Imperfectly-Tradable Health and the Provision of Employment-based Health Insurance*

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Abstract

We study the implications of imperfectly-tradable health on the choices by firms of employment based health insurance (EHI) and wages to offer, and the decisions by workers of whether to (i) accept the EHI and wage, (ii) just accept the wage, or (iii) reject the offer. Workers derive utility from consumption and good health; and health insurance compensates a share of medical spending costs expended to partially offset negative health shocks to a worker's stock of health. A worker is distinguished by his observable productivity and his unobservable and heterogeneous health risk.

In equilibrium, higher skill workers match with more productive firms and receive higher wages. Since good health is a normal good and imperfectly tradable, less skilled workers with small enough health risks will shift the optimal consumption of total spending away from health by declining EHI. This magnifies the adverse selection problem among low productive firms who hire less skill workers. The imperfect tradability of good health driving this rejection resolves a paradox that low productivity firms incur limited costs from offering EHI despite the adverse selection, as most workers decline EHI despite the significant cost subsidy implicit in the health care offered. We show that more productive firms offer more generous EHI and take-up ratios are higher among their workers. Our model reconciles a host of empirical regularities in the SIPP dataset.

JEL Classification: E23, I10, O40.

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NY Times Oct. 19, 2015: *When Billy Sewell began offering health insurance this year to 600 service workers at the Golden Corral restaurants that he owns, he wondered nervously how many would buy it. Adding hundreds of employees to his plan would cost him more than $1 million — a hit he wasn't sure his low margin business could afford. His actual costs, though, turned out to be far smaller than he had feared. So far, only two people have signed up. "We offered, and they didn't take it," he said.*

1 Introduction

There is a large literature that studies health as a durable capital stock (Grossman 1972). However, what has gone largely unstudied is the imperfect tradability of health—one cannot sell health, and one can only 'buy' improvements in health up to some level—and how this interacts with health insurance provision by employers.

The imperfect tradability of health leads to important differences between standard insurance and health insurance. With standard goods, like cars, a risk-averse consumer can choose the optimal scale of a good purchased; and such consumers would take actuarially fair insurance that would cover any damages. In contrast, many low-paid risk averse workers reject health insurance with extensive coverage even when it is heavily subsidized. This is because many young and healthy workers are low-skilled (and hence poorly-compensated), the marginal utility of another dollar exceeds the marginal utility of an increased health stock. Such workers would like to sell some of their health stock, were it feasible. But, for example, a fit individual cannot transfer his or her fitness to another individual, e.g., to lower that person's blood pressure.

The US health insurance system is largely employment-based: over 90% of the insured working-age Americans obtain health insurance coverage through the workplace, known as employment-based health insurance (EHI). When health insurance is linked to employment, "the adverse selection problem of insurance purchase is naturally transferred to the employment process (Diamond, 1992)." In this paper, we study how the imperfect tradability of health affects a worker's health insurance choice, how such choices feedback to affect a firm's choice of the composition of compensation—in particular, the levels of wages and extent of health insurance provision—and how these choices vary with worker/firm productivity and interventions by the state. In practice, the state heavily regulates EHI and wages along many dimensions. In addition to, (i) setting a minimum wage, the state (ii) imposes a charge on employers that do not offer EHI; (iii) offer tax subsidies that reduce the cost to an employer of providing health insurance; and (iv) sets minimum insurance coverage standards and (v) affordability standards that limit the maximum insurance coverage that an employer can offer. We show how the many ways in which the state intervenes in this market feed back to alter the compensation packages that firms offer.

In our equilibrium matching model, workers are characterized by their observable productivity and their unobservable idiosyncratic health risk. Workers have preferences over consumption and health, which are normal goods (c.f. Hall and Jones, 2007). Firms, which differ in their productivities, take the distribution of worker types as given and choose compensation packages to maximize expected profits subject to the rules and regulations set by the state. Firms pay a share of the health insurance premia, with workers who accept the insurance paying the residual.

