

Finkelstein, Amy; Luttmer, Erzo F.P.; Notowidigdo, Matthew J.

**Working Paper**

## Approaches to estimating the health state dependence of the utility function

IZA Discussion Papers, No. 3925

**Provided in Cooperation with:**

IZA – Institute of Labor Economics

*Suggested Citation:* Finkelstein, Amy; Luttmer, Erzo F.P.; Notowidigdo, Matthew J. (2009) : Approaches to estimating the health state dependence of the utility function, IZA Discussion Papers, No. 3925, Institute for the Study of Labor (IZA), Bonn, <https://nbn-resolving.de/urn:nbn:de:101:1-20090119213>

This Version is available at:

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Amy Finkelstein  
Erzo F.P. Luttmer  
Matthew J. Notowidigdo

January 2009

# Approaches to Estimating the Health State Dependence of the Utility Function

**Amy Finkelstein**

*MIT and NBER*

**Erzo F.P. Luttmer**

*Harvard University, NBER and IZA*

**Matthew J. Notowidigdo**

*MIT*

Discussion Paper No. 3925

January 2009

IZA

P.O. Box 7240

53072 Bonn

Germany

Phone: +49-228-3894-0

Fax: +49-228-3894-180

E-mail: [iza@iza.org](mailto:iza@iza.org)

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## ABSTRACT

### Approaches to Estimating the Health State Dependence of the Utility Function<sup>\*</sup>

If the marginal utility of consumption depends on health status, this will affect the economic analysis of a number of central problems in public finance, including the optimal structure of health insurance and optimal life cycle savings. In this paper, we describe the promises and challenges of various approaches to estimating the effect of health on the marginal utility of consumption. Our basic conclusion is that while none of these approaches is a panacea, many offer the potential to shed important insights on the nature of health state dependence.

JEL Classification: D12, I1

Keywords: state dependence, health, insurance, marginal utility

Corresponding author:

Erzo F.P. Luttmer  
Harvard Kennedy School  
79 JFK St.  
Cambridge, MA 02138  
USA  
E-mail: [erzo\\_luttmer@harvard.edu](mailto:erzo_luttmer@harvard.edu)

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<sup>\*</sup> We are grateful to Erik Hurst for helpful comments, and for research support to the National Institute of Aging, Grant Number T32-AG000186 (Notowidigdo) and the U.S. Social Security Administration through grant #10-P-98363-1-05 to the National Bureau of Economic Research as part of the SSA Retirement Research Consortium. The findings and conclusions expressed are solely those of the authors and do not represent the views of the Social Security Administration, any agency of the Federal Government, or the NBER.

## I. Introduction

If the shape of the utility function varies with health status, this will affect the economic analysis of a number of central problems in public finance, including the optimal structure of health insurance and optimal life cycle savings. We define health state dependence as the effect of health on the marginal utility of a constant amount of non-medical consumption. *A priori*, the sign (let alone the magnitude) of any health state dependence is ambiguous. On the one hand, the marginal utility of consumption could decline with deteriorating health (negative state dependence), as many consumption goods – such as travel – are likely complements to good health. In this case, the optimal amount of health insurance benefits would be lower than with state-independent utility, and optimal life cycle savings would decline (assuming health is expected to decline over the life cycle). On the other hand, the marginal utility of consumption could increase with deteriorating health (positive state dependence), as other consumption goods – such as prepared meals or assistance with self-care – may be substitutes for good health. If there is positive state-dependent utility, the optimal amount of health insurance benefits would be higher than with state-independent utility, and optimal life cycle savings would increase. Indeed, we have conducted stylized numerical calibrations which suggest that even a moderate amount of state dependence can have a substantial effect on the optimal level of health insurance benefits and a noticeable effect on the optimal level of life cycle savings (Amy Finkelstein, Erzo F.P. Luttmer, and Matthew J. Notowidigdo, 2008).

In practice, however, almost all papers that estimate the demand for health-related insurance products or that calibrate individuals' optimal life cycle savings assume state independence. This presumably does not reflect a consensus that the shape of the utility function does not vary with health status. Rather, it is indicative of the paucity of the empirical evidence demonstrating how

the shape of the utility function varies with health, which in turn reflects the considerable empirical challenges associated with estimating this parameter.

In this paper, we outline what we believe are the main possible approaches to estimating health state dependence. We distinguish two broad classes of empirical approaches: approaches based on individuals' revealed demand for moving resources across health states, and approaches based on observed utility changes associated with health changes for individuals of different consumption or resource levels. We discuss the appeals and challenges of each, in turn. Our basic conclusion is that while none of these approaches is a panacea, many offer the potential to shed important insights on the nature of health state dependence.

