

The Grossman model after 40 years: a reply to Peter Zweifel

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This morning, I woke up and took a three mile jog. Next, I had a cup of yogurt and two cups of coffee for breakfast and debated with myself about whether I should give up coffee. For lunch I had a salad instead of french fries, and tonight when I return from work, I will forego the gin martini I know I would enjoy. In the coming year, I will have a colonoscopy and a digital rectal exam to screen for cancers. I can assure you that none of these activities represent consumption. I hate jogging, love french fries, and as many of my friends can attest, I like a strong drink or two every now and then. No need to state the obvious about the colonoscopy and digital rectal exam!

Why do I engage in these seemingly unpleasant activities? I do so because they will increase my longevity and improve my health, which will enable me to love my family and friends longer, and enjoy my remaining life more fully. These activities are investments in health, which, like any investment, requires initial sacrifice in return for future benefits. Am I misguided? Not according

to medical science, as there is abundant evidence from high-quality studies that diet, exercise and some preventive screenings extend life and improve health.¹

Appropriately, the canonical model in the field of health economics, which was developed by Michael Grossman 40 years ago [12], recognized this fundamental feature of life and made purposeful, future-oriented investments in health such as those described above the focus of the model. Moreover, investing in health in a purposeful manner that recognizes that such investments represent a tradeoff between current and future utility is not limited to persons living in developed countries. While the scale of investment in health differs, such investment (e.g., purchases of malaria nets, HIV prevention efforts, and purchases related to clean water and improved sanitation) clearly occurs in developing countries. In short, the Grossman model (MGM) is relevant in developed and developing country contexts.

In a recent editorial in this journal, Peter Zweifel argued that Grossman's focus on purposeful, future-oriented action is unwarranted because "... the MGM view is close to untenable. Just about everyone has experienced a spell of very bad health, causing his or her planning horizon to shrink to days or even minutes (when the rescue vehicle after an accident rushes the injured to the nearest hospital)." Zweifel's argument is flawed. There is nothing inconsistent with the desire to obtain beneficial medical care after the onset of unexpected illness (injury) and the focus on health investment in the Grossman model. The Grossman model specifies an age (period)-specific depreciation rate of health (capital) that can take on any value and can have an uncertain time

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¹ See, for example: Burr et al. [3]; De Lorgeril et al. [7]; Ornish et al. [17]; Hooper et al. [14]; Iestra et al. [15]; Orozco et al. [18]; American College of Preventive Medicine [1]; and Zauber et al. [19].

path that is quite discontinuous with many periods of near zero depreciation and a few periods where health shocks severely damage health. While the original Grossman article analyzed the case in which the depreciation rate increased with age and was known with certainty, this is not necessary, although an increasing rate of depreciation with age is probably the most salient feature characterizing the time path of health. Conceptually, *ex post* (illness) investments in health are the same as exercise, diet and preventive screenings—all of these actions are investments in health that require sacrificing current consumption to improve health now and in the future (e.g., rehabilitation services). Just because some health shocks are uncertain makes no difference. The uncertain nature of health shocks is why there is an insurance market to smooth consumption.

This issue brings me to one of the most unfounded assertions in Zweifel's editorial—that there is no empirical evidence that more health care improves health and, therefore, the health investment production function at the core of the Grossman model is empirically unjustified. Regrettably, Zweifel cites (once again, as in his textbook) results reported by researchers that were obtained from analyses with questionable research designs that cannot address the problem of reverse causality that sick people use more health care. Results from these studies indicate that medical care does not improve health, which Zweifel argues is evidence of the empirical bankruptcy of the Grossman model. First, these studies are examining the effect of marginal changes in the use of health care services on health, which may be quite low for a variety of reasons (e.g., price) and not reflective of the overall shape of the health production function. Second, a narrow focus on empirical evidence related to the association between medical care and health ignores the substantial evidence from randomized trials and many observational studies that good health behaviors (investments) are strongly and positively correlated with health and longevity. Third, there is now considerable evidence from studies with more credible research designs than the studies cited by Zweifel that greater (marginal) health care spending (i.e., greater amount of medical care) is associated with reduced mortality [4, 6, 8, 9]. Based on this selective and demonstrably incorrect reading of the literature, Zweifel suggests, disconcertingly, that there is a conspiracy within the health economics community to shield the Grossman model from meaningful criticism ("Or was there collusion between the journal and the author, serving their shared interest in keeping the MGM bandwagon rolling?"). This barely disguised (as a question) accusation is unjustified and disingenuous.