In equilibrium, higher skill workers match with more productive firms and receive higher wages. Because health is a normal good and imperfectly tradable, less skilled workers with low health risks will shift the optimal consumption of total spending away from health by declining EHI. This magnifies the adverse selection concerns of low-productivity firms that hire less-skilled workers. Under plausible conditions, equilibrium outcomes as a function of a firm's productivity evolve as follows:

- The lowest productivity firms offer the minimum wage and as high EHI as possible, subject to the affordability constraint imposed by the government. Almost all workers reject the EHI offer—only very high health risk workers accept—so that despite the high adverse selection, the costs of EHI to a firm are modest. The imperfect tradability of good health driving this rejection resolves the paradox that low productivity firms incur limited costs from offering EHI despite the adverse selection, as most workers decline EHI despite the significant cost subsidy implicit in the health care offered.

- Once firm productivity rises sufficiently, firms begin to raise wage offers, but still extend maximum EHI offers at the binding affordability level. Most workers continue to reject EHI, and EHI continues to represent a pure transfer of surplus to high health risk workers. However, the increased wage offers make it more attractive for workers to accept EHI, so that the health risk of the marginal worker taking EHI falls, reducing the extent of adverse selection, which feeds back to reduce health care premia and increasing uptake.

- When firm productivity rises by enough, and the marginal worker hired rejects EHI, the wage offer needed to attract the marginal worker may rise sufficiently that employers radically change their EHI offerings. In particular, firms may find take-up of the extensive EHI coverage so high that they prefer to switch to offering EHI that just meets the minimum coverage constraint—offering workers the minimum coverage that most take up may become less expensive, and EHI coverage continues to represent a transfer of surplus to workers who take it.

- As firm productivity rises further, the marginal worker hired accepts EHI–and the firm's compensation plan trades off subsidized EHI and wages optimally as it finds the least cost way of providing compensation. Because all workers value cash in the same way, and the marginal worker values EHI the least, all other workers would prefer that the mix of compensation be tilted further toward EHI and lower wages. This creates a potential role for tax subsidies as the firm does not internalize the relative surplus that higher risk workers gain from increased EHI.

We test our model using the sixth wave of the 2008 Survey of Income and Program Participation (SIPP) panel data, and show that our model can reconcile a host of empirical regularities. We use our model to assess the impact of the Patient Protection and Affordable Care Act (ACA), which was signed in 2010 and represents the most significant regulatory overhaul of the U.S. health care system since the creation of the first public health insurance programs, Medicare and Medicaid, in 1965.[1] We argue that policy elements of the ACA can have perverse effects on allocations, inducing low productivity firms to offer EHI that is so excessive that almost no one signs up, allowing the firm to avoid most of the costs of EHI.

Related Literature. The observation that health is imperfectly tradable dates back at least to Grossman (1972). To the best of our knowledge, our paper is the first to study the implications of this imperfect tradability for the choice by firms of the wage-EHI composition of compensation, and the choices by workers of whether to take-up insurance.

Our paper is most closely related to Aizawa and Fang (2016), who build an equilibrium labor market search model to study the impact of the ACA on a firm's decision to offer EHI. They extend Burdett and Mortensen (1998) by incorporating health insurance as a productivity factor.[2] In equilibrium, firms that offer health insurance are larger and pay higher wages. In contrast, our paper focuses on the impact of imperfectly tradability of health on worker health insurance choices, the feedback with a firm's compensation choices, and how these vary with worker/firm productivities. Our paper not only generates the low health insurance take-up ratio among less-skilled workers, it also provides different policy implications. Aizawa and Fang (2016) predict that the employer mandate prescribed by the ACA will induce low productivity firms to reduce the EHI offering rate. This is due to the fact that the subsidized health insurance from the health insurance exchange reduces the value of EHI to workers. While we find that such firm may offer "excessive EHI" to all workers. By doing so, it meets the minimum health insurance requirement from the ACA. At the same time, such strategy also induces a lower take-up ratio among their workers, which effectively reduces the cost of EHI.

Our paper is related to the literature that studies health as a durable capital stock. The seminal contribution is Grossman (1972). Recent contributions include Suen (2007), Feng (2009), Hall and Jones (2007), and Zhao (2012). The paper also contributes to a broad literature that

[1]The four key pillars of the ACA are: (1) Individual Mandate: All individuals must have health insurance that meets the law's minimum standards or face a penalty when filing taxes. (2) Employer Mandate: Employers with at least 50 full-time employees will be required to provide health insurance or pay a fine. (3) Insurance Exchanges: State-based health insurance exchanges will be established where the unemployed, self-employed and workers who are not covered by EHI can purchase insurance. (4) Premium Subsidies: All adults in households with income under 133% of Federal poverty line (FPL) are eligible for Medicaid coverage with no cost sharing.