**Table I: Examples of approaches to estimating health state dependence**

Approach	Paper	Findings
Health insurance demand	Not implemented	N/A
Effect of health on portfolio allocation	Edwards (2008)	Positive state dependence (estimate is not quantified)
Variation in consumption profiles across individuals with different health trajectories	Lillard and Weiss (1997)	Positive state dependence (marginal utility in sick state is 155 percent of that in healthy state)
Variation in self-reported compensating differentials to hypothetical health risks across individuals of different income levels	Sloan et al. (1988)	Negative state dependence (marginal utility in sick state is 8 percent of that in healthy state)
	Viscusi and Evans (1990)	Negative state dependence (marginal utility in sick state is 77 – 93 percent of that in healthy state)
Variation in changes in subjective well-being in response to health shocks across individuals of different permanent income	Evans and Viscusi (1991)	No evidence of state dependence
	Finkelstein, Luttmer, and Notowidigdo (2008)	Negative state dependence (marginal utility after a one-standard-deviation decrease in health is 89 percent of that in the healthy state)

We also describe (and summarize in Table I) examples of each approach and the resulting evidence on state dependence.<sup>1</sup> Our main conclusion from the evidence to date is that there is scope (and need) for much more empirical work on this topic. Many of the approaches we describe have not been implemented or would benefit from additional investigations. In addition, the currently available estimates offer little in the way of a consensus on the sign or magnitude of health state dependence.

## **II. Estimating state dependence based on the demand for moving resources across states**

### ***II.A Demand for state-dependent assets***

A natural way to estimate state dependence of the utility function is to examine willingness to pay for products that offer state-dependent payoff streams. Health insurance is the obvious example. In a first-best world, health insurance equates the marginal utility of consumption across states of health. The nature of any state-dependent utility directly affects the optimal structure of a health insurance policy, and can therefore in principle be inferred from the policy chosen. Estimating state dependence off of health insurance demand is conceptually straightforward and appealing. In practice, however, researchers who attempt to operationalize this approach face (at least) two key challenges.

The first challenge is that market imperfections may limit the range of health insurance options available, and hence preclude detecting certain types of state-dependent utility based on inferences from the observed set of health insurance contracts purchased. In particular, presumably because of obvious moral hazard issues, health insurance policies that pay out *more* than medical expenditures are never (to our knowledge) offered. Therefore, if marginal utility of

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<sup>1</sup> Our discussion does not include papers that estimate a state-dependence parameter as an ancillary parameter in a larger project (often estimated via functional form assumptions). Such papers include, for example, John Rust and Christopher Phelan (1997) and Mariacristina De Nardi, Eric French, and John B. Jones (2006).

consumption were increasing with deteriorating health, this might not be detectable from observing the equilibrium purchases of currently available health insurance contracts.

A second challenge is that insurance demand depends not only on how marginal utility varies with health, but also on other parameters of the utility function, particularly risk aversion. The higher the assumed level of risk aversion, the less positive (or more negative) is the state dependence implied by a given coverage allocation. There is an enormous range of estimates of risk aversion in the literature. For example, Alma Cohen and Liran Einav (2007) review studies that estimate coefficients of relative risk aversion ranging from 1 to over 50. Inferences about state dependence from health insurance allocations could therefore be quite sensitive to plausible assumptions about risk aversion.

A potentially promising way to circumvent both these challenges would be to estimate the willingness to pay for the *last* dollar of comprehensive (i.e., full medical expense reimbursement) insurance coverage.<sup>2</sup> Imagine, for example, that an individual has a choice between two insurance contracts: one that provides comprehensive coverage of all medical expenditures, and one that provides comprehensive coverage except for a \$1 deductible. The willingness to pay in the healthy state for the last dollar of coverage in the sick state is equal to the marginal utility of consumption in the sick state relative to the healthy state, times the probability that the sick state arrives. Since the contract with the \$1 deductible provides virtually full insurance, consumption in the sick state is only marginally lower (by \$1 to be precise) relative to the healthy state, and such a small variation in consumption should have a negligible direct effect on the marginal utility of consumption in the sick state for any plausible curvature of the utility function (i.e., any coefficient of risk aversion). This means that the ratio of marginal utility in the sick state to

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<sup>2</sup> We are grateful to Wojciech Kopczuk for suggesting this idea to us.



marginal utility in the healthy state derived from the willingness to pay provides an estimate of state dependence that should be insensitive to the level of risk aversion.

To be implemented cleanly, this “willingness to pay” approach requires observing the choice between comprehensive coverage of all medical expenditures and slightly less coverage. Such a choice is likely to be hard to find in practice. Thus, as a practical matter, estimates of state dependence are likely to be affected to some degree by the assumed curvature of the utility function. How sensitive the estimates of state dependence are to this assumption will depend on how close to comprehensive (and to each other) the contracts analyzed are, as well as what one thinks are reasonable ranges for risk aversion.<sup>3</sup>

We know of no studies that have used information on health insurance demand or health insurance contracts to estimate health state dependence. We consider this an interesting and potentially quite fruitful direction for further research. A closely related approach would be to examine demand for assets that have returns that are correlated with an individual’s health. Unfortunately, to our knowledge, such assets do not exist in practice.

