Aspirations, Health and the Cost of Inequality*

Jeffrey Allen
BENTLEY UNIVERSITY

Shankha Chakraborty
UNIVERSITY OF OREGON

Final version: JEDC forthcoming

Abstract

How does inequality motivate people and at what cost? In a model of perpetual youth, people have heterogeneous upward-looking aspirations. They value their consumption relative to the conditional mean of those above them in the distribution; their survival depends on health capital produced from time investment and health goods. Higher fundamental inequality, working through the aspirations gap, motivates people to work and save more. Economic outcomes improve but income and consumption inequality worsen because the poor have less capacity to respond on the labor market. By diverting resources from health production, aspirations also worsen mortality, especially for the poor. Though relative income has a strong negative effect on personal health, inequality has a weak effect on population health, explaining an empirical puzzle on the relative income and health gradient.

KEYWORDS: Inequality, Aspirations, Consumption externality, Health, Grossman model, Relative income and health gradient, Heterogeneous agents
JEL CLASSIFICATION: D31, D91, I14, J20

*We thank a co-editor of this journal, Herbert Dawid, and three anonymous referees for valuable feedback. Thanks also to Alfredo Burlando, George Evans, Peter Lambert, Bruce McGough, Tyler Schipper, Mark Thoma and participants at various seminars and conferences for suggestions and discussions. Allen: Dept. of Economics, Bentley University, Waltham, MA 02452. Email: jallen@bentley.edu. Chakraborty: Dept. of Economics, University of Oregon, Eugene, OR 97403-1285. Email: shankhac@uoregon.edu.

1 Introduction

We often care about inequality not for its functional consequences alone, but directly, because of what it means for our relative position in society. This may be due to rivalry with others who are doing economically better, ego rents from being perceived as more successful, or the information that relative position reveals about what it takes to succeed. Positional concerns, in turn, affect our well-being. If they motivate us to work harder or invest in the future, our economic lives improve. Conversely, personal health may decline if a loss of social status triggers a behavioral change or biochemical response from stress, feelings of inadequacy and failure.

This paper deals with how inequality motivates people and at what cost. The idea that inequality can be motivating is most widely associated with Friedman (1962) and underlies Okun's (1975) influential work on the equity-efficiency tradeoff. It has gained currency in policy circles yet received sparse systematic treatment in the academic literature. We show that if inequality motivates the rich as well as the poor, *equilibrium* or *measured* inequality may well worsen.

The very different view, that inequality is costly because it directly and adversely affects health, originates with the work of Marmot (1986), Elstad (1998) and especially Wilkinson (1992, 1996) in the social epidemiology and public health literatures. This *relative income gradient* has been the subject of vigorous debate and conflicting evidence. We identify a behavioral channel through which relative position aggravates personal health and show how this explains the weak aggregate relationship between inequality and population health in the data.

Our framework is a life-cycle economy with heterogeneous ability and upward-looking aspirations. People pursue the consumption standards of those who are better off than them. In an effort to catch up, they work more (higher present consumption) and save more (higher future consumption). Their motivation to do so depends on how far they fall below their aspirations: the poor face a larger aspirations gap and respond more to relative position. Inequality, independently of absolute income, has a first-order welfare effect in this environment. Since the poor are already extended on the labor market, they have less capacity to raise labor supply. This limited capacity worsens measured consumption and income inequality even though everyone enjoys higher income under aspirations.

Aspirations have health consequences too. The survival rate depends on health capital produced from time investment and complementary health goods, a synthesis of Blanchard (1985) and Yaari (1965) with Grossman (1972a). Stepping up labor supply comes at the cost of less discretionary time available for health production.[1] Likewise the greater emphasis on consumption and saving means a lower propensity to spend on health goods. Therefore, higher relative

[1]This response should be interpreted generally, not just working longer hours but taking on multiple jobs or branching into occupations that compensate better but have harsher work environments.

deprivation – equivalently higher aspirations gap – lowers life expectancy. Health production suffers across the distribution, more so among the poor who are worse off in relative terms.

This link between inequality and health marks the first contribution of our paper as it resolves an empirical puzzle – the conflicting micro- and macro-level evidence on health and inequality. Social epidemiologists often cite evidence on mortality and income inequality in the OECD to claim that, distinctly from the effect of absolute income, inequality itself has a first-order negative effect on individual and population health. This and similar claims on the relative income gradient based on aggregate statistics are not robust to careful empirical analysis; the negative association between inequality and population health is weak at best. Disaggregated data, nonetheless, paint a clear and compelling picture: relative position and measures of relative deprivation consistently and negatively predict household health, controlling for absolute income.

In our model higher *fundamental inequality*, that is, inequality in the exogenous ability distribution, elicits a strong response from the poor to increase consumption by disproportionately spending less on health and working more on the labor market. The rich, in turn, spend disproportionately more on health. Taken together, these responses can account for a weak (macro) correlation between measured income inequality and health. Other factors such as economic growth and medical innovations also weaken the aggregate relationship over time as they relax constraints on health investment in poorer households.[2] The absence of a strong relationship between inequality and population health, therefore, should not be taken to imply that inequality has no direct and adverse health effects. If we care about the social cost of inequality, distributional measures such as the life expectancy gap or health Gini are more informative than an aggregate measure such as population life expectancy.

A second contribution of this paper is to further our understanding of aspirations and inequality beyond the naïve Friedman-Okun hypothesis. Much of the existing "Keeping Up with the Jones" (KUWJ) literature focuses on representative agents who aspire to a common standard of living, for instance, average consumption or wealth. Under this common aspiration there is no scope to identify differential effects across the distribution or to study the effect of aspirations on equilibrium inequality. In our model, not just the poor, the rich too are motivated by upward-looking aspirations. This introduces two additional margins. The ability of the rich to more strongly respond to aspirations through labor and capital supply tends to worsen economic inequality. At the same time, since health spending is a superior good, this effect is attenuated by the rich spending more of their marginal income on health rather than wealth.

[2]The model deals with an observable behavioral response to aspirations and inequality. It does not formalize, in particular, the biochemical pathways that link loss of self-esteem and social status to ill health.

Nothing in our analysis suggests that relative income is a stronger determinant of health compared to absolute income. In fact it is because of the latter that economic growth undoes the adverse health effects of inequality.

A third contribution of this paper is methodological. To the best of our knowledge this is the first paper to analyze a Ramsey-type economy with endogenous and heterogeneous aspirations. The analytical complexity of this framework is resolved through quantitative work focused on the stationary distribution. We build on the consumption-based common-aspirations literature, including Abel (1990), Gali (1994), Alonso-Carrera *et al.* (2005, 2007), García-Peñalosa and Turnovksy (2008) and Barnett *et al.* (2010).[3] That aspirations are formed with respect to consumption implicitly assumes that some forms of spending like housing, cars, schools are informative about a household's living standards and generate envy among its neighbors and social circle.[4] This paper is also related to a long line of research on aspirations, status-seeking and preference externality (e.g., Alvarez-Cuadrado and Long, 2012, Azariadis *et al.*, 2013, Corneo and Jeanne, 1998, de la Croix and Michel, 1999, Dupor and Liu, 2003, Fuhrer, 2000, Jin *et al.*, 2011, Kawamoto, 2009), [5] and recent research on health production in an optimizing framework (e.g., Bhattacharya and Qiao, 2007, Chakraborty *et al.*, 2010, Goenka *et al.*, 2014).

The next section discusses the evidence on relative income and health. Section 3 studies the household's decision problem in an intertemporal model. Using quantitative work, section 4 identifies the effect of aspirations and inequality on individual health while section 5 studies the full equilibrium. Section 6 concludes.

2 Evidence and Theory

2.1 An Empirical Puzzle

A central theme in the literature on public health and epidemiology is the health effect of inequality – the relative income gradient – that operates independently of the absolute income gradient that economists typically study. This focus owes much to the work of the social epidemiologist Richard G. Wilkinson who in a series of papers and monographs (Wilkinson, 1992, 1996, Wilkinson and Pickett, 2009) has advanced the hypothesis that inequality adversely affects individual and population health because of psycho-social causes, that inequality is, in and of itself, a health hazard (Deaton, 2001).

For example, there is no correlation between life expectancy and GDP per capita across the

[3] García-Peñalosa and Turnovksy (2008) study heterogeneous aspirations in the Ramsey model to identify a preference specification for which the aggregate behavior does not depend on the distribution of aspirations. The aspirations, however, are posited to be exogenous individual-specific proportions of mean consumption.

[4] In the model distributional rank in and of itself is not valued by individuals for the simple reason that rank is hard to ascertain and value unless it leads to observable outcomes. In other words, people care about their relative position only to the extent that it reveals something about their relative standard of living, consumption being one measure. See also footnote 15.

[5] Some in this literature use relative wealth or income or a signaling good to model status seeking.

OECD, but a distinct negative relationship between life expectancy and inequality (Wilkinson, 1996) and a positive relationship between gains in life expectancy and gains in the income share of the poorest 60% (Wilkinson, 1992). The correlations are interpreted causally. Specifically, it is argued that social circumstances such as loss of self esteem, balance between work and home or loss of control over one's life in more unequal societies trigger behavioral and bio-chemical responses that heighten the risk of heart disease, cancers and other ailments. The particular psycho-social pathways are identified from other studies. Biologist Robert M. Sapolosky's work on primates is frequently cited as illustrating how social dominance, over time, causes physiological responses that can permanently elevate health hazard in humans (Wilkinson, 1996, ch 10). Similarly the Whitehall studies on British civil servants have found a strong inverse correlation between position in the administrative hierarchy and mortality rate. Mortality rate for men in the lowest administrative grade was three times higher than that for men in the highest grade, only a third of which is explained by the effect of income on health choices, the remainder presumably by the direct effect of relative position or inequality (Marmot, 1986, Smith *et al.*, 1990, Wilkinson and Pikett, 2009).[6]

The "Wilkinson hypothesis" has fundamentally influenced the public health debate on how to address health inequalities (Subramanian and Karachi, 2004). But barring notable exceptions such as Deaton (2001) and Eibner and Evans (2005), it has received little attention from economists researching health and inequality. A primary concern is surely identification, particularly when working with aggregate statistics. Setting that aside – for a compelling case would require a "natural experiment" that alters relative income while preserving own income – several other concerns have been voiced. First, Wilkinson's assertion of causality based on the aggregate data has been questioned right from the beginning. Suppose that the survival rate depends on household income through a positive and concave gradient. By Jensen's inequality, a mean-preserving increase in income dispersion would worsen a poorer household's health more than it improves a richer household's, that is, average or population health would worsen. Gravelle (1998), therefore, questions whether a negative correlation between measures of inequality and aggregate health says anything about causality. More pointedly, a negative correlation is entirely consistent with the *absolute income* and health gradient.

A second problem is the robustness of the evidence. Judge (1995) reports that Wilkinson's original findings do not hold up to subsequent data and more careful methodology. While Kaplan *et al.* (1996) and Kennedy *et al.* (1996) find a similar negative relationship between health

[6]Not all of the evidence Wilkinson cites neatly fit this mold. For example the negative effect of unemployment (Wilkinson, 1996, pp. 177-178) or natural disasters (p. 180) on subsequent mortality can be easily understood through the conventional income channel. Partly because of this, and partly because an economic model has little to say about automated biochemical responses to relative position, we focus exclusively on behavioral responses, the social half of Wilkinson's psycho-social hypothesis.

and inequality at the aggregate level for the US, it is sensitive to the southern States: the correlation weakens for white mortality alone (Deaton, 2003). Additionally, as shown in Appendix A, it appears that the aggregate relationship between inequality and health has weakened over time.

Surveying the large body of research since Wilkinson's original work, Subramanian and Kawachi (2004) note that the literature has commonly used the Gini coefficient to measure inequality and "the published evidence so far is by no means conclusive about the relation between income distribution and population health" (p. 78). They call for further work, including a better integration of theory and empirics.