[2]Dizioli and Pinheiro (2016), Dey and Flinn (2005), Brugemann and Manovskii (2010) also develop equilibrium search and matching models to study a firm's decision to offer EHI, and its impact on worker labor market choices.

uses structural models to study the impact of EHI on labor market decisions (e.g., Brugemann and Manovskii (2010), Cole, Kim and Kruger (2014), Feng and Zhao (2014), French and Jones (2004), Hansen, Hsu and Lee (2014), Hall and Jones (2007), Jeske and Kitao (2009), Braun, Kopecky and Koreshkova (2015), Pashchenko and Porapkkam (2012)). We complement this literature by endogenizing a firm's wage and EHI offer.

The paper is organized as follows. Section 2 explains the imperfect tradability of health and its implications. Section 3 builds our theoretical framework. Section 4 derives the equilibrium properties. Section 5 conducts an empirical analysis. Section 6 concludes.

2 Imperfect tradability of health

Goods can be imperfectly tradable for many reasons—geographic or temporal separation or information frictions, for example. Health is imperfectly tradable in many ways—for example, it is infeasible or illegal for a person to transfer his or her health to others—and this imperfect tradability matters for a consumer's health insurance decision.

To highlight this, consider a consumer who has a strictly concave utility function $u(c, h)$ over two commodities, consumption c and health h. The agent is endowed with e units of c and $\bar{h}$ units of h. A shock may reduce the consumer's health stock by ε, where $\varepsilon \sim G(\varepsilon)$. Suppose first that health is perfectly tradable, so that the agent can convert one unit of c into one unit of h by using $m(\varepsilon)$ units of c to offset the negative effect of shock ε by m, so that the amount of h consumed is $h = \bar{h} - \varepsilon + m(\varepsilon)$. If there is an actuarially fair insurance for this shock with a premium $\pi = \int_{\varepsilon} m(\varepsilon) dG(\varepsilon)$ units of good c, then the agent solves:

$$\max_{m(\varepsilon)} \mathbb{E}\left[u(e - \pi, \bar{h} - \varepsilon + m(\varepsilon))\right]. \tag{1}$$

The optimal choice of $m(\varepsilon)$ is given by the solution to the F.O.C.

$$\mathbb{E}\left[u_c(e - \pi, \bar{h} - \varepsilon + m(\varepsilon))\right] = \mathbb{E}\left[u_h(e - \pi, \bar{h} - \varepsilon + m(\varepsilon))\right] \tag{2}$$

and budget balance, where expectations are taken over ε. In equilibrium, the agent chooses $m(\varepsilon)$ to equalize marginal utilities from the two goods and smooth consumption across states.

To understand how imperfectly tradability can alter insurance choices, first suppose that the endowment of c is sufficiently low (or the endowment of $\bar{h}$ is sufficiently high) that

$$\mathbb{E}\left[u_c(e - \pi, \bar{h} - \varepsilon)\right] > u_h(e - \pi, \bar{h} - \varepsilon). \tag{3}$$

Then the agent wants to choose $m^*(\varepsilon) < 0$. Conversely, if the endowment of health $\bar{h}$ is sufficiently low (or the endowment of c is sufficiently high) that

$$\mathbb{E}\left[u_c(e-\pi,\bar{h})\right] < u_h(e-\pi,\bar{h}), \tag{4}$$

the agent wants to choose $m^*(\varepsilon)$ so that $h = \bar{h} - \varepsilon + m^*(\varepsilon) > \bar{h}$.

The imperfect tradability of health renders both possibilities infeasible. The inability to sell health means that an individual cannot choose $m(\varepsilon) < 0$. Consequently, an agent may decline health insurance even if it is subsidized. Further, individuals can plausibly do no better than to restore his or her health stock to pre-shock levels, i.e., $h \leq \bar{h}$. In both cases, the imperfect tradability of health alters insurance choices, as the agent cannot choose health so as to balance the marginal utilities from the consumption good and health.

