An economic concept of the severity of illness

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Abstract

This paper develops a conceptual model of severity of illness. The severity of an individual's illness is a measure of the person's health condition (or health status) which is a primary determinant of the person's demand for medical care. Following common usage, the severity of a person's illness is obtained by comparing the person's level of health when (the person is) sick with the same person's level of health when (the person is) healthy. The severity is simply the difference between those two health levels. The present paper is partly analytical, with some mathematical representations.

In the discussion, effort is made to point out how the severity of a person's illness can be ascertained empirically from the types of survey data available to economists. A hindering problem in Nigeria is the non-availability of such data. In any case, an empirical measure of the severity of illness needs to recognize that the severity of illness is a latent variable. As a result, it is necessary to employ proxies in constructing empirically the latent variable. With the hope that appropriate data will become available in due course, an empirical model can be presented in a future paper.

Introduction

There is an Igbo proverb to the effect that a person in good stead with his 'chi' does not have much need for a 'dibia'. This proverb expresses in lay language an important aspect of a person's demand for health care. Technically, the demand for health care is a derived demand, derived from the demand for health. As such, the proverb implicitly distinguishes between health and health care. According to Michael Grossman (1972), when consumers purchase medical services, it is not these services per se that they desire; what they desire is good health. That is, even though it is health care that a person consumes, it is health that enters the person's utility function. (In this paper the word 'health' is used synonymously with 'health status' and 'health condition'; health care, medical care and medical services are also synonymous.)

A common-sense view of the relationship between health and health care (also deducible from the above proverb) holds that a person gets sick first and then seeks health care. This

common-sense view would be technically correct only if restricted to curative health care, such as hospital inpatient care, which is not demanded prior to the onset of illness. From this common-sense view the above proverb can be restated as follows: If a person is not sick why would the person go to hospital?

Most cross-sectional data indicate that medical care usage is zero for many individuals even among the wealthiest individuals and even in societies with free access to medical care. Likewise, most time-series data show that many persons utilize medical care in some periods but not in some other periods. One explanation for such observed zero medical care usage is the absence of illness and the absence of the expectation of illness. That is, the demand for medical care is a response to the risks of illness (Arrow 1963).

The question is how to operationalize the relationship between health and health care. In order to follow the reasoning in this paper, imagine that the demand for health care involves two inter-related decisions: a binary decision whether or not to seek care, and a conditional decision about how much care to demand. In this paper, the focus is on curative care, the second decision. Representing health status by illness, the next question is how to measure illness and its severity. In the case of curative care, the appropriate health variable is a measure of how ill a person is (the severity of the person's illness). Illness can be conceptualized as a deviation of a person's level of health from a benchmark level at which the person is considered healthy. Then, the severity of the person's illness is defined simply as the magnitude of the health deviation.

The remainder of the paper is as follows. Section 2 presents a review of the appropriate literature. Section 3 conceptualizes SOI. The concept of medical care need is presented in section 4. Sections 5 and 6 present the conclusion and references, respectively. The accompanying graphs are in the appendix.

Overview of the Economics Literature on Severity of Illness

What is the most appropriate concept of health status in a model of demand for medical care? Grossman uses a person's health stock. Fig. 1 in the Appendix shows Grossman's conceptualization of a person's health status, with the fall in a person's health represented as a depreciation (aging?) over the person's lifetime. Fig. 2 is a specialized version of Grossman's model. However, some authors have recognized that natural health depreciation is an inadequate illness process. For example, Phelps (1982, p.19) suggests that a typical person's health stock could look something like figure 3 (Appendix), with the declines in health resulting from 'aging' as well as from 'random events of illness and injury'. Fig. 3 can be generalized to accommodate random incidence, random intensity and random durations of illness. Also, Wolfe and van der Gaag (1981, p283) suggests that measures of health status are best designed for specific purposes.

The question addressed in this paper is how to conceptualize and measure illness. This paper follows the above suggestions. Bearing in mind that the demand for medical care is a response to the risks of illness, it is recognized that for certain types of medical care (at least) such as curative care, illness is the appropriate concept of health status. The sicker the person is the more medical care the person demands, other things equal.

Previous attempts to provide more realistic conceptualization of illness include Williams' (1981) suggestion that "the best measure of health ... must be a 'feeling-functional' one, in which the presumed ideal is a long life in which each individual is able to undertake the normal pattern of activities free of pain and distress. Suppose we designate that ability as being 'healthy', and assign it (arbitrarily) the value 1 for a particular individual. Since 'normal' functioning is a socially conditioned notion, this notion of healthiness may well fall short of 'perfect' health, in the sense of the maximum attainable by anyone, anywhere, ever. Rather it will have the more modest (and more useful) connotation of accepting that there is a threshold below which a society considers someone as 'to all intent and purposes' healthy". Berndit and Williamson (1973, p.59) suggests a hypothetical health meter with which to measure how ill a person is, with calibrations in an 'ordinal scale ranging from the non-impairment level (asymptomatic with no medical care need) to the total impairment level (death). According to Bush (1973, p.55), '[A] patient deviates from some norm of well-being, correctible or not, and we can talk about that deviation' as the conceptual measure of the magnitude of the person's ill-health. The present paper combines, extends and operationalizes these ideas and suggestions from Wolfe and van der Gaag, Williams, Berndit and Williamson, Bush and others.