Yet the disaggregated evidence is clearer: inequality – measured by relative position or deprivation, not the Gini coefficient – has a strong negative effect on individual and household-level health. Besides the studies on relative social position mentioned earlier (and the sources they cite), Deaton (2001) finds that an increase in Yitzhaki's (1979) measure of relative income deprivation within the US states results in worse reported health. Eibner and Evans (2005) confirm this finding for a larger range of health outcomes including mortality and alternative measures of the reference group used to construct the deprivation index. Relative deprivation has a particularly large impact on deaths related to smoking and coronary heart diseases which are known to be associated with long-term stress and excessive work. Both studies control for household income, that is, they identify a mechanism working separately from the direct effect household income has on health production (see also Subramanyam *et al.*, 2009). Studies have replicated the relative income effect for other populations, Dahl *et al.* (2006) for Norway and Kondo *et al.* (2008) for Japan, for instance.[7]

The seeming contradiction between aggregate and disaggregate data is puzzling. Understanding it is important not just for our grasp of health behavior and policy – is income growth alone enough to lift the poor out of poverty and ill health? should we redistribute income or directly tackle health inequality? – but also since much research has come to view aggregate measures of health such as life expectancy as good proxies for the social consequences of inequality, a topic that has emerged to the forefront of public and intellectual discourse in recent years.

[7]This is not to say that all studies support the relative income gradient. In Miller and Paxson (2006), having wealthier neighbors does not aggravate mortality controlling for own income. It is unclear, though, if that necessarily rejects the Wilkinson hypothesis. If crime is lower in wealthier neighborhoods and the effect is strong, it may dominate the adverse relative income channel. Likewise it is hard to control for selection, individuals choosing to locate in wealthier versus poorer neighborhoods.

2.2 A Resolution

What kind of theory do we need to explain the data? The one advanced here relies on preference externality in the form of consumption-based aspirations.

Could a model without such externality explain the evidence? Take the most obvious benchmark, a partial-equilibrium Grossman-Yaari-Blanchard longevity model where there is no consumption externality, markets are perfect and prices exogenous; this is nested by our specification. Since each household is autarkic, relative position in the distribution has an effect on household health only to the extent it is informative about the household's absolute income. Controlling for household income, we would expect relative position to have no effect on household health. As long as rich and poor households face same prices, this is true even with endogenous factor prices. Therefore, such a model would have a hard time explaining the strong micro-level evidence on the relative income gradient. At the macro level, on the other hand, the model would predict a non-causal negative, possibly strong, association between population health and inequality. If health is concave in income, a mean preserving spread in the income distribution would necessarily worsen average population health. That is, the model would be unable to account for the macro evidence either.

Take another alternative without preference externality where relative position in the distribution has a direct bearing on health production. This may be due to credit frictions (Galor and Zeira, 1992), human capital externalities (Galor and Tsiddon, 1997), complementarity between survival and asset accumulation (Chakraborty and Das, 2005) or access to heath care (Gulati and Ray, 2016). Although not all these papers or related ones in the inequality literature directly study health, there are certain commonalities in why relative position matters: poorer households face different relative prices or expected returns or they face a different health production function. Whatever the exact mechanism, inequality has a strongly negative causal effect on household *and* aggregate health in this literature. Here the drawback is the inability to match the macro evidence.[8]

In the model of preference externality advanced in this paper, households aspire to the average consumption level of everyone above them in the distribution. Since poorer households face a larger aspirations gap – a higher relative consumption deprivation – their marginal propensity to invest in health is considerably weaker than the health production function alone suggests. Redistributing income towards them, through a mean preserving spread, does little to raise mean life expectancy. This weakens the negative association between average population

[8]Some of these papers also feature income polarization that accentuates these margins. In Gulati and Ray (2016), the effect of inequality on the poor is non-monotonic at the neighborhood level: at low levels of inequality, increasing the proportion or income of the rich improves provision of local goods like health. This weakens the aggregate relationship but also predicts a positive effect of inequality on the health of the poor as long as initial inequality is low.

health and income inequality even as household health responds strongly to relative position.

3 An Intertemporal Model

Consider a discrete-time infinitely-lived economy where time is indexed by $t = 0, 1, \ldots \infty$. Individuals (interchangeably households) are born with an idiosyncratic labor productivity draw θ, initial asset a_0 and health capital H_0. Every period that he is alive, each individual has a unit time endowment that he allocates between work and leisure.

3.1 Health Production

Much like the Grossman (1972a,b, 2000) model of health as an investment good, individuals accumulate a stock of health through purposeful investment that determines their longevity. Unlike the Grossman model, they do not face a deterministic length of life that is dictated by a minimum health stock. Rather, the model builds on the perpetual youth framework from Yaari (1965) and Blanchard (1985) in that the individual's health capital at the beginning of any period determines his survival probability to the next period.

Health capital depreciates at the rate $\delta \in (0, 1)$. Health at the beginning of $t+1$ for individual i depends on his undepreciated health capital and investment from period t:

$$H_{it+1} = (1-\delta)H_{it} + I_{it}. \tag{1}$$

Investment $I_{it} \geq 0$, in turn, is produced from two inputs. The first is healthy time allocation that, without loss of generality, is simply leisure time $1 - l_{it}$, l_{it} being labor supply.[9] The second input, q_{it}, is market-provided medical care or health goods such as visits to the doctor, drugs, vitamins, etc.. The relative price of this good is constant and normalized to unity (equivalently, the final good can be converted one-for-one into q). Gross health investment depends on these inputs according to an increasing and concave function of leisure and health expenditure $I_{it} = I(l_{it}, q_{it})$ satisfying $I(1, q) = 0 = I(l, 0)$. Suppose that

$$I(l_{it}, q_{it}) = Q(1 - l_{it})^{\alpha} q_{it}^{\rho}, \tag{2}$$

[9] This is a special case of Grossman's model where leisure time can be purely consumed or devoted to health production. Were people to invest healthy time into health production and separately value non-healthy time leisure, higher labor supply would lower both types of non-working time. Either way, the essential tradeoff is that higher consumption via higher labor supply entails a health cost. The non-rivalness of healthy time and leisure in our model does not fundamentally affect this tradeoff. And it is this tradeoff that underlies how higher inequality – higher aspiration gap – motivates people to work harder at the cost of poor health.

where $Q > 0$, $\alpha, \rho \in (0,1)$ and $\alpha + \rho \leq 1$.

Health capital determines the survival probability ϕ_{it} through an increasing concave function $\phi_{it} = \phi(H_{it})$ that satisfies $\phi(\underline{H}) = 0$ for some $\underline{H} \geq 0$ and $\lim_{H\to\infty} \phi(H) = 1$ for $t \geq 1$. The function is taken to be

$$\phi(H_{it}) = \xi \left(1 - \frac{\nu}{H_{it}}\right)^{\tau}, \; t \geq 1 \tag{3}$$

where $\tau \in (0,1)$, $\xi > 0$, $\nu > 0$ and H is restricted above ν. To ensure that the agent is alive in the initial period $t = 0$, we assume that $\phi_{i0} = 1$. The unconditional probability of being alive until period t is

$$\Phi_{it} = \prod_{n=0}^{t} \phi_{in}. \tag{4}$$

Health capital has no effect on i's decision problem except through survival. We introduce health this way because much empirical work in this area uses mortality statistics.

3.2 Preferences

Utility in any period depends on personal consumption, leisure and relative position in the consumption distribution. Specifically, people aspire to the average consumption of all those who consume at least as much as they do; for the highest-consumption individual, that benchmark is simply his own consumption.[10]

$$\bar{C}_{it} = \frac{\sum_{j=1}^{N} \mathbb{1}(c_{jt} \geq c_{it}) c_{jt}}{\sum_{j=1}^{N} \mathbb{1}(c_{jt} \geq c_{it})} \tag{5}$$

where $\mathbb{1}(c_{jt} \geq c_{it})$ is an indicator function that takes the value 1 if true and 0 otherwise. It is important to note that unlike much of the literature on status-seeking, aspiration levels here are individual-specific.[11]

To understand how the aspirations gap, or relative deprivation $\bar{C}_i / c_i$, varies across the population consider a hypothetical exogenous and continuous consumption distribution $\mathscr{F}(c)$ for

[10] This notion of aspirations is closer to the status-seeking literature than Genicot and Ray (2016). That aspirations are determined by an individual's position in the consumption distribution may be viewed as one version of Frank's (1985) idea that people pick role models from those who are positioned above them along some dimension they care about.

[11] The assumption that people's reference group comprises of the entire distribution above them is informed by the empirical literature discussed in section 2.1. If the reference group is more restricted – people with consumption levels only within a certain range of an individual's, or more generally, higher subjective weight attached to people whose consumption levels are closer – then relative income would matter less for household behavior both theoretically and empirically.

which $\bar{C}_i = \int_{c_i}^{\infty} x d\mathscr{F}(x) / [1 - \mathscr{F}(c_i)]$. In general it is not possible to sign $\partial\left(\bar{C}_i / c_i\right) / \partial c_i$ unambiguously. Consider two examples commonly used in the inequality literature, Log Normal and Pareto. Figure 1 shows that $\bar{C}_i / c_i$ is monotonically decreasing in consumption level for Log Normal (left panel). The fractal property of the Pareto distribution (right panel) means both rich and poor face the same aspirations gap. In both cases, higher inequality implies a higher aspirations gap at all consumption levels. However, even for a Pareto ability distribution, the

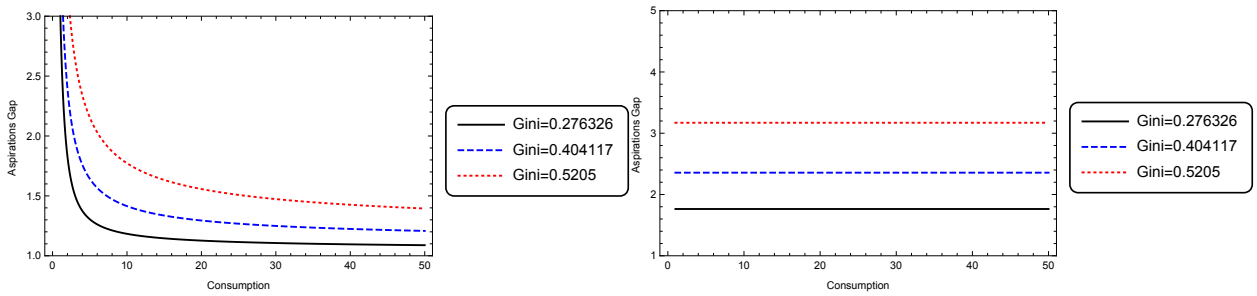


Figure 1: Consumption Deprivation for Log Normal (left) and Pareto (right) $\mathscr{F}(c)$

equilibrium consumption distribution studied later (resulting from the interaction between c and $\bar{C}$), behaves similar to the Log Normal case in that the poor face a larger aspirations gap.

Drawing on the macro KUWJ literature, particularly Gali (1994), we adopt the CES specification for individual i's preferences over consumption and leisure

$$u_{it} \equiv U(c_{it}, \bar{C}_{it}, l_{it}) = \frac{c_{it}^{1-\sigma}}{1-\sigma} \bar{C}_{it}^{\psi\sigma} + \gamma \frac{(1-l_{it})^{1-\sigma}}{1-\sigma} \tag{6}$$

where $\sigma > 0$ and $0 < \psi < 1$. As a baseline, we set $\psi = (\sigma - 1)/\sigma$ with $\sigma > 1$, similar to Abel (1990) where the aspirations level is mean consumption.

A different way of specifying (6) distinguishes between the responsiveness to own consumption $(1-\zeta)$ versus relative consumption (ζ) more clearly:

$$u_{it} = \frac{\left\{c_{it}^{1-\varsigma}\left(c_{it}/\bar{C}_{it}\right)^{\zeta}\right\}^{1-\sigma}}{1-\sigma} + \gamma \frac{(1-l_{it})^{1-\sigma}}{1-\sigma}$$

where $\zeta \in [0,1]$ may be interpreted as the "degree of positionality", that is, the fraction of the utility increase from the last unit spent that is due to higher relative consumption (Johansson-Stenman *et al.*, 2002, Aronsson *et al.*, 2010).[12] It is easy to see that, for (6), $\zeta = \psi\sigma/(\sigma-1)$ which requires $\psi \in [0, (\sigma-1)/\sigma]$. This means our baseline choice of $\psi = (\sigma-1)/\sigma$ corresponds to households who respond only to relative consumption $c/\bar{C}$. Baseline results are therefore to be

[12] We are grateful to an anonymous referee for elucidating this point.

viewed as an upper bound on how adversely relative deprivation affects health accumulation. We later allow for $\psi < (\sigma - 1)/\sigma$.

