The Role of Dynamics in the Health-Education Gradient

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It is well known that among elderly Americans, education and health are negatively correlated. Researchers find that the educated tend to score higher in tests of physical well-being, report fewer health limitations, are more likely to remain healthy, and are less likely to die. But even among the less educated, most individuals are of good health during young and middle age. Clearly, a large part of the education gradient in health is a result of differences in the dynamic process of health and aging. Understanding this dynamic process of health is therefore a necessary step in uncovering the root causes of observed health inequality in society.

Halliday (2009) and Heiss, Börsch-Suppan, Hurd, and Wise (2009) are leading examples of a literature that conceptualizes health as a latent variable and estimates how this variable evolves as individuals age using large panel data sets. Empirically, estimates of the dynamic health process can only be as good as the measures of health on which they are based. Up until now, these estimates have typically been based on extremely coarse measures of health. For instance, both Halliday (2009) and Heiss, Börsch-Suppan, Hurd, and Wise (2009) rely on dichotomous measures of "good" and "bad" health derived from self-reported health status from the Panel Study of Income Dynamics (PSID) and the Health and Retirement Study (HRS) respectively.[1] Thus, the empirical basis for current estimates of the dynamic processes of health is relatively weak because it ignores the wealth of data on individual health that has recently become available in some data-sets, most notably the HRS.

We contribute to this literature both methodologically and empirically. First, we show how to use factor analytic methods to summarize several measures of health in a low dimensional vector representing latent health status. This allows us to use the many health

[1] In part of their work, Heiss et al. also exploit a dichotomous disability indicator from the HRS.

measures available in the HRS while maintaining a parsimonious specification. Second, we develop a simulation-based estimator of the dynamic process of health. Our approach conceptually separates the static measurement of health from the estimation of the dynamic process.[2] The dynamic model allows us to explore how endogenous mortality, severe health crises (such as heart attacks or cancers), and more gradual processes affect aging. Third, we estimate both models separately by sex and for low and high education groups in the HRS. The results reveal how much inequality in old age is driven by differences in health at age 50 (the beginning of our sample) and how much stems from differences in the aging process.

The Static Measurement Stage

The health measures we exploit include subjective measures such as self-rated health, indices of functional limitations, and objective measures (grip strength, lung function, and walking speed) that have only recently become available. The data comes from the 1994-2006 waves of the HRS. The objective measures are only available in years 2004 and 2006. We model latent health as a mixture of normal random variables.[3] We group individuals into two education categories, by gender and by 5 year age groups. Figure 1 shows how latent health is distributed for males of each education type between ages 65-69.

The education gradient in health is immediately apparent. The educated are significantly more likely to be of worse health.[4] The figure also makes clear that the distribution of health is characterized by non-normalities. Standard estimates of latent health distributions impose normality and are likely to miss this important feature of the data. Dynamic models are furthermore likely to be misspecified if they ignore the role of non-normalities. For instance, a plausible explanation for the above bi-modal patterns stresses the role of health crises, such as heart attacks or the onset of cancers. To the extent that health dynamics following such adverse events differ from the usual aging process, the conditional expected path of health following a health event is likely to differ across the support of health.

[2] While it is possible to proceed in one step only, we believe that this clear separation between the static and the dynamic estimation delivers additional insights into what features of the data drive our estimates.
[3] In the paper, we show that the distribution of the latent health variable is non-parameterically identified.
[4] The units are defined with respect to population standard deviations in log grip strength. A one unit change in the latent health variable predicts a one standard deviation change in log grip strength.

Figure 2 shows the distribution of health for an older age group. Not surprisingly, health deteriorates with age. More surprising however is that among those with 12 years of education, there are almost no individuals with health levels that are comparable to the average 65-69 year old. Among the more educated however, we do see that there is still a substantial portion with reasonably good health.

The Dynamic Measurement Stage

After estimating how health differs by age and education, we use the panel dimension of our data to estimate the evolution of health for individuals. In particular, we develop a simulated moments estimator for three related dynamic health models. Conceptually, our method is straight forward. We start by drawing a simulation sample from our previously estimated distribution of latent health for the youngest age group (50-55). We use the dynamic model (and a given set of parameters) to simulate the evolution of latent health for each individual in this sample until death. In each period, we simulate the measurement model using our previously estimated parameters. Finally, we choose parameters for the dynamic model such that the joint distribution of measures within individuals across time matches the corresponding joint distribution in the observed HRS data as closely as possible.

We use this method to estimate three dynamic health models of increasing complexity. Because we are interested in how health dynamics differ with sex and education, we estimate the models separately by sex and education group. First, we estimate a model that characterizes the health dynamics using a simple ARMA process. Then, we explore the consequences of endogenous mortality by allowing the mortality rate to depend on latent health. In our third model, we explore the role of health crises such as heart attacks, strokes, and diagnoses of severe diseases such as cancers. We let the parameters of the dynamic health process including the incidence rate of future events change after such an event occurs. This allows us to examine whether differences in the aging process across education are driven by the incidence and severity of discrete health crises, rather than a more continuous aging process.