The severity of a person's illness is a measure of health status. Health status is a latent variable and as such it is not measurable directly. That is the reason health professionals use diagnostic conditions, illness symptoms and other indicators of disease and disability (instead of a health meter) in attempting to ascertain how ill a person is. That is also the reason proxies for health status are used in empirical models. As a result, explanatory variables in empirical models of medical care utilization usually include proxies as for health status such as work-loss days, number of sick days in bed, activity limitations and the person's perception of his own health (Wedig 1988). van de Ven and van Praag (1981) use an 'index of unhealthiness'. It is to be recognized that the severity of a person's illness is itself a latent variable.

In using the proxies, an underlying supposition is that, given the diagnostic conditions and other indicators of disease, other invariant personal characteristics are irrelevant in determining the severity of the person's illness. That is, these proxies (diagnostic conditions, etc.) are sufficient statistics for SOI. This is so

even though persons with different characteristics (different ages, for example) may indeed have different symptoms and different diagnoses. There may even be direct (say, age-related) differences in medical care utilization. As an example, consider a homeless patient. Knowledge of the patient's homelessness may lead health professionals to suspect (and diagnose) pneumonia. But once pneumonia has been diagnosed, homelessness becomes irrelevant in determining the severity of his illness. Likewise, persons of different races, ages or genders may have different diseases and, therefore, different diagnoses. For example, some diseases are male diseases while some others are female diseases. But once the diagnoses are given, such characteristics as gender or age are no longer important determinants of the severity of each person's illness. As a further example, consider differences in chronic health conditions such as between a diabetic and an amputee. Such differences are accounted for by the diagnoses. That is, although both the diabetic and the amputee have chronic health conditions, the diabetic is considered sick while the amputee is not. This can explain why the diabetic requires medical care (insulin, for example) while the amputee does not.

Several severity of illness and case-mix indices such as the United States Medicare's diagnosis related groupings (DRGs) suppose that the sicker a person is, the more medical resources the person utilizes, ceteris paribus (see, for example, Horn and Sharkey, 1983). That is, the more severe illnesses require larger medical resources to 'cure'. Most of those indices make use of data from hospital patient files which are usually not available to economists.

For economists, the severity of a person's illness can be obtained empirically from survey data. For example, Multiple-Indicators-Multiple-Causes (MIMIC, Joreskog and Goldberger, 1975) or Linear Structural Model for Latent Variables (LISREL, Joreskog and Sorbom, 1989) regressions can be employed to obtain various coefficients. This amounts to estimating the health levels in equation 3.1. The estimated coefficients can then be used to predict the severity of illness for each person in the sample.

Concept of Severity of Illness (SOI)

This section formalizes the concept of illness and severity of illness (SOI). SOI is a measure of how ill a person is (and a measure of health status). When is a person sick and when is a person healthy?

Illness can be conceptualized as a deviation of a person's level of health from a benchmark level at which the person is considered healthy. It is then possible to propose a variable called 'severity of illness' which is a measure of how ill a person is. The severity of a person's illness is defined simply as the magnitude of that person's health deviation. This implies a claim that a person's severity of illness (a single-dimensional variable) is an adequate representation of the person's health status (which itself is a multidimensional variable).

This concept of health status recognizes that a person is considered healthy or otherwise relative to himself or herself and not relative to other standards. Then the cure of a person's illness is the restoration of the person's health to its benchmark level with no attempt to create a super-man out of him. The sicker the person is, the larger the severity is, by definition. Analytically, the cure of a person's illness corresponds to a reduction of the severity to zero.

Imagine that there exists a hypothetical health meter with which the severity of a person's illness can be measured. Such a meter must recognize that when health professionals treat a sick octogenarian, for example, they make no attempt to recreate his twenty-year-old self (or any twenty-year-old) out of him. Rather, they aspire to return the octogenarian's health to the level it usually takes when he is healthy. That level a person's health usually takes when the person is healthy can be taken as a benchmark. In addition, the health meter must recognize that a healthy octogenarian can have lower vitality and virility (and other such health proxies) than a sick twenty-year-old. Yet, the meter must indicate that while the sick twenty-year-old needs curative medical care, the healthy octogenarian does not, all else equal. But age is only one of the many personal characteristics that distinguish one individual from another. In general, the severity of each person's illness is ascertained by comparing that person's level of health when sick with the (benchmark) level of health of the same person when healthy. The key problem is, of course, that health is a latent variable.