Zweifel's second criticism of the Grossman model is the assumption of a constant marginal cost of investment in health, but even he admits this is a minor criticism ("Admittedly, this is not part of the core dynamic optimum condition"). Notably, this feature of the Grossman model

was first critiqued by Ehrlich and Chuma [11] and responded to by Grossman [13]. The bottom line is that allowing for increasing marginal cost of health investment, as in Ehrlich and Chuma [11], will change the time path of health investment, but otherwise, have little impact on the basic predictions of the Grossman model. In addition, it seems to me that arguing about the functional form of the production function of health investment is not an argument against the Grossman model, but an acknowledgement of its essential correctness and ability to incorporate different possibilities within a unified framework.

The final criticism of Zweifel is that the health production function in the Grossman model allows for complete repair of health—investments in health can completely offset depreciation, which raises the specter of infinite life. Again, this criticism was noted by others. Case and Deaton [5] raised this issue, but show that as long as the rate of depreciation increases with age then life will be finite because the costs of repair grow and people will "optimally" choose to die, which is exactly the Grossman model. This criticism is truly minor because of the compelling fact that the rate of health depreciation does in fact increase with age. Here too, the criticism of the functional form of the health production function is not an argument against the Grossman model, but an acknowledgement that the Grossman framework is vital and perfectly capable of incorporating different specifications of some of its basic relationships, for example, incomplete repair.

To sum up, Zweifel's criticism of the Grossman model is seriously flawed. His call for researchers to jettison the conceptual focus on purposeful, forward-looking investment in health is simply inconsistent with overwhelming evidence of such behavior among people in developed and developing countries. Similarly, his claim that people have very little control over their health and that such control is limited to a very short time horizon (e.g., tomorrow) is also inconsistent with evidence linking health behavior to future health. Zweifel's technical criticisms of Grossman's specifications of the health and health investment production functions are more of an acknowledgement of the usefulness of the Grossman framework than a criticism. These criticisms have been raised previously and addressed more thoroughly by others, and the Grossman model does not need to be abandoned to incorporate different functional forms of key relationships.

Overall, Zweifel's argument that health is largely the result of a random process and that all activity to improve health is *ex post* and a form of consumption is demonstrably wrong. Zweifel's proposed model based on these premises also has a glaring weakness. The only way such a model can explain differences in health is by differences in random, biological shocks to health and differences in contemporaneous ability to repair health subsequent to

illness. Such a model has little power to explain observed differences in health by socioeconomic status and demographic characteristics because of the widespread access to health insurance that equalizes ex post use of medical treatment across individuals, and because socioeconomic status and demographic characteristics are largely unrelated to biological differences (and if they were the question would be why and bring us back to Grossman model for an explanation).

Is the Grossman model perfect? No, but it provides a logically consistent framework to: (1) explain observed differences in health, investments in health including medical care, and consumption; and (2) evaluate public and private policies to affect these outcomes. It is as relevant today as it was 40 years ago. Can it be improved? Yes, and perhaps the most productive aspect of the Zweifel editorial was to point out the important distinction between ex ante and ex post investments in health, which is not developed in the Grossman model. Incorporating this distinction into the Grossman model seems worthwhile in my opinion. For example, one approach would be to specify a health production function such as:

$$\begin{aligned} H_{t+1} &= H_t + \pi_t I_t - \delta_t H_t - \rho_{t+1}(I_t) \lambda_{t+1}(m_{t+1}) H_t \\ H_{t+1} &= \pi_t I_t + H_t [1 - \delta_t - \rho_{t+1}(I_t) \lambda_{t+1}(m_{t+1})] \end{aligned} \quad (1)$$

where

- H is health stock;
- I is investments in health such as exercise and nutrition;
- π is a parameter that translates investments into health;
- δ is a biological rate of depreciation of health;
- ρ is the probability of an adverse health event that deviates from biological path;
- λ is the loss of health stock due to adverse event (occurs at beginning of period);
- and m is medical care that can be used to offset adverse health event.

Note that, in this formulation, investments in health augment the health stock and affect the probability of an adverse event in the next period. Medical care can be used (ex post) to mitigate the effects of the health shock. The production function of Eq. (1) distinguishes between ex ante and ex post investments in health and allows for substitution possibilities between ex ante and ex post investments in health that likely occur (see [10]).

In closing, I would argue that a more productive way to move the health economics field forward is not to emphasize changes in consumer preferences and the use of ex post health care resources, as suggested by Zweifel, but to integrate the health production function of Eq. (1), or related specifications, into the models of health and

longevity developed by Ehrlich and Chuma [11], Murphy and Topel [16] and Becker [2].

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