A final point about the utility function. Since $\sigma > 1$, to ensure that utility from being alive always exceeds that from death, we normalize the latter to a large negative number such that $\underline{U} < \inf\{U(c_{it}, \bar{C}_{it}, l_{it})\}_{t=0,i=1}^{\infty,N}$. A complete specification of individual preferences is then

$$U(c_{it}, \bar{C}_{it}, l_{it}) = \begin{cases} \frac{c_{it}^{1-\sigma}}{1-\sigma}\bar{C}_{it}^{\psi\sigma} + \gamma\frac{(1-l_{it})^{1-\sigma}}{1-\sigma}, & \text{if agent } i \text{ is alive} \\ \underline{U}, & \text{otherwise.} \end{cases}$$

3.3 Decision Problem

Individual i's labor productivity θ_i is time invariant, drawn at the beginning of his life from the distribution $\Gamma(\theta)$ with finite support. The wage rate per efficiency unit of labor w is constant and exogenous. The return on investment $\tilde{R}_{it}$ is individual-specific. Since individuals die over time, to ensure their assets are accounted for we assume a perfect annuities market (Yaari, 1965). Under a perfectly competitive market, the zero profit condition implies equilibrium annuitized investment return of $\tilde{R}_{it} = R/\phi_{it}$, R being the constant return on investment. Implicitly this assumes access to an international capital market where the borrowing and lending rates are $R-1$ (see below). This in turn implies a constant aggregate capital-labor ratio from a CRS technology, and constant wage per efficiency unit of labor.

Individual i's budget constraint at t is

$$c_{it} + q_{it} + a_{it+1} = w\theta_i l_{it} + \tilde{R}_{it} a_{it}, \tag{7}$$

where a denotes financial assets.[13] He maximizes expected lifetime utility

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[\Phi_{it} \left\{ \frac{c_{it}^{1-\sigma}}{1-\sigma}\bar{C}_{it}^{\psi\sigma} + \gamma\frac{(1-l_{it})^{1-\sigma}}{1-\sigma} \right\} + (1-\Phi_{it})\underline{U} \right], \tag{8}$$

where $\beta \in (0,1)$ is the subjective discount rate, subject to the health transition equation (1), health production (2), survival function (4), budget constraint (7), and the usual no-Ponzi game condition, given θ_i and initial conditions (a_{i0}, H_{i0}). To conserve notation we do not explicitly distinguish between calendar time and age of the individual even though not all individuals will be alive every period. Three simplifying assumptions are made:

[13] Annuity firms are owned by households. Since they do not make profits, we do not explicitly include (zero) dividends from their ownership on the income side.

Assumptions

A1 The household takes into account how its health choices affect its annuity return $\tilde{R}$;

A2 This is a small open economy that takes the world interest factor R as given;

A3 The household's decision problem is solved assuming the economy has reached the stationary distributions of health, wealth and consumption and that $\beta R = 1$.

The rationale for (A1) is that people often purchase insurance based on actuarial tables.[14] For (A3), we impose stationarity of the consumption distribution, derive health and wealth dynamics consistent with that assumption and then focus exclusively on the steady-state relationship between health, wealth and aspirations.

For the state vector $(\theta_i, a_i, H_i, \bar{C}_i)$ and vector of controls (a_i', l_i, q_i), the dynamic programming problem for individual i is

$$V(\theta_i, a_i, H_i, \bar{C}_i) = \max_{l_i, a_i', q_i} \left\{ u\left(c_i, \bar{C}_i, l_i\right) + \beta\phi\left(H_i'\right) V\left(\theta_i', a_i', H_i', \bar{C}_i'\right) + \beta\left(1 - \phi\left(H_i'\right)\right) \underline{U} \right\} \tag{9}$$

subject to

$$\begin{aligned} a_i' &= w_t \theta_i l_i + \frac{R}{\phi(H_i)} a_i - q_i - c_i, \\ H_i' &= (1-\delta) H_i + Q(1-l_i)^{\alpha} q_i^{\rho}, \\ \bar{C}_i' &= \Omega(\theta_i, a_i, H_i, \bar{C}_i, \Xi), \\ \theta_i' &= \theta_i, \end{aligned} \tag{10}$$

where V is the value of being alive, a_{i0}, H_{i0} and $\phi_{i0} = 1$ are given, Ω is a belief function that determines how i perceives its aspiration to evolve, and Ξ is the joint distribution of θ, a and H in the population. Under (A3), $\bar{C}_i' = \bar{C}_i$ and Ω need not be specified.

3.4 A Static Version

To gain some intuition it will help to consider a static decision problem. Suppose that $\psi = (\sigma - 1)/\sigma$, $\beta = 1$, $\gamma = 0$, $\xi = \tau = \nu = 1$, $\delta = 1$, $\theta = 1$ and $\bar{C}$ is constant. Let the health scale start at zero and each household be initially endowed with $(1-\phi)\tilde{a}/\phi$ assets; $\tilde{a} > (1-\alpha)w/\alpha$ ensures that consumption is non-negative. Finally assume that utility from death is normalized to zero

[14] It has the computational advantage of reducing the state space since the annuity return is not part of it. In any case, computational results using a coarser grid are similar under price-taking behavior.

and that $\underline{v} = -\underline{U}$. In steady state, the decision problem from above becomes

$$\max_{c,q,l} \quad V(c, H; \bar{C}) \equiv \psi_L(H)\, v(c, \bar{C}) \tag{11}$$

subject to

$$c + q = wl + \tilde{a} \tag{12}$$

$$H = f(q, l) \tag{13}$$

given $\tilde{a}$, where ψ_L represents average lifespan of the household and V lifetime utility. Instead of (4), suppose the survival function is $\phi(H) = H/(1+H) \in (0,1)$ which implies $\psi_L(H) = 1 + H$.

Suppose health production required health goods alone, that is, $\alpha = 0$ and $\rho = 1$. In an interior optimum, the household equates the marginal cost and benefit from health investment:

$$Qc^{\sigma}\left(\underline{v} + \frac{(c/\bar{C})^{1-\sigma}}{1-\sigma}\right) = Qq,$$

from which it follows that $\partial q/\partial w > 0$, $\partial(\partial q/\partial w)/\partial \bar{C} < 0$ and $\partial^2 q/\partial w^2 > 0$. That is, health is a normal good, the marginal propensity to invest in it worsens with the aspirations level and, as in Hall and Jones (2007), richer households spend a higher share of their income on health.

For the more general version with $\rho = 1 - \alpha$, health production is subject to diminishing returns as healthy time has a natural upper bound of unity. In this case, the relationship between health and longevity can be fully gauged from the behavior of health expenditure q outlined in the proposition below (see Appendix B for proof).

Proposition 1. *The solution to the household's static optimization problem (11) subject to (12) and (13) consists of*

(i) A health investment function $q(w)$ that is increasing and convex in labor income, $q'(w) > 0, q''(w) > 0$;

(ii) Health outcomes $H(w) = Q[\alpha/(1-\alpha)]^{\alpha} w^{-\alpha} q(w)$ and $\psi_L(H(w)) = 1 + H(w)$, both increasing and concave in labor income; and

(iii) $\partial q'(w)/\partial \bar{C} < 0$.

As in the case before, health expenditure is a superior good. Even so, health capital and longevity are both concave in labor income by Prop. 1(ii), that is, the marginal return to health is diminishing in income. Prop. 1(iii) establishes the marginal propensity to invest in health (MPIH) is decreasing in the aspirations level $\bar{C}$ in the general case. At low income levels, that is

low w, the marginal product of health investment is high. On the other hand, for a given $\bar{C}$, the aspirations gap $\bar{C}/c$ is larger and the marginal utility from catching up higher. An income gain is disproportionately allocated towards consumption spending over health investment. Hence the MPIH falls the poorer a household gets.[15] Since the lifespan function remains concave in income, it is still the case that a mean preserving spread in income lowers average health. That effect, however, gets weaker the more responsive the household becomes to aspirations (Prop 1(iii)).

In sum, Proposition 1 establishes that healthy spending is a superior good and that the MPIH is diminishing in the aspirations gap. The latter helps resolve the empirical puzzle discussed in section 2.1. The former comes into play when aspirations are endogenous, more precisely when richer households face a lower aspirations gap. Households can enjoy life at the extensive margin (longevity) or at the intensive (consumption) margin which is subject to stronger diminishing returns under plausible parameterizations. Higher inequality, by providing more income to the rich, incentivizes their health investment over wealth accumulation. It is possible for their health to improve so much that overall population health improves under higher inequality. This too weakens the negative relationship between income and health at the macro level. But it plays a more substantive role later in determining how health accumulation amplifies fundamental inequality.

3.5 Optimal Behavior in the Intertemporal Model

Returning to (9), consider the optimal choices of a_i', l_i, and q_i. First take the consumption Euler equation $c_i'/c_i = \left(\beta R\right)^{\frac{1}{\sigma}} \left(\bar{C}_i'/\bar{C}_i\right)^{\psi}$ that under (A3) simplifies to

$$\frac{c_i'}{c_i} = \left(\frac{\bar{C}_i'}{\bar{C}_i}\right)^{\psi}. \tag{14}$$

This immediately implies that each individual's consumption reaches steady state whenever the aggregate consumption distribution is stationary. The perfect annuities market assumption ensures that this is independent of the individual's mortality rate.

[15] This result is quite general and holds as long as aspirations are not directly based on health status. In other words, a direct preference over health as a consumption good can overturn these results if health itself is a social good. We see little evidence of it among the poor and lower middle-class. Even among the well-to-do, subgroups who socially signal their health and fitness goals are far from representative. Part of the problem may be that unlike certain health outcomes (death, illness) and health choices (gym membership, diet fads), an individual's intrinsic health is not observed by others. It is also unclear whether some of these choices – crash diets for example – actually improve health.

Alternatively, our results are overturned if consumption and health are *strongly* complementary; complementarity alone is not sufficient for this as equation (1) shows.

Similarly, from the optimal choices for labor supply and health expenditure and noting (2) we have

$$\left(\frac{\bar{C}_i^{\psi}}{c_i}\right)^{\sigma}(1-l_i)^{\sigma-1}\left(w\theta_i(1-l_i)-\frac{\alpha}{\rho}q_i\right)=\gamma. \tag{15}$$

Consider a simple comparative statics exercise. Suppose at the optimum the individual experiences an exogenous increase in his aspiration level $\bar{C}_i$. How do healthy time investment and health expenditure respond? Through the budget constraint, personal consumption in the expression above is positively related to labor supply, negatively to health expenditure. The remaining terms on the left-hand-side of (15), on the other hand, depend negatively on labor supply and health expenditure. Therefore, the left-hand-side is unambiguously decreasing in labor supply. When $\bar{C}_i$ increases, an increase in labor supply can restore equality to the first order condition. This means healthy time investment, all else constant, falls from an increase in aspirations.

The response of health expenditure, on the other hand, is ambiguous depending on the strength of the response through consumption versus returns to health expenditure. Those returns fall since healthy time investment falls, lowering the incentive to spend on the health good. In fact, for the special case of $\gamma = 0$, labor supply and health spending are inversely related in equation (15) and the latter falls for sure. Hence we conclude that a rise in aspirations lowers healthy time investment for sure and, possibly health expenditure. The latter is always true in the parameter space chosen in section 4.

3.6 Dynamic Equilibrium

$\bar{C}_i$ is the outcome of household behavior in the full-fledged dynamic equilibrium of this economy which is defined below and quantitatively analyzed in the next section. Evolution of $\mathscr{I}_t$, the set of economically active households, follows the replacement assumption (A4) specified in section 5.

Definition 2. *The **dynamic equilibrium** of this economy consists of a finite set of individuals $\{\mathscr{I}_t\}_{t=0}^{\infty}$ where $\#\mathscr{I}_t = N > 1$, a consumption distribution $\{C_{it}\}_{i\in\mathscr{I}_t}$, controls $\{l_{it}, a_{it+1}, q_{it}\}$ and state variables $\{\theta_i, a_{it}, H_{it}, \bar{C}_{it}\}$ for $i \in \mathscr{I}_t$ such that*

(i) The controls $\{l_{it}, a_{it+1}, q_{it}\}$ represent the optimal solution to (9) *subject to* (10)*, given $\{\theta_i, a_{it}, H_{it}, \bar{C}_{it}\}$,*

(ii) The health stock evolves according to (2) *for a given set of optimal controls $\{l_{it}, a_{it+1}, q_{it}\}$ and H_{it}, and*

(iii) Aspirations are in equilibrium, that is, the distribution of aspirations $\{\bar{C}_{it}\}$ *taken as given for the solution to* (9) *subject to* (10) *generates the distribution of optimal consumption* $\{C_{it}\}_{i\in\mathscr{I}_t}$ *that is consistent with those aspirations according to* (5),

given constant prices $\{w, R\}$ *and the initial distribution of* $\{H_0, a_0\}$ *in the population.*

4 Household Behavior

4.1 Parameterization

Parameter values are reported in Table 1. Individuals start their planning horizon at age 20 which means all life expectancy numbers reported below are conditional on age 20. The length of a period is chosen to be a year, so the discount rate is set to 0.96. The implied return on saving is 4.17% consistent with long-run US data. The weight on leisure in the utility function, γ, is set to 0.5. The implied average share of working hours is 0.35, close to McGrattan and Rogerson's (2004, Table 1) 0.36 estimate for 2000 assuming discretionary hours per day to be 16. We follow Carroll *et al.* (1997) in choosing $\sigma = 2$ and $\psi = (\sigma - 1)/\sigma = 0.5$. The associated degree of positionality of 1 is same as Abel (1990) and close to the 0.8 estimated by Fuhrer (2000) using an internal consumption benchmark. Alternative values of ψ with lower degrees of positionality are also considered.