Even though asset returns are uncorrelated with individual health, Ryan D. Edwards (2008) argues that it is nevertheless possible to estimate health state dependence from asset allocations. Specifically, he shows that an increase in the probability of uninsured health shocks will lead people to reduce their demand for risky assets if the marginal utility of consumption decreases with health (positive state dependence). However, this relationship depends on assuming a functional form for utility in which positive state dependence occurs if and only if the coefficient of relative risk aversion exceeds one. Using data from the Study of Assets and Health Dynamics Among the Oldest Old (AHEAD), Edwards (2008) finds that those who perceive a higher

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<sup>3</sup> In addition, implementation requires exogenous variation across individuals in the price they face for different health insurance contracts, so that one can cleanly estimate demand; such variation is not ubiquitous but may be available in specific applications.

probability of uninsured health shocks hold a lower share of their assets in risky securities. For the assumed functional form of the utility function, this finding indicates positive state dependence. In addition, inferences about health state dependence from asset allocation also require that changes in health do not have a direct effect on portfolio choice as they might, for example, if health affects life expectancy.

### *II.B Consumption profiles*

One might also try to infer state dependence from the relationship between health and the time profile of consumption. Optimizing individuals will adjust their consumption path to increase consumption in periods when marginal utility is high and decrease it in periods when marginal utility is low. Thus variation in the consumption profile across individuals with different health trajectories reveals the relative demand for resources across different health states.

The conceptually cleanest way to implement this approach would be to examine differences in consumption profiles across otherwise similar individuals who face different expected health shocks. At a practical level, however, it is likely to be quite difficult to identify currently similar individuals with different expected health trajectories. Potentially, one might try to use information on genetic or other medical tests that convey information about the probabilities of later onset of conditions that are currently asymptomatic to try to implement this approach. One might also try to examine the profile of consumption paths over a time period that spans the ex-ante expected recovery from a transitory health condition (such as a broken leg). We know of no studies that have attempted to infer health state dependence from the difference in consumption profiles across individuals of the same demographics but with different expected health

trajectories. One reason may be that data containing information on such expected health trajectories are not commonplace. However, we believe they could provide an exciting and potentially quite fruitful opportunity for estimating state dependence.

It is probably easier to obtain data in which one observes individuals experiencing unexpected adverse health events, such as the onset of diabetes in one but not another observably similar individual. Since the individual life cycle budget constraint must be satisfied (resources must be consumed or left to the next generation), inferring state dependence from the consumption profile of individuals who have experienced different unexpected health events requires (in contrast to inferences based on expected health events) strong assumptions about the nature of bequest motives. Estimates of state-dependent utility using this approach can be sensitive to what is assumed about bequest motives (another subject on which there is little consensus). For example, is a decline in consumption following an unexpected negative health shock evidence that the marginal utility of consumption is lower in poor health or is it evidence of the individual having a strategic bequest motive (raising the bequest to induce children to provide more care)?

We know of only one paper that attempts to infer health state dependence from consumption profiles across individuals with different health trajectories. Lee A. Lillard and Yoram Weiss (1997) build a structural model of consumption in which the marginal utility of consumption depends on health but the marginal utility of bequests does not. They infer consumption in the Retirement History Survey from income flows and asset changes, and compare consumption paths across individuals who vary both in experienced health shocks and in expected health shocks (expectations are based on demographic characteristics). They estimate that the marginal

utility of consumption in the sick state is 55 percent higher than that in the healthy state (i.e., positive state dependence).

As the discussion of Lillard and Weiss (1997) illustrates, another challenge in estimating state dependence off of consumption trajectories is that it requires panel data with broad-based consumption measures (in addition to health measures). This is a relatively high data hurdle, especially because it is crucial that one have a broad measure of consumption, rather than merely observing a single component of consumption (such as the measure of food consumption in the Panel Study of Income Dynamics); what matters for questions such as the optimal level of insurance is not how consumption may substitute across categories but what happens to total consumption. Lillard and Weiss (1997) circumvent this problem by using income flows and asset changes to infer consumption. The need to proxy for consumption that is not directly observed is also a challenge for the papers that attempt to implement the next class of approaches.

### **III. Estimating state dependence based on observed utility changes associated with health events at different consumption levels**

An alternative approach to estimating health state dependence is to estimate the variation across individuals of different consumption levels in the utility change they experience with a given health shock. This is both as simple and as hard as it sounds. It is conceptually simple in that it directly estimates the cross partial derivative of interest (how the marginal utility of consumption varies with health or, equivalently, how the marginal utility of health varies with consumption), and practically difficult due to the inherent difficulty in measuring marginal utility.