Health has other distinguishing features that matter. The effective marginal cost of improving health may rise as more of a shock is offset. One can capture this via a treatment technology g such that the level of health following shock ϵ and treatment $m(\epsilon)$ is $h = \bar{h} - \epsilon g(m(\epsilon))$, where $g(0) = 1$, $g' < 0$ and $g'' > 0$. One can augment this to capture the imperfect observability of the effects of health treatments via a medical technology that converts m units of consumption goods into $g(m, \iota)$ units of health, where ι is an unobservable idiosyncratic component that affects a treatment's effectiveness. For the same medical condition, a treatment may be more effective for patient ι than ι', so that for the same ϵ health shock, to improve the health of patient ι' to that of ι, i.e., for $g(m, \iota) = g(m', \iota')$, one needs $m' > m$. Health insurance policies can only contract on the observable shock ε, not the unobservable ι, reducing the value of insurance.

Now consider the standard practice in the United States that a firm's compensation package consists of a wage offer and a health insurance offer. The imperfect tradability of health will affect labor market decisions and health insurance choices by firms and workers. Ceteris paribus, more workers will decline health insurance when their wage offer is lower. So, too, for a given wage offer, workers with higher health stocks or who are less likely to receive adverse health shocks will tend to decline health insurance. In both cases, these choices will feed back to alter a firm's compensation decision via the effects on the cost of health insurance. We next study the implications for the labor market decisions of workers and firms.

3 The Model

Our model features workers who are distinguished by their observable productivity types and by their unobservable health risks, which are private information to workers. To focus on the impacts of the imperfect tradability of health on firm and worker labor market decisions, we assume that labor markets are perfectly segmented by a worker's observable productivity,[3] and we abstract away from other frictions.

[3] This perfect segmentation assumption is common in the literature—see e.g., Lee and Saez (2008), Hungerbuhler and Lehmann (2009) or Lavecchia (2016).

3.1 Environment

There is a continuum of workers. A worker with income c and health h, derives utility $u(c)+\theta(h)$, where both u and θ are increasing, strictly concave functions. Each worker is endowed with $\bar{h}$ units of health, but may receive negative shocks that reduces her health stock to $\bar{h} - \bar{\epsilon}$. We assume that $u'(c) > \theta'(\bar{h})$ for c is sufficiently small, and $\theta'(\bar{h} - \bar{\epsilon}) > u'(c)$ for c sufficiently large.

A worker is fully described by (x, p), where her productivity type $x > 0$ equals the revenues the worker would create at a firm that uses that skill, and p is the probability the worker would receive the negative health shock $\bar{\epsilon}$. A worker's productivity x is public information, but her health risk p is private information to the worker. We assume that p is distributed according to CDF $F(p)$ on support $[\underline{p}, \bar{p}]$, where $0 < \underline{p} < \bar{p} \leq 1$, with associated density function φ_p. A worker's productivity and health type are independently distributed, and health status does not affect productivity. As an alternative to working at a firm, a worker can pursue home employment that delivers the worker revenues of $b(x)$, where $0 < b(x) < x$, and $b'(x) \in (0, 1)$. Here, $b' > 0$ captures that more productive workers have more valuable alternatives if they reject an employment offer.

Health shocks can be offset by medical expenditures. Devoting $m \geq 0$ to medical care raises the health stock of a worker who received shock $\bar{\epsilon}$ to $h = \bar{h} - \bar{\epsilon} g(m)$, where $g(0) = 1$, $g(m) \geq 0$, and $g'(m) < 0$, $g''(m) \geq 0$ for $g(m) > 0$. Here, $m \geq 0$ reflects the imperfect tradability of health—an individual cannot sell some of his or her stock of health.

Each worker with productivity x is randomly matched with a single firm that can productively employ that worker. The firm offers a compensation package that consists of a wage $w(x)$ and (possibly) employer provided health insurance $m_{ehi}(x)$ that we describe below. Given the employment offer and her health risk p, a worker decides whether (a) to take the wage offer together with the health insurance (if offered); or (b) to take the wage offer and reject the health insurance; or (c) to reject the employment offer and work in home employment, earning $b(x)$.