Parameter	Value	Description	Source
β	0.96	Discount rate	
σ	2	Elasticity of substitution	Carroll *et al.* (1997)
α	0.91	Leisure share in health production	1 - ρ
ρ	0.09	Health good share in health production	Health expenditure share of GDP in 2000
Q	0.195	Health investment productivity	Scale
ξ	0.9857	Scale parameter for survival probability	Population Life Expectancy at 20 in 2000.
τ	0.15875	Shape parameter for survival probability	Life Expectancy at 20 Gap in 2000
ν	0.1	Scale parameter for survival probability	Scale
w	20	Wages	Scale
H_{i0}	Varies	Initial stock of health	
γ	0.5	Weight on leisure	Average share of working hours
ψ	0.5	Responsiveness to reference consumption	Carroll *et al.* (1997)
δ	0.03	Depreciation of health capital	Rockwood and Mitnitski (2007)
N	500	Population size	Scale
R	$1/\beta$	Rate of return on savings	

Table 1: Parameter Values

Steady-state inequality depends on exogenous labor productivity differences that we refer to as *fundamental inequality*. The state space Θ for this productivity is discretized and agents are endowed with productivities ranging from 1 to 20 in increments of $\kappa = 0.01$. The probability (population weights) corresponding to the θ's are chosen from a Pareto distribution. To generate exogenous variation in inequality, several combinations of the minimum and shift parameters of the Pareto distribution are used.

Initial population and the (exogenous) wage rate are scaling parameters; their values are set arbitrarily. Each individual is endowed with an initial health close to his steady state and initial asset holding of zero. The former is arrived at by solving the health transition equation (1) for a given set of policy rules. It ensures that the simulations are local to the stationary distribution; see assumption A4 below.

The health parameters Q and ν are also scale parameters. Q pins down steady-state health and ν dictates the range of values health can take. They are chosen so that the state-space for health capital is relatively small and contains steady-state health (note from (4) that the latter does not directly depend on ν). The depreciation rate of health capital is taken to be 3% (Rockwood and Mitnitski, 2007). Utility from death is normalized to -5000 so that all households strictly prefer to be alive.[16]

The remaining health parameters $(\alpha, \rho, \tau, \xi)$ are targeted to specific moments in the data. There is little guidance in the empirical literature on α and ρ since their estimates vary across studies and have large variance (e.g. Grossman, 1972b). We impose CRS $\rho = 1 - \alpha$, then pick ρ in order that the share of health expenditure in GDP is 15.4% as in the US in 2000 (Hall and Jones, 2007).

The parameter ξ is chosen to reproduce population life expectancy of 56.64, same as that in the US in 2000 (World Development Indicators) taking into account that model agents start at age twenty. Life expectancy differs substantially between the rich and the poor in the US, the gap widening in recent decades (Meara *et al.*, 2008, Olshanksy *et al.*, 2012). Singh and Siahpush (2006) construct a relative deprivation index based on a number of indicators like education, occupation, wealth and unemployment, all of which are closely related to relative income. They report (*ibid.*, Table 3) that in 1998-2000 life expectancy at birth for the highest socio-economic decile was 79.2 and for the lowest socio-economic decile 74.7, a gap of 4.5 years; τ is chosen to match this gap between the top and bottom deciles.

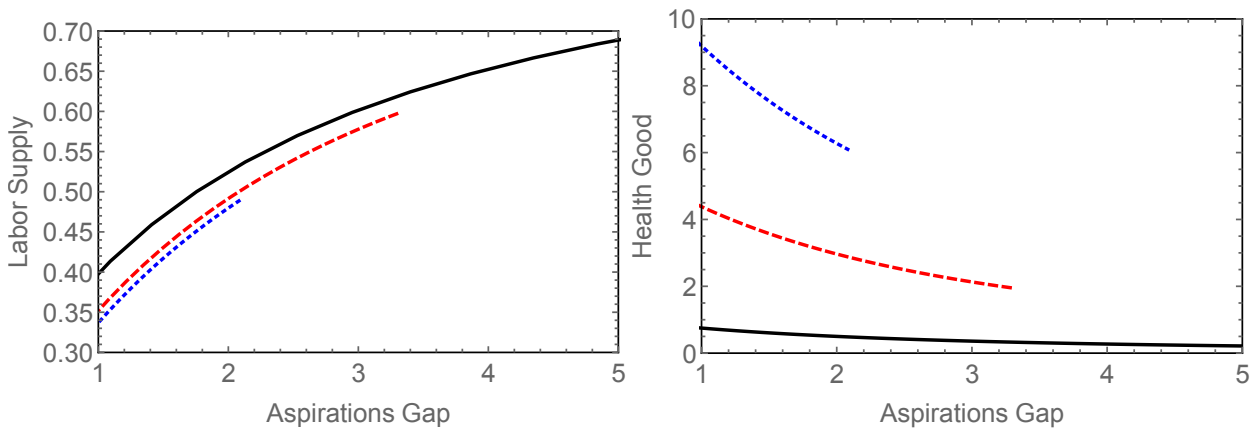
[16] As $\underline{U}$ becomes more negative, people acquire a greater distaste for death and invest more in health. The approach we followed is to set $\underline{U}$ sufficiently low so that people prefer to be alive, then set other parameter values to match the data.

4.2 Policy Functions

Central to the relationship between health and inequality is the effect of relative deprivation at the household level. This is best understood through policy rules that map the state vector $(\theta_i, a_i, H_i, \bar{C}_i)$ to health decisions.

Health Production

Figure 2 plots optimal labor supply and health expenditure for three productivity levels by exogenously varying $\bar{C}_i$ and using the consumption function to calculate the aspirations gap $\bar{C}_i / c_i$. Without loss of generality, health capital is set to 8 and assets to zero. A larger aspira-



(a) Labor Supply (b) Health Expenditure

Figure 2: Health inputs vs Aspirations Gap $(\bar{C}_i / c_i)$
Solid: $\theta = 1$, Dashed: $\theta = 5$, Dotted: $\theta = 15$

tions gap unambiguously raises labor supply and, as conjectured before, lowers spending on the health good.[17]

To what extent are these effects due to the conventional absolute income effect versus socially-minded behavior? Figure 3 gauges that by contrasting the case of $\psi = 0.5$ (baseline) with $\psi = 0$ (no aspirations). When people are non-aspirational, relative consumption has no health effect, only absolute income matters. Under aspirations, on the other hand, labor supply, health expenditure and overall health strongly respond to relative consumption; health worsens as one moves down the consumption distribution (higher $\bar{C}_i / c_i$).

[17] Some of the policy functions are not reported for the entire range of the aspirations gap because the gap does not extend as far for higher productivity individuals.

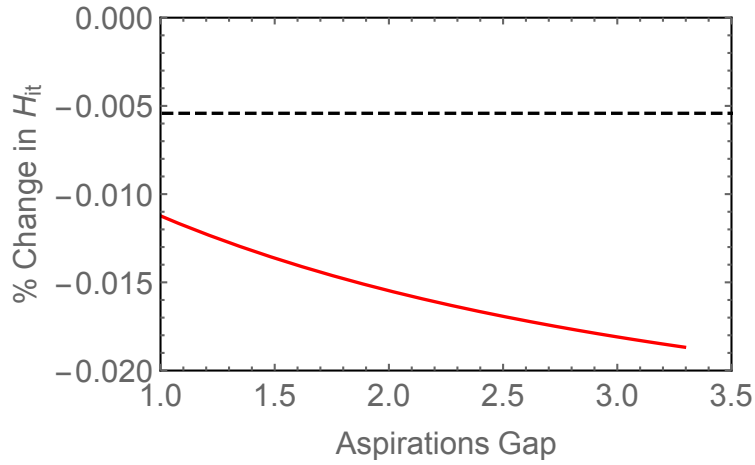


Figure 3: Aspirations and Health Production
Solid: Baseline, Dashed: No Aspirations

Life Expectancy

Since those with the largest aspiration gap invest the least in health, we obviously expect them to have lower life expectancy. Figure 4 confirms this by contrasting the baseline case of aspirations ($\psi = 0.5$) with one without ($\psi = 0$) for the same productivity distribution.

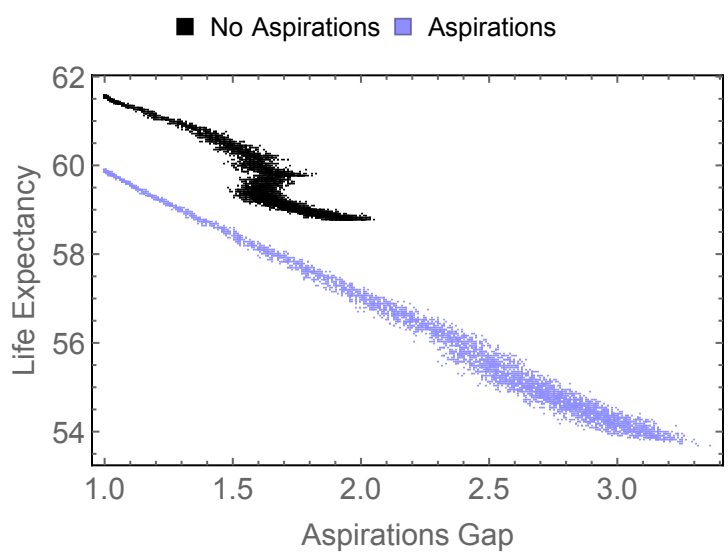


Figure 4: Life Expectancy at Age 20 vs Aspirations Gap
Ability Gini is 0.49 in both cases

The highest aspirations gap in the figure differs between the two cases, being smaller for $\psi = 0$. But the highest aspirations gap in both cases applies to the same least productive individual whose life expectancy falls by about 2 years under aspirations. Another way this can be seen is from the life expectancy distribution. The life expectancy gap between the lowest and

highest deciles of the consumption ratio $\bar{C}_i / c_i$ (that is, between the most and least productive individuals) is 5.467 with aspirations in Figure 4, significantly lower at 2.526 years without.

In summary, these results establish that relative position or consumption deprivation – as measured by $\bar{C}_i / c_i$ – has a negative effect on an individual's health because the greater marginal valuation placed on personal consumption is met through less investment in health production. That higher values of fundamental inequality imply greater aspirations gap in the population means that higher inequality could lead to higher life expectancy gaps in the population and, possibly, lower average life expectancy. A fuller appreciation of these results requires us to study the economy-wide picture.

5 Aspirations, Health and Inequality

Implications of household behavior for aggregate outcomes are developed in stages. First we demonstrate how aspiration shapes income inequality in the absence of health accumulation: results hinge on the response of labor supply.

We then build on section 4.2 to show that inequality has a sizable effect on population health. Finally we show how the model can jointly account for the strong micro-level and weak macro-level effect of inequality on population health.

5.1 From Household Behavior to the Full Equilibrium

Though factor prices are exogenous, there is a feedback loop between the consumption distribution and household behavior. The full equilibrium requires that households' aspirations be consistent with the consumption distribution (Definition 2(iii) above). The evolution of $\mathscr{I}_t$ has to be specified too since some households die every period.

Assumption

A4 Deceased households are replaced by an equal number of new households each with its own productivity draw and initial conditions $a_{i0} = 0$ and $H_{i0} = X(\theta_i)$, where X is a function that produces the steady-state level of health for a given productivity.