### *III.A Compensating differentials*

One potential path is to estimate compensating wage differentials associated with various job-related health risks. The marginal utility of health is given by the product of the compensating differential times the marginal utility of consumption. The degree of state dependence can be found by estimating how the marginal utility of health varies across individuals with different consumption levels.

This approach, of course, faces all of the well-known challenges involved in estimating compensating differentials. An additional challenge is estimating (or proxying for) the curvature of the utility function – i.e., how the marginal utility of consumption varies with consumption. The sign and magnitude of the estimate of state dependence could be quite sensitive to the assumed or estimated curvature of the utility function; as noted earlier, the large range of estimates on the coefficient of relative risk aversion indicates that there is little consensus about this curvature.

In a series of papers, W. Kip Viscusi and co-authors implement this compensating differential approach. The authors survey individuals regarding the amount of money they would require to compensate them for hypothetical exposure to specific health risks, and examine how these self-reported compensating differentials vary with income (their proxy for consumption). Using this basic approach, William N. Evans and W. Kip Viscusi (1991) find no evidence of state-dependent utility, W. Kip Viscusi and William N. Evans (1990) estimate that the marginal utility of income in the diseased state is between 77 percent and 93 percent of the marginal utility in the healthy state, and Frank A. Sloan et al. (1988) estimate that the marginal utility of income in the diseased state is only 8 percent of that in the healthy state. The wide range of estimates obtained in different versions of this approach may reflect differences in the diseases studied and

populations examined. Viscusi and Evans (1990) estimate the state-dependent utility of chemical workers by comparing the survey responses of workers with different incomes to questions concerning the amount of money they would require to compensate them for hypothetical exposure to new chemicals such as asbestos or TNT. Evans and Viscusi (1991) apply this same approach to consumers exposed to different hypothetical injuries from insecticides or toilet bowl cleaners, and Sloan et al. (1998) examine individuals with and without multiple sclerosis faced with varying hypothetical probabilities of acquiring (or being cured from) the disease. The different estimates obtained by these different studies may also reflect their different assumptions regarding the curvature of the utility function.

### ***III.B Utility proxies***

A second potential way to estimate marginal utility is to use utility proxies such as subjective well-being. One can then estimate in a panel how the utility proxy changes in response to health shocks, and how this change varies across individuals of different consumption levels. One attractive feature of this approach is that, unlike all of the other approaches discussed thus far, it does not require that individuals are able to forecast the shape of their utility function in a different health state in an unbiased manner.

Counterbalancing this attraction are important concerns about the use of subjective well-being as a proxy for utility. Subjective well-being measures surely contain a great deal of noise relative to any signal value, which creates problems for the precision of estimates of state dependence. More importantly, for the approach to produce unbiased estimates of state dependence, it is necessary that subjective well-being or a monotone transformation of it can be interpreted as a cardinal measure of utility that is comparable across individuals with different

levels of resources. One can select the monotone transformation such that the curvature of the implied underlying cardinal utility function matches existing estimates of risk aversion. However, given the considerable range of estimates of risk aversion in the literature, there will likely be a range of plausible monotone transformations. Estimates of state dependence could potentially vary a great deal (and in sign as well as magnitude) within the range of plausible monotone transformations. Finally, this approach requires panel data with either broad-based consumption measures in addition to health measures (a similarly high data hurdle to that required by using consumption profiles), or additional theoretical assumptions (as in Finkelstein, Luttmer, and Notowidigdo, 2008).

Finkelstein, Luttmer, and Notowidigdo (2008) implement this approach using panel data on the elderly from the Health and Retirement Survey and permanent income as a proxy for consumption; they estimate that relative to an individual who is healthy (i.e., has no chronic diseases) a one-standard-deviation increase in the number of chronic diseases is associated with an 11 percent decline in the marginal utility of consumption.

#### **IV. Conclusion**

Health state dependence of the utility function can have important implications for a range of economic behaviors. Yet we have relatively little empirical evidence on health state dependence, and what we do have is inconclusive in both sign and magnitude. We have sketched a number of potential, promising approaches to empirically estimating health state dependence. Some have not, to our knowledge, ever been attempted. Others have been implemented but would benefit from additional explorations using different populations, data, or assumptions.

Beyond the first-order question of the average health state dependence in the population, it

would also be interesting to learn more about variation in health state dependence. The nature of health state dependence may well vary across different diseases, or across different individuals (e.g., of different ages). There may also be important non-linearities (or even potential non-monotonicities) in the effect of health on the marginal utility of consumption. All of these are interesting and important questions for further research.



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