To calibrate such a health meter, imagine that person i has a level of health H_i^* that implies he is healthy. H_i^* is a personal benchmark in the sense that H_i^* may be different from H_j^*, for another person $j \neq i$. Also, let H_i denote person i's actual level of health (whether he is healthy or sick). For completeness, one can adopt the condition that a person cannot be better than healthy: $H_i \leq H_i^*$.

With the above definitions in mind, illness is defined as the fall or deviation of person i's health H_i from its benchmark. The severity of a person's illness s_i is defined as the magnitude of this deviation in health. That is, SOI is defined (by the following identity) as:

$$s_i \equiv H_i^* - H_i$$

As long as $H = H^*$, a person is considered healthy even if his H^* is low.

In order to generalize this model, consider a person's lifetime, $0 \leq t \leq T$. t is a measure of time, for example, age. As suggested by Grossman, the person is born with an initial level of health H_0 (initial health stock) and dies at H_d. That is, a person is healthier than another if he has a higher health stock.

In comparison, the model developed in this paper recognizes that a person is considered healthy or otherwise relative to himself or herself and, as such, illness is a health deviation from a personal benchmark. In fig. 4 (Appendix), the function H(t), in dashed line, is the person's actual level of health at any age t. The solid line in fig.

4 shows $H^*(t)$, the benchmark function, indicating that the person is healthy. $H^*(t)$ depends on personal characteristics (including chronic health and genetic conditions, etc.) and is related to the natural processes of growth, aging and dying. $H^*(t)$ is a datum, unaffected much by medical care usage, especially in the short run. Contemporaneous illnesses have negligible 'short-run' effects on $H^*(t)$, but may have 'long-run' effects. One of the uses of medical history is to help determine the person's health benchmark, $H^*(t)$ (see van de Ven and van der Gaag, 1982, p.173). The cure of a person's illness is the restoration of his health to its benchmark level. Symbolically, at any time t,

$H(t) = H^*(t)$ if the person is healthy.

$H(t) < H^*(t)$ if the person is sick.

SOI at any time is denoted by s(t), defined as the difference between H^* and H.

$$s(t) \equiv H^*(t) - H(t) \geq 0.$$

$s(t) = 0$ if the person is healthy.

$s(t) > 0$ if the person is sick.

In diagnosing person i's illness, health professionals attempt to determine $s_i(t)$. Person i is considered healthy if $s_i(t) = 0$ ($H_i(t) = H_i^*(t)$). He is considered sick if and only if $s_i(t) > 0$ ($H_i(t) < H_i^*(t)$). For example, the person is sick at $t = t_1$ and healthy at $t = t_2$ in fig. 4 (Appendix) even though $H(t_1) > H(t_2)$. Note that $s(t_1) > s(t_2)$. The sicker the person is, the larger his or her s(t) is. The cure of a person's illness corresponds to a reduction in s(t) to zero.

Medical Care Need

The above model of SOI can be employed to operationalize medical care need. Let s_0 represent the severity of a person's illness at the beginning of a time period. The purpose of curative medical care is to reduce s_0 possibly to zero. Let M be the amount of medical care utilized in the period. Let h(M) represent an index of the effectiveness of medical care, with first and second derivatives $h'(.) > 0$, $h''(.) < 0$. In the health economics literature, h(.) is termed a health production function (Grossman 1972, Pauly 1980, p.44). h(.) embodies existing medical technology as well as relevant personal characteristics.

Imagine that there is an objectively (or scientifically) determined amount of medical care, M^+, required to reduce s_0 to zero. M^+ is the person's medical care need (Boulding 1966) which can be obtained by solving the following identity:

$$s_0 - h(M^+) \equiv 0$$

Note that the sicker a person is, the more his medical care need, all else being equal. If medical care were free, a sick person would choose to utilize M^+, all else equal. But given that the demand for medical care is derived from a constrained utility maximization problem, if medical care is not free, the

optimum amount of medical care the person actually demands may be less than his medical care need. Aaron (1981) attributes much of the rise in health care costs in developed countries since World War II to the fact that, in those countries, health care was viewed as a need and a right.

Conclusion

This paper formalizes and operationalizes the concept of severity of illness. The severity of a person's illness (rather than the level of a person's health) is the most appropriate concept of health status in models of demand for medical care, especially curative medical care such as hospital inpatient care.

The measure of health status presented in this paper is with respect to medical care usage. In relation to this, if a person's disease is neither curable nor controllable with medical care, the person requires no medical care even though such a person may indeed be sick with regards to other types of care (nursing care, for example), but with regards to medical care utilization, the person's ill-health is irrelevant. Weisbrod (1991) suggests that incurable diseases have been expensive mainly due to 'half-way technologies'.

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