The zero initial assets assumption is in keeping with a perfect annuities market where assets of the deceased are seized by competitive risk-neutral annuity firms. Since individuals enter and exit the economy every period, it is possible that a non-trivial measure of them never get close to their steady-state health and wealth levels. Starting them close to their steady-state health

ensures faster convergence. We check convergence to the stationary distribution by looking at the time paths of average consumption, labor, and the Gini coefficient.[18]

In the closed-economy Ramsey model with heterogeneous households, the steady-state wealth distribution requires a well-defined demand for capital that is introduced through a diminishing returns production function (e.g. García-Peñalosa and Turnovksy, 2014). Here, as in many open economy models, the interest rate is exogenous. To ensure a steady state, open economy models often assume an endogenous discount rate, for example β as a function of consumption or income. In this model, though the effective discount rate $\beta\Phi$ is endogenous, under perfect annuities market, the expected return on saving is independent of Φ. It is possible then for an individual to accumulate unlimited assets over time. Since the numerical solution method discretizes the state space for assets over a finite grid, assets can converge to the upper bound of that state space in finite time. Were that to happen, eventually the asset distribution would become degenerate and all income heterogeneity would come from labor income. In the simulations, only a tiny minority of high productivity individuals face this issue; mortality risk ensures that most individuals die well before reaching the upper bound of the asset space. Moreover, when an individual dies, he is replaced by one with no initial assets. Mortality and the replacement assumption together ensure that the vast majority of agents are in the interior of the state space and the steady-state asset distribution is non-degenerate.

5.2 Is Inequality Motivating?

Friedman's (1962) spirited defense of capitalism argues that the inevitable inequality that results from private enterprise is desirable because, among other factors, it motivates people to strive for something better. Presumably doing so places them in a financially stronger position.

Our model can test this conjecture since inequality, through the aspirations gap, incentivizes work and asset accumulation and may attenuate fundamental inequality if the poor respond more strongly. We first eliminate health by setting $\tau = 0$ and study how the presence of aspirations alters the income distribution. Figure 5 contrasts (solid lines correspond to best non-linear fits) steady-state household income at different productivity levels with and without aspirations: all households are clearly economically better off when they are aspirational. But Figure 5 also hints at a differential effect: more productive (richer) households may be relatively better off under aspirations.

[18] Typically these three variables reach stationary values after 100 simulation periods. In what follows each of the simulations were run for 500 periods with a "burn-in" period of 500 that was dropped from the sample. A stationary distribution always exists in the parameter space we study. Though convergence and uniqueness are not analytically established, neither has been an issue in the simulations for a range of parameter values near those used in Table 1 and initial conditions reported above.

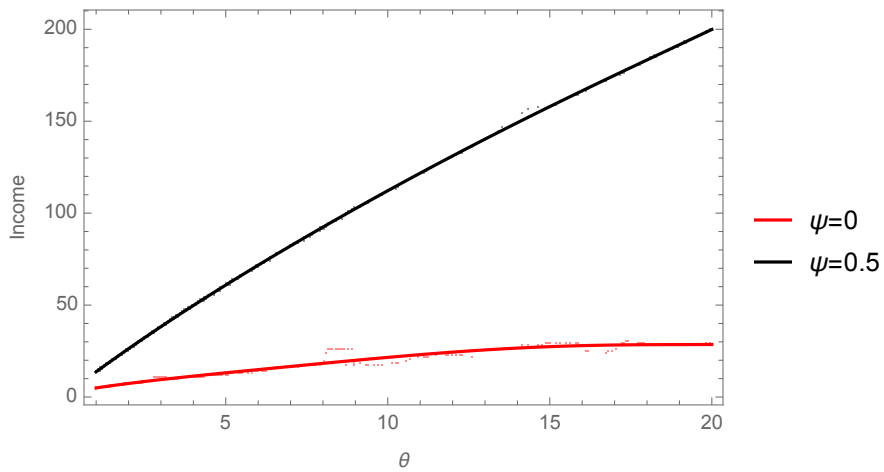


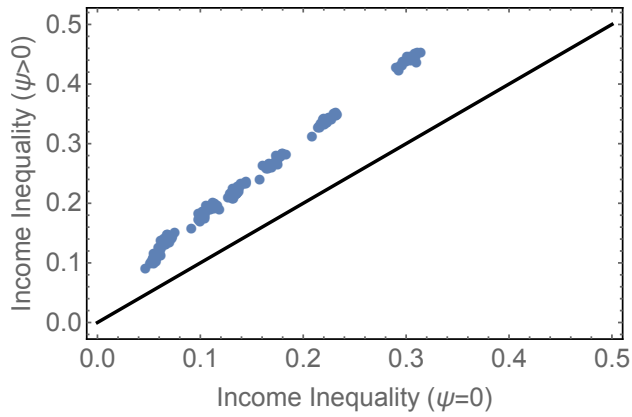
Figure 5: Effect of Aspirations on Household Income

To see this clearly, compare consumption and income inequality with and without aspirations. Figure 6 is produced by exogenously varying inequality in the underlying productivity distribution through *mean preserving spreads*. The solid (black) line is the 45° line. Despite the same underlying productivity distribution, income (panel *a*) and consumption (panel *b*) inequality are, contrary to Friedman's conjecture, consistently higher under social aspirations.

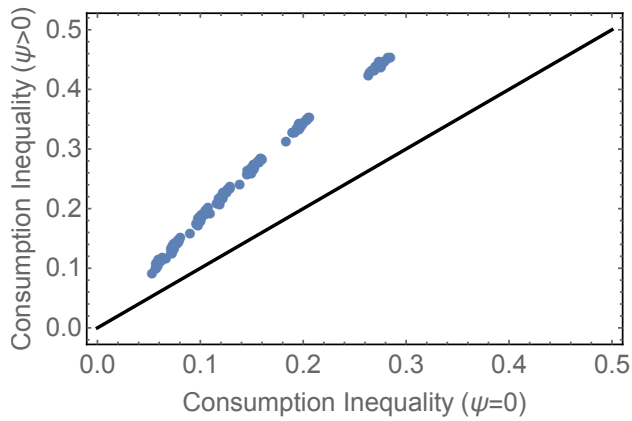
This must mean aspiration affects rich and poor households differently. All differences in steady-state income from labor and capital arise purely from lifetime labor supply (recall that individuals start without financial assets). If aspiration prompts highly productive (richer) individuals to respond more on the labor market than less productive (poorer) ones, fundamental inequality would be aggravated, not alleviated. Figure 7 studies this by plotting two labor supply ratios against fundamental inequality: labor supply by median income individuals relative to that by bottom decile individuals (panel *a*) and labor supply by the top decile relative to labor supply by the median (panel *b*).

We know from before that aspiration motivates all households to supply more labor. What Figure 7 shows is that this response systematically differs across the productivity distribution: the poor supply proportionally more labor than the rich. In the figure, there is a greater dispersion in labor supply without aspirations (plus): richer individuals supply considerably less at any level of fundamental inequality. Under aspirations (asterisk), these individuals increase their labor supply more than poorer ones. In the simulations labor supply of the bottom 10% actually fell relative to the median as inequality increased. [19]

[19] In other words, the income effect on leisure of an increase in wage per worker dominates the substitution effect for all individuals. Aspirations distort these effects differently across the distribution because the poor face a higher aspirations gap and respond to it more strongly. Note also that though richer individuals always supply less labor than poorer ones, their higher productivity and lifetime wealth accumulation are sufficient to raise their relative income and consumption levels.



(a) Income Inequality



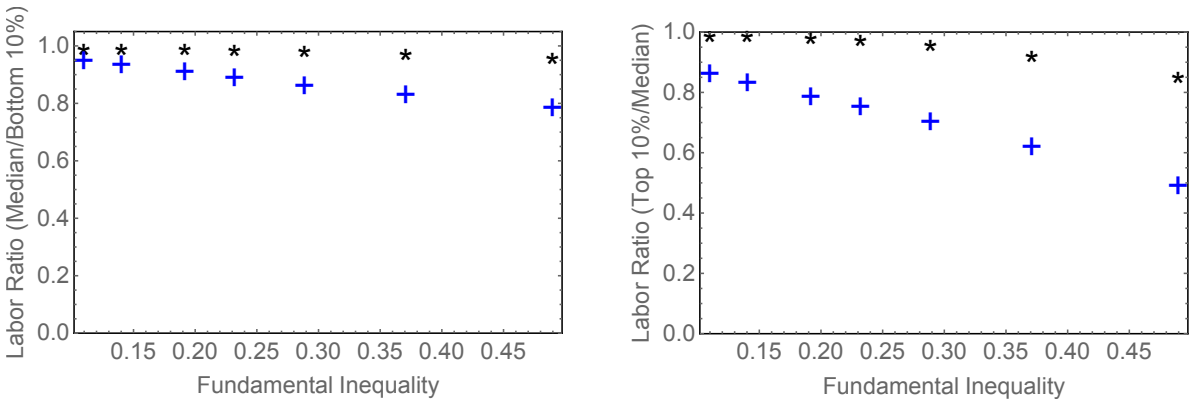
(b) Consumption Inequality

Figure 6: Aspirations and Inequality
Solid: 45° Line, Markers: Simulations

That less productive (poorer) individuals supply more labor than more productive (richer) ones is a testable prediction of the model. For simulations that produce an empirically reasonable value of Gini of 0.357 (compared to 0.36 in the US in 2000 as per OECD database), the bottom half of the income distribution supplies on average 36.2% of their labor endowment while the top half supplies 33.3%, a gap of about 8%. Among the employed in the US, those with less than high school education worked for 7.96 hours per "average day" in 2013 compared to 7.44 hours for those with bachelor's degree and higher, a gap of about 7% (Bureau of Labor Statistics, American Time Use Survey, Table 4).[20]

We conclude that since richer households have more capacity to respond on the labor mar-

[20]The comparison by labor earnings is less clear cut for obvious reasons (Table 5). Interestingly, a recent study by the Center for Disease Control (Morbidity and Mortality Weekly Report, April 3, 2015) notes a systematic discrepancy even in sleep time, something usually taken to be non-discretionary in macro-models. In particular, more than 35% of adults below the poverty line enjoyed less than six hours of sleep per night in 2013. Among those earning more than four times the poverty line, 27.7% did.



(a) Median/Bottom 10% Labor Supply

(b) Top 10%/Median Labor Supply

Figure 7: Relative Labor Supply and Fundamental Inequality
This figure plots the ratio of labor supply of the median and the bottom decile and the top decile and median against fundamental inequality with and without aspirations
Blue/Plus: No Aspirations, Black/Star: Aspirations

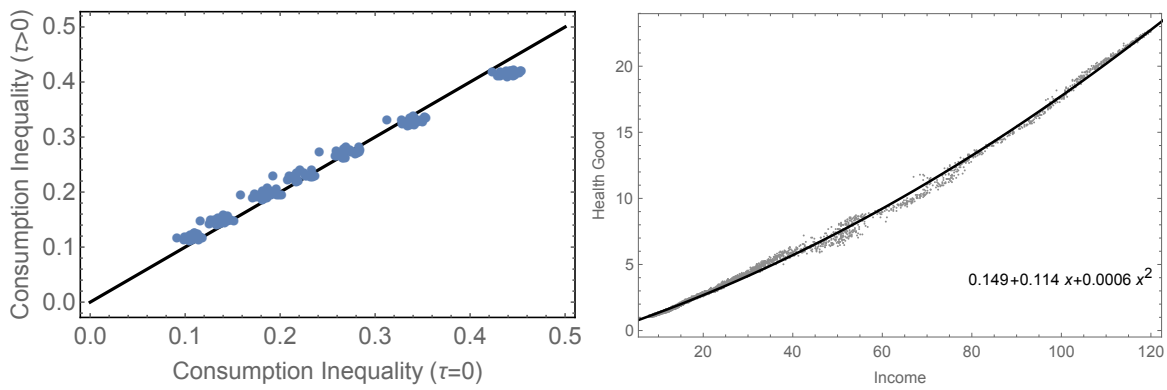
ket, equilibrium inequality rises under aspirations. Notably this occurs without market (e.g. credit) frictions distorting investment behavior across the income distribution or (health) cost to being aspirational. Credit frictions would only exacerbate matters if they were to affect the poor disproportionately. And introducing health costs, as we show next, worsens absolute *and* relative health of the poor, amplifying the effect aspirations has on overall welfare.

