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The gender gap in mortality: How much is explained by behavior?☆

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ABSTRACT

In developed countries, women are expected to live about 4–5 years longer than men. In this paper, we develop a novel approach to gauge the extent to which gender differences in longevity can be attributed to gender-specific preferences and health behavior. We set up a physiologically founded model of health deficit accumulation and calibrate it using recent insights from gerontology. From fitting life cycle health expenditure and life expectancy, we obtain estimates of the gender-specific preference parameters. We then perform the counterfactual experiment of endowing women with the preferences of men. In our benchmark scenario, this reduces the gender gap in life expectancy from 4.6 to 1.4 years. When we add gender-specific preferences for unhealthy consumption, the model can motivate up to 89 percent of the gender gap. Our theory offers also an economic explanation for why the gender gap declines with rising income.

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1. Introduction

In this paper, we propose a new approach, based on counterfactual computational experiments, in order to identify the behavioral (or economic) contribution to observed gender differences in morbidity and mortality. Since the first life tables were constructed in the mid-18th century, it is a well established fact that women, on average, live longer than men (Luy, 2003). While the gender gap, defined as female excess life expectancy, was first observed in developed countries, in the 21st century, it has become a universal phenomenon. Women are now on top everywhere (Barford et al., 2006). The size of the gender gap is not a natural constant. In OECD countries, it increased in the period 1950–1970 and declined afterwards. Moreover, across contemporaneous countries, the gender gap appears to be strongly negatively associated with GDP per capita (Cullen et al., 2015). In the richest countries women are expected to live about 4 to 5 years longer than men (Oksuzyan et al., 2008). The variance of the gender gap across time and countries indicates that the gap cannot be explained as a purely biological phenomenon.

Any attempt to explain the gender gap in mortality must address the phenomenon that women, at any age, appear to be less healthy than men. Fig. 1, replicated from Mitnitski et al. (2002a), shows the estimated association between age and health deficits for Canadian men and women, measured by the frailty index. The frailty index is suggested by gerontologists as one particularly straightforward metric to measure health deficits. As humans age, they develop an increasing number of aging-related disorders, ranging from mild nuisances (e.g., reduced vision, incontinence) to serious conditions (e.g., strokes, cancer). The frailty index provides the (unweighted) relative number of health deficits that an individual has, from a long list of potential deficits. The power law association shown in Fig. 1 is estimated with great precision ($R^2 > 0.95$) for men and women, and suggests a "natural rate" of aging, which is estimated to be around 4 percent for men and 3 percent for women. Similar results have been obtained for similar populations (e.g. U.S. Americans, Australians, and Swedes; Rockwood and Mitnitski (2007)). The stylized fact that women start out less healthy and age slower than men has

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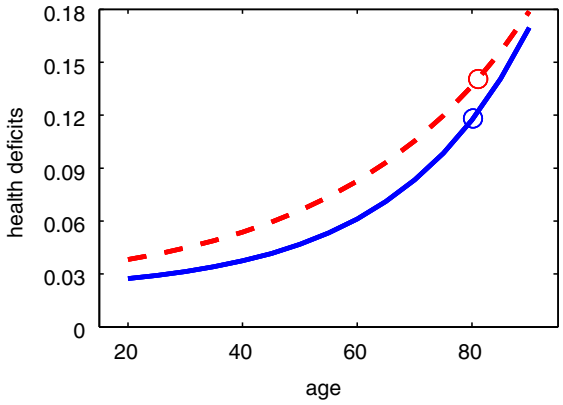

Fig. 1. Health deficits and life expectancy for men and women. Estimated frailty index for Canadian men (solid line) and women (dashed line); data from Mitnitski et al. (2002a). Dots: life expectancy at 20; data from World Life Expectancy (2015).

a microfoundation in biology, based on reliability and redundancy of body cells (Gavrilov and Gavrilova, 1991; Fries, 1980).[1]

On average, however, women, despite their larger number of health deficits at any age, die later than men. This implies the fact that, at the time of death, women have accumulated more health deficits than men. This notion is confirmed by another study of Mitnitski et al. (2002b) showing that sex-specific mortality rates are estimated with great precision as a power law (log-log association) of the frailty index ($R^2 > 0.95$), and that men are more likely to die than women for any given number of health deficits. The inverse association between health and longevity across sexes is known as the morbidity-mortality paradox (Verbrugge, 1988; Case and Paxson, 2005; Kulminski et al., 2008).