Workers can only get health insurance via employers (EHI). Insurance of m_{ehi} commits the firm to providing medical services of m_{ehi} when a worker receives a health shock. An employer procures the insurance from a competitive insurance market: the health insurance premium of $\pi_{ehi}(w, m_{ehi}, b)$ equals the expected medical spending per person among workers who receive employment offer (w, m_{ehi}) and sign up for EHI, where b enters because it influences which worker types join a firm. Firms split the premium costs with workers, with a firm paying fraction $1 - \psi$ of the premium, and a worker paying the residual. For simplicity, we assume that here is no private health insurance. However, when a worker receives a health shock, she can purchase additional medical services in a competitive market. For example, she can purchase additional coverage as a supplement to EHI.

The government regulates this market. The government

- Sets a minimum wage $\underline{w}$, i.e., a lower bound on wage offers by firms.

- Sets bounds on appropriate levels of EHI. EHI must meet both a minimum quality standard $m_{ehi} \geq \underline{m} > 0$, and an affordability standard $k > 0$ limiting the share of a worker's wage that EHI premia payments comprise, $\frac{\psi \pi_{ehi}}{w} \leq k$.[4]

- Offers employers a tax subsidy τ to firms that offer appropriate levels of EHI, so that if the health insurance premium is $\pi_{ehi}(w, m_{ehi}, b)$, the firm only pays $(1-\psi)(1-\tau)\pi_{ehi}$.

- Charges a firm a (per uncovered worker) penalty $\tau_m \geq 0$ for not offering appropriate levels of EHI, i.e., as mandated by ObamaCare. We assume that τ_m is not so high that a firm must offer EHI in order to operate profitably: $x - max\{\underline{w}, b(x)\} - \tau_m \geq 0$, for all x.

We separate firms by their productivities to better match empirical regularities (there is little variety in health care plans at a firm). However, since the penalty τ_m for not offering EHI is per (uncovered) worker, and we assume away all fixed costs associated with providing health insurance, it is equivalent to consider a single representative firm that conditions offers on the observable productivities of potential workers. We work with this formulation in what follows.

Timing. The economy has four stages:

1. Firms offer a compensation package $\{w(x), m_{ehi}(x)\}$ to workers with productivity x.

2. Insurers set EHI premia $\pi_{ehi}(w, m_{ehi}, b)$.

3. Given a compensation package $\{w(x), m_{ehi}(x)\}$, EHI premium $\pi_{ehi}(w, m_{ehi}, b)$, and the payoff from home employment $b(x)$, a type (x, p) worker selects one of three possible employment alternatives (employed and EHI insured ($\delta_I = 1$), employed and no EHI ($\delta_U = 1$), and home employed ($\delta_b = 1$)).

4. Production takes place, wages (if employed) are paid, and health shocks are realized. Workers hit with health shocks receive health insurance (if chosen), which they can augment with supplemental medical services, $m^*(w, m_{ehi}, \pi_{ehi}, b, \delta)$, where we omit the x index.

Definition 1 *Equilibrium is characterized by:* ***1)*** *a compensation package choice by firms* $\{w^*(x), m^*_{ehi}(x)\}$, ***2)*** *EHI premium,*$\pi_{ehi}(w, m_{ehi}, b)$, *and* ***3)*** *a worker's choice of employment* $\Phi^{emp} : \{p, w(x), m_{ehi}(x), \pi_{ehi}(w, m_{ehi}, b), b(x)\} \rightarrow \delta$ *and private health care payments* $\Phi^m : \{w(x), m_{ehi}(x), \pi_{ehi}(w, m_{ehi}, b), b(x), \delta\} \rightarrow m$ *such that the compensation package is feasible* ($w \geq \underline{w}$, *and* $m_{ehi} > \underline{m}$, $\psi \pi_{ehi} k \leq k$ *if EHI is offered) and maximizes expected firm profit given the feasibility constraints, and the EHI premium earns insurance companies zero expected profit given correct conjectures about worker choices, which, in turn, maximize expected worker utility.*

[4]Qualitative outcomes are unaffected if the affordability limit is in levels, i.e., $w - \psi \pi_{ehi} \leq k$