5.3 Inequality as Health Hazard

Economic inequality under health production

Lower health production lowers expected lifetime and, hence, wealth accumulation. Since this effect ought to be stronger for the poor, one would expect consumption inequality to worsen under health production. Interestingly that happens only at low and moderate levels of inequality as Figure 8(a) shows (similarly for income inequality). An opposing effect gains traction as inequality rises. Since the income elasticity of health spending exceeds unity, the rich spend disproportionately more on health (Figure 8(b)), which tends to lower equilibrium income and consumption inequality.[21] As Figure 9 shows the strength of this effect does depend on the de-

[21] The data, however, does not support the result that health spending is a superior good. For example, in the US in 2015, households with income above $150,000 spent 4.5% of their income on health care and health insurance while those below $19,999 spent 8.2% (Bureau of Labor Statistics). One reason is surely that the poor experience more frequent health shocks. This margin is absent in the model: health outcomes are discrete, either survival or death, which precludes curative expenditures. A more general setup would relate health capital to morbidity outcomes. Secondly, at least in the US, the very poor often do not have health insurance and rely on ER visits for treatment. These expensive visits raise their health spending. Not all these individuals, however, end up paying for those treatments.



(a) Consumption Inequality with and without Health

(b) Health Spending is a Superior Good

Figure 8: The Effect of Health on Equilibrium Inequality under Aspirations

gree of positionality: as the degree of positionality falls, the income elasticity of health spending rises. At higher degrees of positionality and inequality in the ability distribution, higher funda-

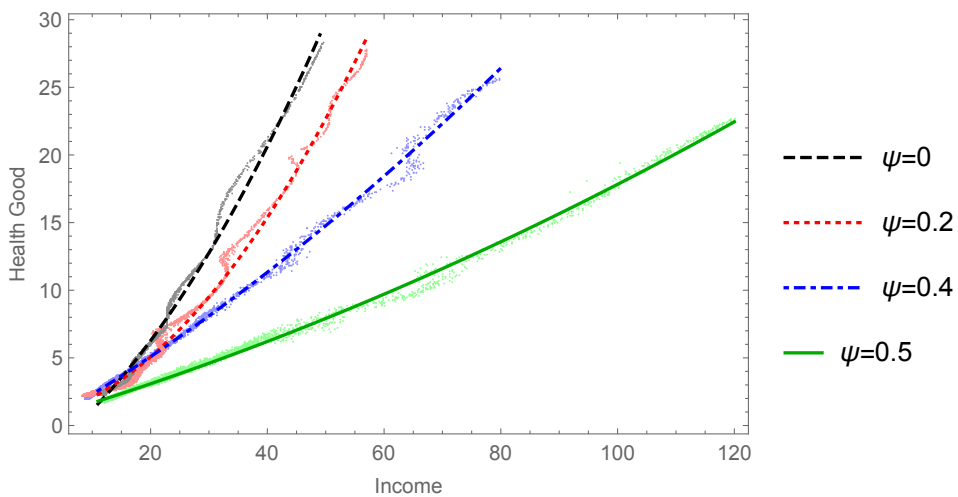
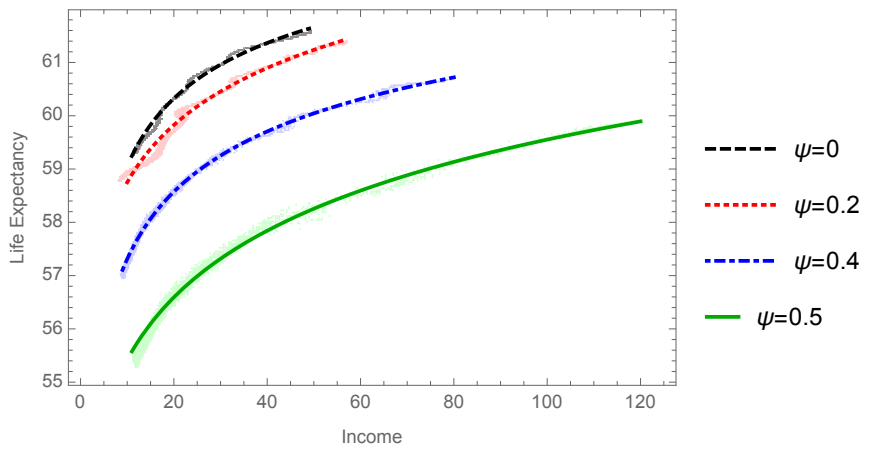


Figure 9: Health Spending is a Superior Good

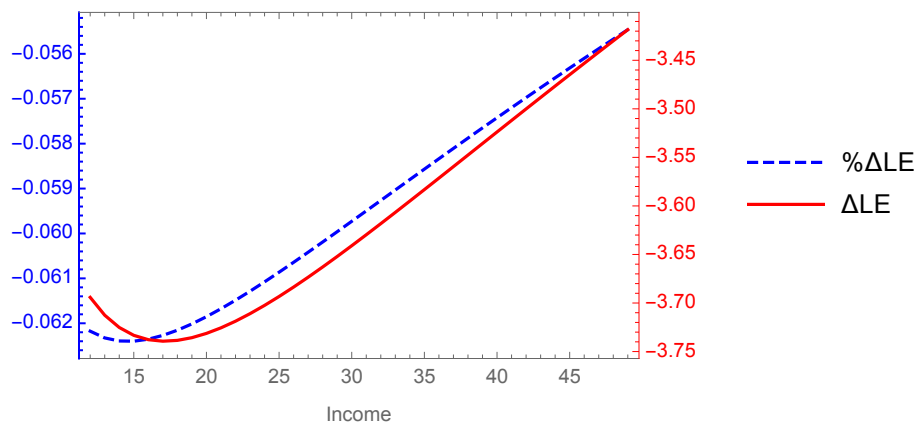
mental inequality may *lower* measured income and consumption inequality. The former falls because the rich accumulate less assets and supply less labor, the latter because they also step up health spending.

Health inequality

What about health? Figure 10(a) plots simulated data for household steady-state life expectancy (calculated as $1/(1-\phi(H))$) and income corresponding to $\psi \in \{0, 0.2, 0.4, 0.5\}$. Each line in the figure corresponds to a nonlinear fit to model-generated data.



(a) Life Expectancy at Age 20 and Income, with and without Aspirations



(b) Percentage and Absolute Deviation in Life Expectancy relative to No-Aspirations

Figure 10: Household Income and Health with and without Aspirations

As with the policy functions above, regardless of how socially minded households are, aspirations adversely affect health production. For example, as ψ goes from 0 to 0.2 or 0.4 to 0.5, health production and life expectancy worsen for any income level. The equilibrium relationship between health and income gets flatter too: the marginal propensity to invest in health is weakened at lower income levels since poorer households face a larger aspirations gap which raises their marginal utility from consumption. This result is similar to the effect on saving of inherited taste in de la Croix and Michel (1999), conspicuous consumption in youth in Corneo and Jeanne (1998) and consumption-based common aspirations in Alonso-Carrera *et al.* (2005), and the effect on leisure of average consumption in Dupor and Liu (2003). Figure 10(b) presents the absolute and relative change in life expectancy going from $\psi = 0$ to $\psi = 0.5$: the rich suffer the least in both absolute and relative health, though at sufficiently high income levels the loss

is trivial.[22]

The health cost of inequality

A simple way to assess the cost of inequality is to consider "compensating variation" with respect to aspirations. For example we can ask how much additional consumption an aspirational household needs to have the same expected utility were it to be non-aspirational. Alternatively, we can ask how many additional years of life expectancy the household needs to be indifferent between being aspirational and non-aspirational behavior.

The first approach cannot be implemented as expected lifetime utility under aspirations is always lower for a given health stock. This outcome echoes Dupor and Liu's (2003) result that consumption externalities can lower utility ("jealousy"). Hence we take the second approach. Holding consumption, labor supply and aspirations gap constant, Figure 11 plots the additional years of life expectancy that aspirational households of various productivities need relative to no-aspirations. The three lines differ in the underlying Gini for labor productivity. The health cost is substantial for poorer households: 6.1 life years lost by the least productive decile compared to 3.4 life years for the most productive decile. The solid (black) line in the figure corresponds to the Gini that the model was calibrated to, the two dashed lines (red and blue) correspond to a 10% increase and decrease in this Gini. Across the three curves, higher is inequality, worse the effect of aspirational behavior on life expectancy, especially for low productive (poorer) households.

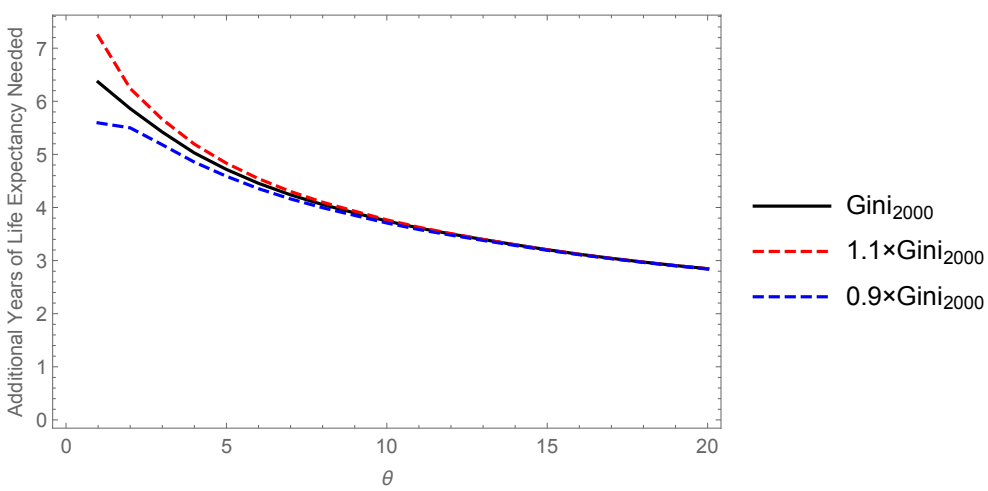


Figure 11: The Health Cost of Aspirations

[22]This cannot be seen from the figure directly. Because aspirations induce people to pursue higher income and consumption, the equilibrium distributions of income differ between $\psi = 0$ and $\psi = 0.5$. Specifically the baseline case leads to a wider range of equilibrium income for the same underlying productivity distribution.

5.4 The Relative Income Gradient

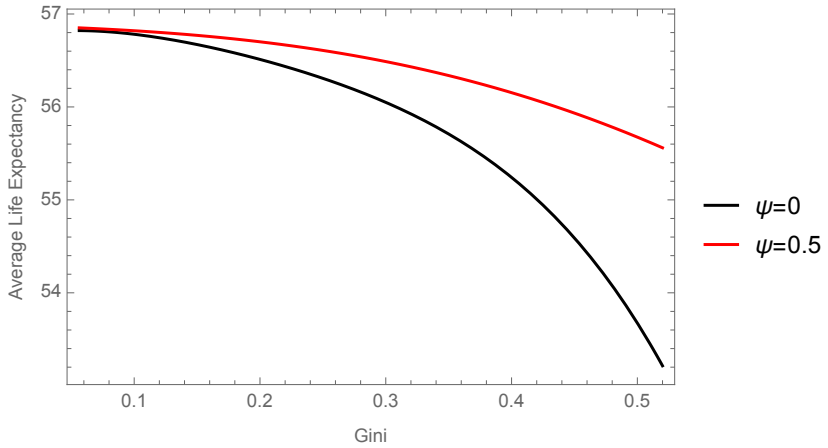
Weak Aggregate Relationship

Returning to the previous discussion on the empirical puzzle, note, first of all, the strong concavity of the no-aspirations case in Figure 10. Without aspirations, mean preserving spreads of the underlying productivity distribution will produce a relatively strong effect on population life expectancy. Unless opposing macroeconomic forces come into play, a model without aspirations predicts a strong aggregate relationship between health and inequality. Moreover, recall from Figure 3, health investment does not respond to relative position without aspirations. That means, the no-aspirations model would not explain the strong micro-level evidence on the relative income gradient either.