The gender gap and the morbidity-mortality paradox have attracted researchers from the natural and social sciences. Across fields, there seems to be consent that any sufficient explanation should be based on both biological and behavioral factors (Rieker and Bird, 2005; Oksuzyan et al., 2008). However, it is difficult to assess the extent to which biology and behavior contribute to the explanation of these phenomena. Answering these questions is an important endeavor in order to assess how much of the gender gap could potentially be closed by policy changes and in order to predict future trends of the gender gap.

From the biological perspective it has been observed that women are more likely to suffer from acute illnesses and nonfatal chronic conditions, including arthritis, constipation, thyroid conditions, gall bladder conditions, headaches, and migraines. These conditions lead to poorer self-rated health but contribute little to the risk of death. For a given age, men are more likely to suffer from life-threatening chronic diseases, including coronary heart disease, some cancers, cerebrovascular disease, emphysema, liver cirrhosis, and kidney disease (Verbrugge, 1985; Bird and Rieker, 1999; Case and Paxson, 2005). Biology offers explanations based on hormonal, autoimmune, and genetic factors. For example, women have lower risk of cardiovascular disease due to the protective effects of estrogen which lowers the levels of low density lipoproteins. Women are also equipped with a better immune system, which makes them less likely to die from parasitic and infectious diseases but more likely to suffer from autoimmune diseases. Regarding genetics, women are less likely to suffer from diseases linked to the *X*-chromosome, of which men have only one. Since *X*-linked defects are usually encoded in recessive genes, men are more likely to develop these conditions (Holden, 1987; Austad, 2006; Oksuzyan et al., 2008).

From the behavioral perspective, it is observed that women are, on average, less willing to engage in risk-taking health behaviors, such as smoking, drinking, drug use, and hazardous driving. Women are also more likely to prefer fruits and low-fat foods, and to consume less meat and salt. Women utilize health care services more frequently than men, even when controlled for sex-specific conditions; women use more prescription and over-the-counter medicine, they demand more vitamin supplements, and they utilize routine screening exams more frequently (Waldron, 1993; Wardle et al., 2004). One study concludes that women demand not only more total medical care but also more of each type of care, an observation which seems to hold across developed countries and over time (Sindelar, 1982).

Most of the studies on gender-specific health behaviors and outcomes (including those on the frailty index) are based on self-assessments. This raises the concern of gender-specific reporting attitudes. On average, more health-conscious women may overemphasize their health deficits while more status-concerned men, on average, may underreport them. The seminal study of Case and Paxson (2005) resolved these concerns by showing that differences in self-rated health can be fully explained by differences in health conditions, leaving no room for gender bias in reporting. However, while men and women with the same conditions had similar self-reported health, men were observed to be more likely to die from these conditions, indicating that men experience them with greater severity.

Most important for our study is perhaps the observation that men and women essentially suffer from the same life-threatening diseases but that women tend to experience them later in life. For example, the incidence of coronary heart disease starts rising about 10 years earlier for men than women (Verbrugge, 1985). This observation is useful to explain the morbidity-mortality paradox. It is also quite intuitive. Because the chronic and fatal conditions that lead to an earlier death of men are aging-related and because both men and women age as they get older, we expect women to develop these diseases as well, yet later in life. Simplifying and summarizing these insights in terms of Fig. 1, we observe a gender gap because women suffer more from non-fatal health deficits and develop fatal health deficits later in life. The female delay in fatal health deficit accumulation can be explained by female biology (e.g. estrogen production) as well as by female behavior (e.g. less smoking).

One approach suggested in order to assess how much of the gender gap can be attributed to biology and behavior is to consider subpopulations, in which men's and women's lifestyle are more similar. Preston and Wang (2006), for example, investigate gender differences in the mortality of smokers and non-smokers and estimate that changes in smoking patterns contributed about 20% to the declining gender gap. Luy (2003) compares life expectancy of the cloistered subpopulation in Bavaria with that of the German population at large. For the period 1965 to 1990, he observes that the life expectancy of nuns exceeds that of monks by 2.3 years. At the same time, German women on average lived between 5 and 6 years longer than men. While studies of nuns and monks, smokers, and other subpopulations suggest that a large part of the gender gap can be motivated by gender-specific preferences and behavior, there remains the question of out-of-sample validity.

In this paper, we propose an alternative, theory-based approach that utilizes counterfactual computational experiments. We set up a standard economic model of health deficit accumulation (Dalgaard and Strulik, 2014) and calibrate it separately for men and women such that it replicates life expectancy and the life cycle

[1] In this paper, we consider aging as a biological phenomenon (increase of health deficits per year) rather than a chronological phenomenon (by one year every year). Chronologically, men and women age equally fast but biologically, men age faster than women. For a recent study on the performance of the frailty index as an indicator of biological age, see Kim et al. (2017). See Rockwood et al. (2005) on the methodology of the frailty index.

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