3.2 Optimization

Worker: Let m_U and m_I represent the medical services purchased by uninsured and EHI-insured workers respectively when they receive health shock ϵ. For an employed worker,

$$\begin{aligned} V^I(p,w,m_{ehi},\pi_{ehi}) &= (1-p)[u(w-\psi\pi_{ehi})+\theta(\bar{h})] \\ &\quad +p\cdot\max_{m_I\geq 0}[u(w-\psi\pi_{ehi}-m_I)+\theta(\bar{h}-\epsilon g(m_{ehi}+m_I))] \\ V^U(p,w,m_{ehi},\pi_{ehi}) &= (1-p)[u(w)+\theta\left(\bar{h}\right)]+p\cdot\max_{m_U\geq 0}[u(w-m_U)+\theta(\bar{h}-\epsilon g(m_U))] \end{aligned}$$

are, respectively, the value function of a worker with health risk p, who is employed at wage w and EHI insured with premium π_{ehi}, and the value function of an employed worker who rejects EHI. We omit dependence of arguments on x. Because EHI does not enter a self-insured worker's optimization problem, we write $V^U(p,w)$ henceforth.

Let $V^H(p,b)$ denote the value function of a worker with health risk p who pursues home employment that pays $b(x)$, and who purchases medical services of m_b after a health shock:

$$V^H(p,b)=(1-p)[u(b)+\theta(\bar{h})]+p\cdot\max_{m_b\geq 0}[u(b-m_b)+\theta(\bar{h}-\epsilon g(m_b))].$$

The worker chooses employment status, δ, to maximize expected utility,

$$\begin{aligned} &\max_{\delta\in\{0,1\}^3}\delta_I V^I(p,w,m_{ehi},\pi_{ehi})+\delta_U V^U(p,w)+\delta_b V^H(p,b) \qquad (5) \\ s.t. \qquad &\delta_I+\delta_U+\delta_b=1. \end{aligned}$$

Upon meeting with a firm that offers EHI, the worker will accept the job if and only if

$$\max\left\{V^U(p,w),V^I(p,w,m_{ehi},\pi_{ehi})\right\}\geq V^H(p,b), \qquad (6)$$

accepting EHI if and only if

$$V^I(p,w,m_{ehi},\pi_{ehi})\geq V^U(p,w). \qquad (7)$$

Optimization by workers and firms immediately implies that there are only two possible qualitative employment outcomes: either 1) $w=max\{\underline{w},b(x)\}$ and no one chooses home employment (strict inequality only if $\underline{w}>b(x)$); or 2) $w<b(x)$ and every worker type hired by the firm takes EHI. In particular, a firm would never offer $w>max\{\underline{w},b(x)\}$, because every potential worker type would accept a lower wage offer. So, too, if $w<b(x)$ any worker type that would not want EHI would prefer home employment at $b(x)$ to working at a lower wage, and the marginal worker hired is just indifferent between being hired or not.

When $w=max\{\underline{w},b(x)\}$ and EHI is offered, optimization by workers implies that if some, but not all, worker types accept EHI then there is a critical cutoff on worker health risk types $\tilde{p}_{ehi}(w, m_{ehi}, \pi_{ehi}, b)$, determined by $V^U(p, w) = V^I(p, w, m_{ehi}, \pi_{ehi})$: a worker with health type p signs up for EHI only if and only if $p \geq \tilde{p}_{ehi}(w, m_{ehi}, \pi_{ehi}, b)$. This follows immediately because the relative attraction to a worker of accepting EHI rises with p, i.e., $\frac{dV^I}{dp} > \frac{dV^U}{dp}$. If $V^U(\bar{p}, w) > V^I(\bar{p}, w, m_{ehi}, \pi_{ehi})$, then no worker will choose EHI; and if $V^U(\underline{p}, w) \leq V^I(\underline{p}, w, m_{ehi}, \pi_{ehi})$ then all workers take EHI. Because the firm gives workers with risk types $p > \tilde{p}_{ehi}$ strictly more than is necessary to induce them to work at the firm, it wants to minimize these 'excessive transfers' to higher health-risk type workers.

When $w < b(x)$, then either $w \geq \underline{w}$ binds on the firm, or $V^H(p, b) = V^I(p, w, m_{ehi}, \pi_{ehi})$—a worker would not accept a job if $V^H(p, b) > V^I(p, w, m_{ehi}, \pi_{ehi})$, but would if the inequality were reversed, and if $V^H(\underline{p}, b) > V^I(\underline{p}, w, m_{ehi}, \pi_{ehi})$ and $w > \underline{w}$, the firm can always reduce w marginally and all worker types would still choose to work at the firm.