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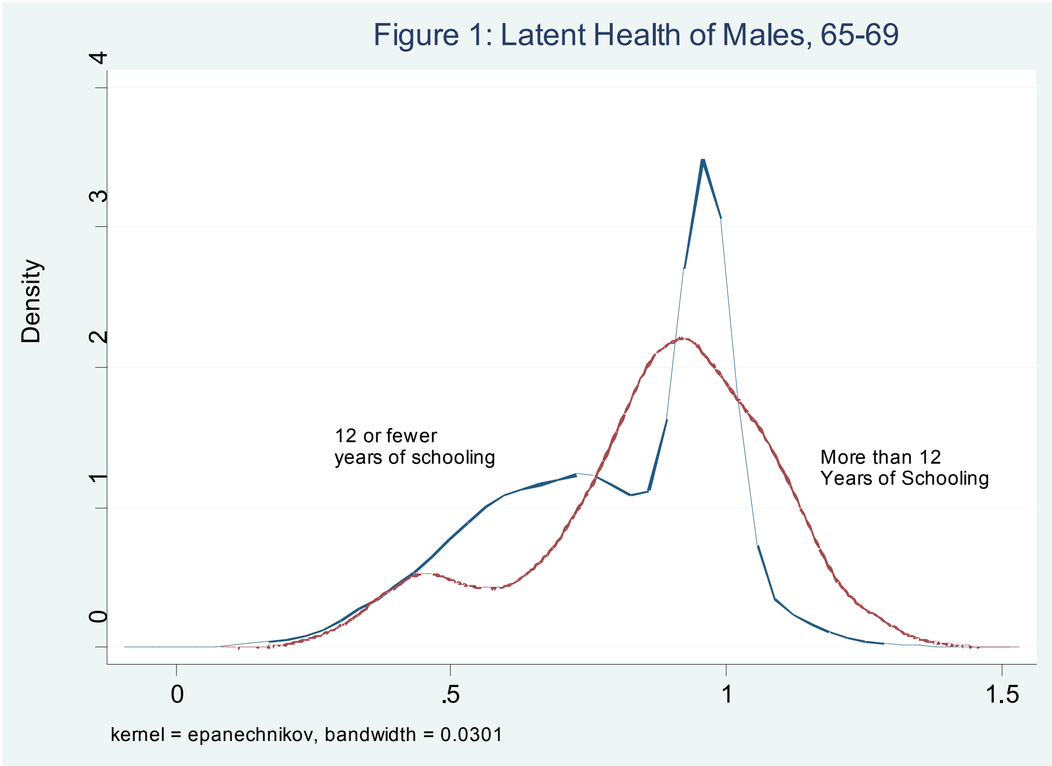
Figure 1: Latent Health of Males, 65-69
Density
0
1
2
3
4
0
.5
1
1.5
12 or fewer
years of schooling
More than 12
Years of Schooling
kernel = epanechnikov, bandwidth = 0.0301

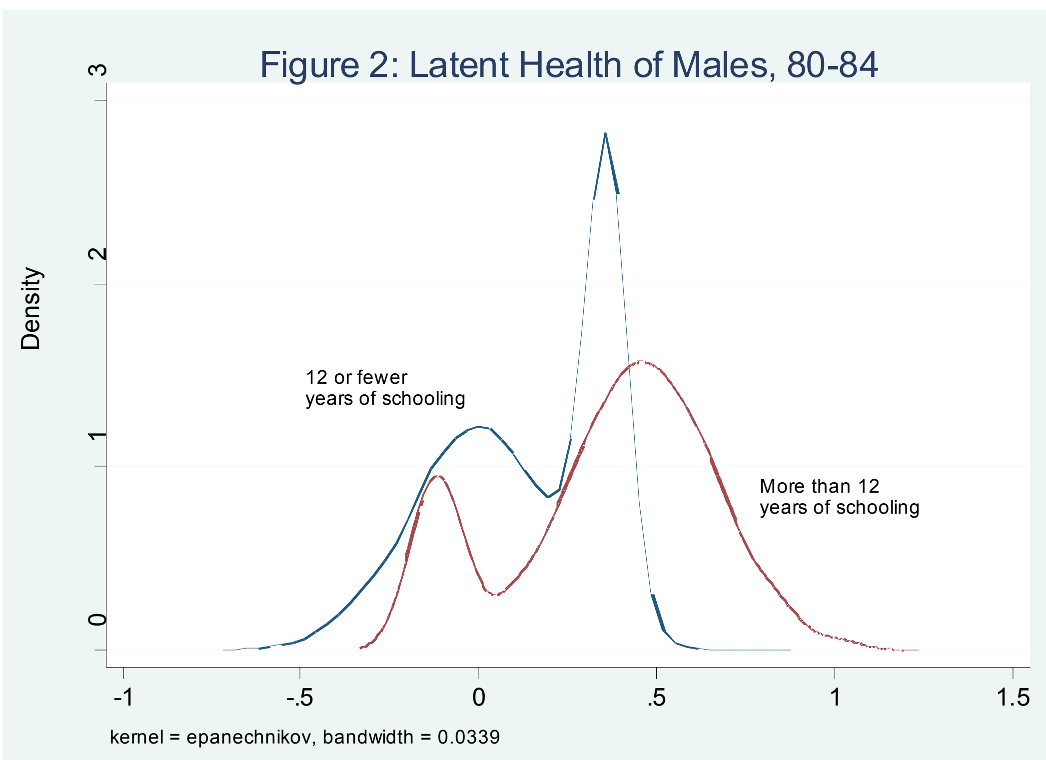
Figure 2: Latent Health of Males, 80-84
Density
0
1
2
3
-1
-.5
0
.5
1
1.5
12 or fewer
years of schooling
More than 12
years of schooling
kernel = epanechnikov, bandwidth = 0.0339