality diets. This prediction is consistent with empirical studies in the nutrition literature; see for instance Lin (2005).

Summarizing, our baseline model predicts that consumers with higher income have better diets, lower morbidity rates and hence longer life expectancy. This is the case because wealthier consumers can afford better (or high quality) diets which reduce the probability of dying. This version however, does not consider the traditional argument that wealthier agents can afford more medical services. In the next section, we incorporate both channels.

3 The Two Mechanisms

The previous baseline model can be extended to include the use of medical services explicitly. Let m be the quantity of medical care and q be its price. Now let h be a measure of the current health status and let us assume that is strictly increasing in both consumer's diet, x, and medical expenditures, m. The corresponding health production function is then given by

$$h = i(x,m).$$

In this new environment the survival probability, $\Phi(h)$, which is a strictly increasing function of health, is affected by both the quality of the diet and the level of medical expenditures. The consumer's problem is now given by

$$\mathcal{V} = \max_{c,x,m}[u(c) + \beta\Phi(i(x,m))V(w)]$$

subject to

$$c + p(x) + qm = w; \quad c \geq 0; \quad m \geq 0; \quad x \in [\underline{x}, \bar{x}] .$$

The first-order conditions characterizing the optimal choice (c, x, m, h) are given by

$$\beta\Phi'(h)i_x(x,m)V(w) = u'(c)p'(x) \tag{5}$$

$$\beta\Phi'(h)i_m(x,m)V(w) = u'(c)q \tag{6}$$

$$c + p(x) + qm = w \tag{7}$$

$$h = i(x,m). \tag{8}$$

As we can see from the first-order conditions, the income level of an agent impacts her health through both the dietary and medical expenditure choices which in turn affect her life expectancy. To see this carefully, we have from (5) and (6) that

$$\frac{i_m(m,x)}{q} = \frac{i_x(m,x)}{p'(x)}, \tag{9}$$

which characterize the relationship between m and x. Total differentiation of equation (9) yields

$$\left[\frac{i_{mm}}{q} - \frac{i_{xm}}{p'(x)}\right] dm = \left[\frac{i_{xx}}{p'(x)} - \frac{i_{mx}}{q} - \frac{p''(x)}{[p'(x)]^2} i_x\right] dx. \tag{10}$$

Given that $p(x)$ is increasing in x and strictly convex cost function, we have $dm/dx > 0$ as long as we have a health production function where dietary quality and medicare services are complimentary and both health inputs have decreasing returns to scale; i.e, $i_{x,m}(x,m) \geq 0$, $i_{xx}(x,m) \leq 0$ and $i_{mm}(x,m) \leq 0$.

If we now totally differentiate the two first-order conditions we obtain:

$$\left[qu''(c) - \beta\Phi'(h)i_m V'(w)\right] dw = \left[\beta\Phi'' i_m^2 V(w) + \beta\Phi' i_{mm} V(w) + q^2 u''(c)\right] dm \\ + \left[qu''(c)p'(x) + \beta\Phi'' i_m i_x V(w) + \beta\Phi' i_{mx} V(w)\right] dx \tag{11}$$

$$\left[qu''(c) - \beta\Phi'(h)i_m V(w)\right] dw = \left[p'(x)^2 u''(c) - u'(c)p''(x) + \beta\Phi''[i_x]^2 V(w) + \beta\Phi_{xx} V(w)\right] dm \\ + \left[qu''(c)p'(x) - \beta\Phi' i_m i_x V'(w) + \beta\Phi' i_{mx} V(w)\right] dx. \tag{12}$$

Under standard assumptions for preferences and health production functions, it is easy to see from (11) and (12) that if $[qu''(c)p'(x) - \beta\Phi' i_m i_x V'(w) + \beta\Phi' i_{mx} V(w)] \leq 0$, then

$$\frac{dh}{dw} > 0;\ \frac{dx}{dw} > 0;\ \frac{dm}{dw} > 0$$

which implies that agents with higher income have better health, higher quality diets and consume more medical services which in turn results in longer life expectancy. This is case whenever the complementarity between inputs of the health production function, the quality of diets and medical services, is not too large. These predictions are consistent with the well known stylized facts.

4 Concluding Remarks

In this note we have explored how income heterogeneity affects an agent's health and life expectancy through the medical and dietary channels. The implications of the dietary channel highlight public policy considerations regarding potential tax and subsidies to improve health and increase life expectancy for low income households. Our framework suggests that the Food Stamps program should provide larger subsidies to high quality and healthier foods. Subsidizing ″healthier″ foods might be more cost effective since having a healthier diet is preventive in nature which is cheaper than delivering actual medical services.

References

1. Drewnowski, A. and S. E. Specter (2004): "Poverty and Obesity: The Role of Energy Density and Energy Costs," *American Journal of Clinical Nutrition* 79, p.6-16.

2. Hall, R. and C. Jones. (2007): "The Value of Life and the Rise in Health Spending," *Quarterly Journal of Economics*, 122:1, 39-72.

3. Feng, Z (2009) "Macroeconomic Consequences of Alternative Reforms to the Health Insurance System in the U.S.," unpublished manuscript.

4. Lin, B. (2005): "Nutrition and Health Characteristics of Low-Income Populations Body Weight Status," *Agriculture Information Bulletin* 796-2.

5. Lin C., Rogot E., Johnson N.J., Sorlie P.D. and Arias E. (2003): "A Further Study of Life Expectancy by Socioeconomic Factors in the National Longitudinal Mortality Study," *Ethnicity and Disease* 13(2):240-7.

6. Rao (1989): "Diet, Mortality and Life Expectancy: A cross National Analysis," *Journal of Population Economics* 1:1432-1475.

7. Suen, R. (2005): "Technological Advance and the Growth in Health Care Spending," Economie D'Avant Garde Research Report No. 13.

Appendix

Table 1: Prevalence of Selected Health Conditions, 2004*

	Coronary Heart Disease	Hypertension	Stroke	Diabetes
*Education***				
Less than high school	9.7	29.8	5.0	11.7
High school diploma	7.6	25.9	2.8	8.1
Some college	7.5	24.9	2.6	7.6
Completed college or higher	5.4	20.4	2.0	5.8
*Family Income****				
Less than $20,000	9.2	26.5	4.7	10.4
$20,000 or more	6.0	21.1	2.2	6.4
$75,000 or more	5.3	20.0	1.9	5.3
Total***	**6.4**	**22.0**	**2.6**	**7.1**

* The reported figures are in percentages. All the figures are age-adjusted to the 2000 U.S. population.

** The reported figures are for persons aged 25 years and over.

*** The reported figures are for persons aged 18 years and over.

Source: Summary Health Statistics for U.S. Adults: National Health Interview Survey, 2004.

Table 2: Distribution of BMI by Selected Characteristics, 2004*.

	Underweight	Normal/Healthy weight	Overweight but not obese	Obese
*Education***				
Less than high school	1.7	31.4	36.2	30.6
High school diploma	1.6	33.6	37.3	27.5
Some college	1.5	33.3	37.7	27.5
Completed college or higher	1.5	45.1	35.7	17.7

* The reported figures are in percentages. All the figures are age-adjusted to the 2000 U.S. population. See Footnote 3 for details.

** The reported figures are for persons aged 25 years and over.

*** The reported figures are for persons aged 18 years and over.

Source: Summary Health Statistics for U.S. Adults: National Health Interview Survey, 2004.