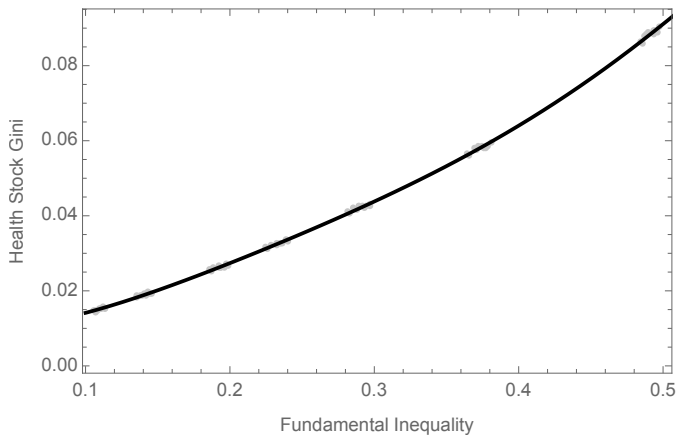
Aspiration provides one mechanism that reconciles the two sets of evidence. Despite the relatively higher productivity of health investment, aspirational poorer households scale back on healthy time and health goods as they face a larger aspirations gap. In Figure 10(a), a marginal decrease in household income decreases health by a relatively small magnitude if aspirational motives are strong. Higher inequality in the form of a mean-preserving spread in household income, lowers average health by less. This weakening effect of income is entirely consistent with the same household responding strongly to relative deprivation as measured by the consumption gap $c_i/\bar{C}_i$ in partial equilibrium (recall Figure 2).

A clearer picture is presented in Figure 12(a) which plots model-generated population life expectancy against different values of income inequality with and without aspirations. It is derived from the estimated relationships in Figure 10 after ensuring that the curves for $\psi = 0$ and $\psi = 0.5$ yield the same life expectancy at the mean steady-state income level (to control for the level difference in Fig 10 since the model is not being recalibrated for $\psi = 0$). Higher inequality has a modest negative relationship with average life expectancy; the association weakens with aspirations.

While Figure 12 on its own does not explain why some studies using aggregate data find a stronger relationship when many other do not, it hints at the possibility. Factoring in stochastic income shocks, market imperfections and macroeconomic shifters (see below), we conclude that if the deterministic relationship between health and inequality at the aggregate level is weakly concave, it may be hard to *consistently* observe a negative correlation between the two. Measures of health inequality, on the other hand, are more informative about the consequences of income inequality. In Figure 12(b), higher fundamental inequality strongly raises health (longevity) inequality in the population.



(a) Life Expectancy at Age 20 and Inequality



(b) Health Inequality versus Fundamental Inequality

Figure 12: Health and Inequality

Weakening Aggregate Relationship

As identified in appendix A, the aggregate relationship between health and inequality has weakened in recent decades. Two obvious explanations are economic growth and medical innovations.

Looking again at Table 3, the sub-sample shows that after 2000 income growth had a significant effect on life expectancy, so it could be that increases income are causing the weakening relationship. We simulate the model economy by varying the wage rate to 10 and 30 from the baseline value of 20.[23] We find that increasing income decreases the gradient between life ex-

[23] In comparison to the baseline, a wage of 30 represents an 52% increase in GDP, while a wage of 10 represents a 54% reduction. Though the wage rate w and aggregate return to capital r are constant in this model, this approach is similar to what one would do in a closed-economy under a Cobb-Douglas technology like $K^{\varepsilon}(BL)^{1-\varepsilon}$. In steady state, an increase in TFP B would increase the wage rate leaving unchanged the return to capital.

pectancy and inequality. This is obvious from the regression results produced from the simulated data and reported in Table 2: an increase in the wage rate weakens the negativity of the inequality-life expectancy gradient. One would, of course, expect higher income to raise health expenditure and healthy time investment. There is, however, a biological constraint on how much that can raise life expectancy (upper bound on ϕ). Therefore the impact of a uniform increase income will be weaker in those economies with already high life expectancy/low inequality than those with low life expectancy/high inequality. The negative effect of GDP growth after 2000 in Table 2 could have to do with how widely those income gains have been shared; in practice, labor earnings have stagnated suggesting that GDP growth was associated with a worsening of the aspirations gap for the lower tail of the distribution.

		Inequality (Gini)
$w = 10$	Income	-5.981^{***}
		(-7.361)
	Consumption	-6.232^{***}
		(-7.337)
$w = 20$	Income	-5.364^{***}
		(-6.75)
	Consumption	-5.763^{***}
		(-6.735)
$w = 30$	Income	-5.164^{***}
		(-6.32)
	Consumption	-5.504^{***}
		(-6.345)

t-stats in parentheses, significance levels: ***: 1%, **:5%, *:10%

Table 2: Model: Life Expectancy and Inequality

A second candidate explanation for the weakening correlation is changes in health production. For instance, improvement in medicine or access to medical care can yield better health from a given set of inputs. A simple way to test this is to exogenously increase health productivity Q; we consider outcomes under $Q = 0.195$ (baseline) relative to $Q = 0.2925$ for the same baseline wage of 20. The higher value of Q raises life expectancy to be sure, but also weakens the correlation between income and health. The slope coefficient goes from -5.763 to -5.011 for consumption inequality, from -5.264 to -4.625 for income inequality as Q increases. This makes intuitive sense: a higher Q increases the marginal benefits of healthy time investment and health expenditure for those with lower life expectancy (income) who are already supplying labor close to their maximum potential. The differential effect on poorer households relative to richer ones can lessen the erosive effects of inequality.

5.5 Further Remarks

These household-level results on the aspirations gap and health outcomes and aggregate-level results on inequality and overall life expectancy or life expectancy inequality may also arise under income-based aspirations. For example, if people cared about relative income because of upward-looking aspirations, then given his financial wealth, the only way an individual can raise his present income is by supplying more labor. That comes at the cost of less time in health production. This is also true in our model except that those income gains are valued only to the extent they helped raise relative consumption and, as we saw in the simulations, health spending also fell. If people cared about relative income, on the other hand, their higher earnings would be valued directly as well as functionally. Health spending would rise as long as health is a normal good and that would tend to substitute for the missing health time investment. As long as time and health expenditure are not too substitutable, overall health production would suffer. Similar results can be obtained under wealth-based aspirations. The important point is that as long as aspirations are formed on the basis of non-health goods or outcomes, there is a trade-off between being aspirational and being healthy.

It should be noted that not all our results require heterogeneous aspirations. Take common aspirations with respect to mean consumption. Households below the mean have a positive aspirations gap, the gap increasing the poorer a household is. The qualitative response to the aspirations gap among these households would be similar: higher labor supply, higher income, lower health production than without aspirations. Households above the mean, on the other hand, have a negative aspirations gap. Deriving "pride" from their relative success, they would supply less labor, earn less income and realize better health than otherwise. In any case, in this world, aspiration has the effect of attenuating, not amplifying, fundamental inequality. Moreover, the income elasticity of health spending would rise more strongly with household income, contra-evidence. How motivating aspirations is thus depends on how it differs across the distribution.

Upward-looking aspirations seem a more plausible description of human behavior than common aspirations.[24] The idea that the poor and the rich both desire the same standard of living contradicts what we observe, more so in light of recent media reports on attitudes towards rising inequality (Rampall, 2011 and Wood, 2011 for example). Despite spectacular income growth among the top 1-5% of households in the US over the last thirty years, researchers have observed among them a lingering feeling of not being rich, of being "middle class". One explanation is that the sharp divergence of incomes within this group itself has caused status anxiety as the rich and the super-rich constantly compare their lives with those doing even bet-

[24] Alternatively, the model requires that people respond more strongly to those economically better off than to those worse off.

ter. Of course, pursing upward-looking aspirations in our model (negligibly) worsens the health of the rich which, depending on one's perspective, may seem counterfactual. In reality, the rich are better equipped to redress this through better healthcare and production technologies.

6 Conclusion

We developed a model of upward-looking aspirations and demand for health to study the effect of inequality. The model showed that relative deprivation within a reference group is an important determinant of mortality. In addition, it showed that even though social aspirations can be motivating, income and consumption inequality are worsened since poorer households are limited by how much they can respond to those aspirations. When households invest in health, this worsening inequality is accompanied by another welfare cost, worsening absolute and relative health for poorer households. Finally, we provided an explanation for why the correlation between inequality and life expectancy at the aggregate level is weak and possibly declining over time.

In analyzing the effect of aspirations on household behavior, we assumed for tractability that all households are aspirational. Since not meeting one's aspirations, "aspirations failure", lowers utility, not everyone may choose to be aspirational. Typically we would see this among the poorest households who psychologically opt out of the rat race (Barnett *et al.*, 2010) or may choose not to make investments that raise their relative income (Genicot and Ray, 2010). Non-aspirational behavior would obviously neutralize the effect that aspirations has on health production. Since lack of aspirations lowers household income, their health would suffer still because of the conventional absolute income gradient. How inequality affects the decision to be aspirational and how adversely health is affected by that decision are topics for further research. Another useful extension to this paper would be to explore the role of policy. Redistributive taxation or health investment subsidies can improve health outcomes by making individuals feel relatively less deprived. Public health provision that lowers the shadow price of health for poorer households is another way to contain the social cost of inequality and aspirations failure.

Appendix

Appendix A

Table 3 reports – pooled over time and countries – simple linear regressions of inequality (Gini coefficient) on life expectancy (at birth).[25] The second and third rows add annual GDP growth rate and average GDP growth rate (over the sub-period) respectively for robustness. Evidently whatever negative association we see between between life expectancy and inequality weakens in the latter period. This pattern is robust to splitting the sample at 1985, 1990, 1995, 2000, and 2005 (not shown).

	Full Sample	Before 2000	After 2000
Gini	-9.386^{**}	-13.167^{***}	-8.831^{**}
	(-2.486)	(-2.853)	(-1.993)

	Full Sample	Before 2000	After 2000
Gini	-9.234^{**}	-13.791^{***}	-7.302^{*}
	(-2.477)	(-3.0179)	(-1.735)
GDP Growth Rate	-0.167	0.055	-0.391^{***}
	(-1.637)	(0.425)	(-3.555)

	Full Sample	Before 2000	After 2000
Gini	-7.370^{**}	-12.928^{***}	-8.393^{**}
	(-2.058)	(-2.862)	(-8.393)
Mean GDP Growth Rate	-0.308^{*}	0.135	-0.662^{***}
	(-1.932)	(0.573)	(-4.012)

t-stat in Parentheses. Significance: ***: 1%, **:5%, *:10%

Table 3: Data: Life Expectancy and Inequality

[25] Gini data come from the OECD, CIA World Fact Book and the Deininger and Squire Dataset. The Gini coefficient in this sample is between 0 and 1. Life expectancy and income data covering 1974-2010 are from the OECD. "GDP growth" in Table 3 corresponds to the year the Gini is reported, "mean GDP growth" to average growth between observations (Gini coefficient observations occur at irregular intervals in the data).

Appendix B

In an interior optimum the household equates the marginal cost and benefit from the two types of health investment, q and $1-l$, respectively:

$$(1-\alpha)Qq^{-\alpha}(1-l)^{\alpha}\left[\underline{v}+\frac{(c/\bar{C})^{1-\sigma}}{1-\sigma}\right]=(1+H)\frac{c^{-\sigma}}{\bar{C}^{1-\sigma}},$$
$$\alpha Qq^{1-\alpha}(1-l)^{\alpha-1}\left[\underline{v}+\frac{(c/\bar{C})^{1-\sigma}}{1-\sigma}\right]=w(1+H)\frac{c^{-\sigma}}{\bar{C}^{1-\sigma}}.$$

It follows that healthy time and health good investment are linearly related, $1-l=[\alpha/(1-\alpha)]q/w$. Using this, rewrite the budget constraint as $c=wl+\tilde{a}-q=w+\tilde{a}-q/(1-\alpha)$. Optimal health expenditure is then the implicit solution to

$$\alpha^{\alpha}(1-\alpha)^{1-\alpha}Qc^{\sigma}\left[\underline{v}\bar{C}^{1-\sigma}+\frac{c^{1-\sigma}}{1-\sigma}\right]=(1+H)w^{\alpha}$$

with c given by the equation above and $H=Q[\alpha/(1-\alpha)]^{\alpha}w^{-\alpha}q$. Straightforward differentiation shows that

$$\frac{\partial q}{\partial w}=\frac{(1-\alpha)\left(-\underline{v}Q(\sigma-1)\sigma\left(\frac{\bar{C}}{c}\right)^{1-\sigma}+Q+\left(\frac{\alpha}{1-\alpha}\right)^{1-\alpha}(\sigma-1)w^{\alpha-1}\right)}{Q\left(-\underline{v}(\sigma-1)\sigma\left(\frac{\bar{C}}{c}\right)^{1-\sigma}-\sigma+2\right)}>0$$
$$\frac{\partial}{\partial\bar{C}}\left(\frac{\partial q}{\partial w}\right)\propto-\frac{\underline{v}(\sigma-1)^{3}\sigma\left(\frac{c}{\bar{C}}\right)^{1-\sigma}\left((1-\alpha)Qw+\alpha\left(\frac{\alpha}{1-\alpha}\right)^{-\alpha}w^{\alpha}\right)\left((\sigma-2)\left(\frac{c}{\bar{C}}\right)^{1-\sigma}+\underline{v}(\sigma-1)\right)}{Qw\bar{C}\left((\sigma-2)\left(\frac{c}{\bar{C}}\right)^{1-\sigma}+\underline{v}(\sigma-1)\sigma\right)^{3}}<0$$

It is tedious but straightforward to show that (details available upon request) $q(w)$ is convex, that is, $q''(w)>0$. Hence the income elasticity of health spending exceeds unity. Straightforward differentiation establishes that $H(w)$ and $\Psi(w)$ are both increasing and concave functions.

References

1. Abel, Andrew B. (1990), "Asset Prices Under Habit Formation and Catching up with the Joneses", *American Economic Review*, 80(2): 38-42.

2. Alonso-Carrera, Jaime, Jordi Caballé and Xavier Raurich (2005), "Growth, habit formation, and catching-up with the Joneses", *European Economic Review*, 49: 1665-1691.

3. Alonso-Carrera, Jaime, Jordi Caballé and Xavier Raurich (2007), "Aspirations, Habit Formation and Bequest Motive", *Economic Journal* 117, 813-836.

4. Alvarez-Cuadrado, Francisco and Ngo Van Long (2012), "Envy and inequality", *Scandinavian Journal of Economics*, 114(3): 949-973.

5. Aronsson, T. and O. Johansson-Stenman (2010), "Positional Concerns in an OLG Model: Optimal Labor and Capital Income Taxation", *International Economic Review* 51, 1071-95.

6. Azariadis, Costas, Been-Lon Chen, Chia-Hui Lu and Yin-Chi Wang (2013), "A two-sector model of endogenous growth with leisure externalities", *Journal of Economic Theory*, 148 (2), 843-857.

7. Barnett, Richard, Joydeep Bhattacharya and Helle Bunzel (2010), "Choosing to keep up with the Joneses and income inequality," *Economic Theory*, 45: 469-496.

8. Becker, Gary, Tomas Philipson and Rodrigo Soares (2005), "The Quantity and Quality of Life and the Evolution of World Inequality", *American Economic Review*, 95(1): 277-291.

9. Bhattacharya, Joydeep and Xiao Qiao (2007), "Public and Private Expenditures on Health in a Growth Model," *Journal of Economic Dynamics and Control*, 31 (8), 2519-2535.

10. Blanchard, Olivier J. (1985), "Debt, Deficits, and Finite Horizons", *Journal of Political Economy*, 93(2): 223-247.

11. Carroll, Christopher D., Jody Overland and David N. Weil (1997), "Comparison Utility in a Growth Model", *Journal of Economic Growth*, 2(4): 339-367.

12. Carroll, Christopher D., Jody Overland and David N. Weil (2000), "Saving and Growth with Habit Formation", *American Economic Review*, 90(3): 341-355.

13. Chakraborty, Shankha and Mausumi Das (2005), "Mortality, human capital and persistent inequality", *Journal of Economic Growth* 10, 159-192.

14. Chakraborty, Shankha, Chris Papageorgiou, and Fidel Pérez Sebastián (2010), "Diseases, infection dynamics and development", *Journal of Monetary Economics* 57(7), 859-872.

15. Corneo, Giacomo and Olivier Jeanne (1998), "Social organization, status and savings behavior", *Journal of Public Economics*, 70: 37-51.

16. Dahl, Espen, Jon Ivar Elstad, Dag Hofoss and Melissa Martin-Mollard (2006), "For whom is income inequality most harmful? A multi-level analysis of income inequality and mortality in Norway", *Social Science & Medicine*, 63: 2562-2574.

17. de la Croix, David and Philippe Michel (1999), "Optimal growth when tastes are inherited", *Journal of Economic Dynamics and Control*, 23: 519-537.

18. Deaton, Angus (2001), "Relative Deprivation, Inequality, and Mortality", *NBER Working Paper* No. 8099.

19. Deaton, Angus (2002), “Policy Implications of the Gradient of Health and Wealth”, *Health Affairs*, 21(2): 13-29.

20. Deaton, Angus (2003), “Health, Inequality, and Economic Development”, *Journal of Economic Literature*, 41(1): 113-158.

21. Dupor, Bill and Wen-Fang Liu (2003), “Jealousy and Equilibrium Overconsumption”, *American Economic Review*, 93(1): 423-428.

22. Eibner, Christine and William N. Evans (2005), “Relative Deprivation, Poor Health Habits, and Mortality”, *Journal of Human Resources*, 40(3): 591-620.

23. Elstad, Jon Ivar (1998), “The psycho-social perspective on social inequalities in health”, *Sociology of Health & Illness*, 20(5): 598-618.

24. Frank, Robert (1985), *Choosing the Right Pond: Human Behavior and the Quest for Status*, New York: Oxford University Press.

25. Friedman, Milton (1962), *Capitalism and Freedom*, Chicago University Press.

26. Fuhrer, Jeffrey C. (2000), “Habit Formation in Consumption and Its Implications for Monetary-Policy Models”, *American Economic Review*, 90(3): 367-390.

27. Gali, Jordi (1994), “Keeping up with the Joneses: Consumption Externalities, Portfolio Choice, and Asset Prices”, *Journal of Money, Credit and Banking*, 26(1): 1-8.

28. García-Peñalosa, Cecilia and Stephen J. Turnovsky (2008), “Consumption externalities: a representative consumer model when agents are heterogeneous”, *Economic Theory*, 37: 439-467.

29. García-Peñalosa, Cecilia and Stephen J. Turnovsky (2014), “Income Inequality, Mobility and the Accumulation of Capital”, *Macroeconomic Dynamics*, forthcoming.

30. Galor, Oded and Daniel Tsiddon (1997), “The distribution of human capital and economic growth”, *Journal of Economic Growth*, 2(1): 93-124.

31. Galor, Oded, and Joseph Zeira (1993), “Income Distribution and Macroeconomics." *The Review of Economic Studies*. 60(1): 35-52.

32. Genicot, Garance and Debraj Ray (2016), “Aspirations and Inequality”, *Econometrica*, forthcoming.

33. Goenka, Aditya, Lin Liu, and Manh-Hung Nguyen (2014), “Infectious diseases and endogenous growth”, *Journal of Mathematical Economics*, 50, 34-53.

34. Gravelle, Hugh (1998), “How much of the relation between population mortality and unequal distribution of income is a statistical artefact?”, *British Medical Journal*, 316 :382-385.

35. Grossman, Michael (1972a), "On the Concept of Health Capital and the Demand for Health," *Journal of Political Economy*, 80(2): 223-255.

36. Grossman, Michael (1972b), *The demand for health: a theoretical and empirical investigation*, NBER Books.

37. Grossman, Michael (2000), "The Human Capital Model," chapter 7 in A.J. Culyer and J.P. Newhouse (ed.) *Handbook of Health Economics*, vol. 1, Elsevier Science.

38. Gulati, Namrata and Tridip Ray (2016), "Inequality, Neighbourhoods and Welfare of the Poor", *Journal of Development Economics*, forthcoming.

39. Hall, Robert E. and Charles I. Jones (2007), "The Value of Life and the Rise in Health Spending", *Quarterly Journal of Economics*, 122(1): 39-72.

40. Jin, Ye, Hongbin Li, Binzhen Wu (2011), "Income inequality, consumption, and social-status seeking", *Journal of Comparative Economics*, 39 (2), 191-204.

41. Johansson-Stenman, O., F. Carlsson, and D. Daruvala (2002), "Measuring Future Grandparents' Preferences for Equality and Relative Standing", *Economic Journal* 112, 362?83.

42. Judge, Ken (1995), "Income Distribution And Life Expectancy: A Critical Appraisal", *British Medical Journal*, 311(7015): 1282-1287.

43. Kaplan, George, Elsie R. Pamuk, J. M. Lynch, Richard D. Cohen and Jennifer L. Balfour (1996), "Inequality in income and mortality in the United States: analysis of mortality and potential pathways," *British Medical Journal*, 312, 999-1003.

44. Kawamoto, Koichi (2009), "Status-seeking behavior, the evolution of income inequality and growth", *Economic Theory*, 39: 269-289.

45. Kennedy, Bruce P., Ichiro Kawachi, and Deborah Prothrow-Stith (1996), "Income distribution and mortality: cross sectional ecological study of the Robin Hood index in the United States," *British Medical Journal*, 312, 1004-7.

46. Kondo, Naoki, Ichiro Kawachi, S.V. Subramanian, Yasuhisa Takeda and Zentaro Yamagata (2008), "Do social comparisons explain the association between income inequality and health?: Relative deprivation and perceived health among male and female Japanese individuals", *Social Science & Medicine*, 67, 982-987.

47. Lubik, Thomas and Wing Leong Teo (2014), "Deep Habits in the New Keynesian Phillips Curve", *Journal of Money, Credit and Banking*, 46 (1): 79-114.

48. Marmot, R.G. (1986), "Social inequalities in mortality: the social environment", in R.G. Wilkinson (ed.), *Class and Health: Research and Longitudinal Data*, Tavistock, London.

49. Meara, Ellen R., Seth Richards and David M. Cutler (2008), "The Gap Gets Bigger: Changes In Mortality And Life Expectancy, By Education, 1981-2000", *Health Affairs*, 27(2): 350-360.

50. McGrattan, Ellen and Richard Rogerson (2004), "Changes in Hours Worked, 1950-2000", *Federal Reserve Bank of Minneapolis Quarterly Review*, 28(1): 14-33.

51. Miller, Douglas L. and Christina Paxson (2006), "Relative income, race, and mortality", *Journal of Health Economics*, 25: 979-1003.

52. Olshansky, S. Jay, Toni Antonucci, Lisa Berkman, Robert H. Binstock, Axel Boersch-Supan, John T. Cacioppo, Bruce A. Carnes, Laura L. Carstensen, Linda P. Fried, Dana P. Goldman, James Jackson, Martin Kohli, John Rother, Yuhui Zheng and John Rowe (2012), "Differences In Life Expectancy Due To Race And Educational Differences Are Widening, And Many May Not Catch Up", *Health Affairs*, 31(8): 1803-1813.

53. Okun, Arthur (1975), *Equality and Efficiency: The Big Tradeoff*, Brookings Institution Press.

54. Rampall, Catherine (2011): "Rich People still don't realize they're Rich", Economix, *New York Times*, April 19. Web. Sept. 29, 2015.

55. Rockwood, K and A. B. Mitnitski (2007): "Frailty in relation to the accumulation of deficits", *Journals of Gerontology Series A: Biological and Medical Sciences* 62, 722.

56. Singh, Gopal K. and Mohammad Siahpush (2006), "Widening socioeconomic inequalities in US life expectancy, 1980-2000", *International Journal of Epidemiology*, 35: 969-979

57. Smith, G. D., M. J. Shipley and G. Rose (1990), "Magnitude and Causes of Socioeconomic Differential in Mortality: Further Evidence from Whitehall Study", *Journal of Epidemiology and Community Health*, 44(4): 265-70.

58. Subramanian, S. V. and Ichiro Kawachi (2004), "Income Inequality and Health: What Have We Learned So Far?", *Epidemiologic Reviews*, 26: 78-91.

59. Subramanyam, Malavika, Ichiro Kawachi, Lisa Berkman and S.V. Subramanian (2009), "Relative deprivation in income and self-rated health in the United States", *Social Science & Medicine*, 69, 327-334.

60. Wilkinson, Richard G. (1992), "Income distribution and life expectancy," *British Medical Journal*, 304(6820): 165-168.

61. Wilkinson, Richard G. (1996), *Unhealthy Societies: the Afflictions of Inequality*, Routledge, London.

62. Wilkinson, Richard G. and Kate Pickett (2009), *The Spirit Level: Why Greater Equality Makes Societies Stronger*, Bloomsbury Press.

63. Wood, Graeme (2011), "Secret Fears of the Super-Rich", *The Atlantic*, April. Web. Sept. 29, 2015.

64. Yaari, Menahem E. (1965), "Uncertain Lifetime, Life Insurance, and the Theory of the Consumer", *Review of Economic Studies*, 32(2): 137-150.

65. Yitzhaki, Shlomo (1979), "Relative Deprivation and the Gini Coefficient", *Quarterly Journal of Economics*, 93:321-324.