***Careful, this argument relies on uniqueness of zero profit π_{ehi}. Possibly say at outset: assume and verify.

Finally, sufficiently high p types must work for the firm, else it is not operating, and the firm could profitably offer $w = max\{\underline{w}, b(x)\}$ and no EHI, as $x - max\{\underline{w}, b(x)\} - \tau_m > 0$, as all workers would accept.

Firms: A firm chooses its compensation package $\{w(x), m_{ehi}(x)\}$ to maximize expected profit (integrating over a worker's unobserved health type) given the minimum wage constraint $w \geq \underline{w}$, and the minimal and affordability coverage constraints on EHI, $m_{ehi} \geq \underline{m}$ and $\frac{\psi \pi_{ehi}}{w} \leq k$.

$$\begin{aligned} \Pi &= \max_{w, m_{ehi}} \int_{\tilde{p}_{job}(w, m_{ehi}, \pi_{ehi}, b)}^{\bar{p}} [x - w] \, dF(p) \\ &\quad - \int_{\tilde{p}_{ehi}(w, m_{ehi}, \pi_{ehi}, b)}^{\bar{p}} (1 - \psi) \cdot (1 - \tau) \cdot \pi(w, m_{ehi}) dF(p) \end{aligned} \tag{8}$$

where $\tilde{p}_{job}(w, m_{ehi}, \pi_{ehi}, b) = \underline{p}$ if $w \geq b$, and $\tilde{p}_{job}(w, m_{ehi}, \pi_{ehi}, b) = \tilde{p}_{ehi}(w, m_{ehi}, \pi_{ehi}, b)$ if $w < b$.

Note we implicitly assume that there exists a unique π_{ehi} clears the insurance market for given w and m_{ehi}. We provide conditions under which this is valid in the next section.

Health insurance: Health insurance companies charge actuarially fair premia. The price of health insurance π_{ehi} equals the expected health spending among workers who sign up for EHI in the workplace. In equilibrium, the premium $\pi_{ehi}(w, m_{ehi}, b)$ is pinned down implicitly by the solution to

$$\pi_{ehi}(w, m_{ehi}, b) = \frac{\int_{\tilde{p}_{ehi}(w, m_{ehi}, \pi_{ehi}, b)}^{\bar{p}} p \cdot m_{ehi} dF(p)}{\int_{\tilde{p}_{ehi}(w, m_{ehi}, \pi_{ehi}, b)}^{\bar{p}} dF(p)}. \tag{9}$$

4 Analysis of equilibrium

We begin by identifying a lower bound $\hat{w}$ on wages such that any worker with wage income less than $\hat{w}$ always prefers to go without EHI, where

$$\psi u'(\hat{w}) = \theta'(\bar{h} - \bar{\epsilon}g(0))\bar{\epsilon}g'(0). \tag{10}$$

One can also identify an upper bound $\bar{m}(w)$ on the extent of EHI such that if $m_{ehi} > \bar{m}(w)$ then all workers with wage w will reject fairly-priced EHI of m_{ehi}, where

$$u(w - \psi\bar{m}) + \theta(\bar{h} - \bar{\epsilon}g(\bar{m})) = \max_{m_U} u(w - m_U) + \theta(\bar{h} - \bar{\epsilon}g(m_U)). \tag{11}$$

It is immediate that no firm will ever offer a wage exceeding max $\{\underline{w}, b(x)\}$, as all workers would accept a wage $w(x) = b(x)$ in lieu of home employment. The questions become what EHI offer will a firm make if any, and when will it combine an attractive offer of EHI together with a wage that is less than b that may attract workers with higher health risks, but possibly not those with low health risks?

There are two possible equilibrium outcomes for a given x. First, the firm offers a wage $w(x) = b(x)$, and the marginal workers hired does not take up EHI. This is represented by the left panel of Figure 1. In such case, all workers work for the firm, $\tilde{p}_{job} = \underline{p}$. Worker with health risk types $[\tilde{p}_{ehi}, \bar{p}]$ will take up EHI. Accordingly the firm's profit is given by

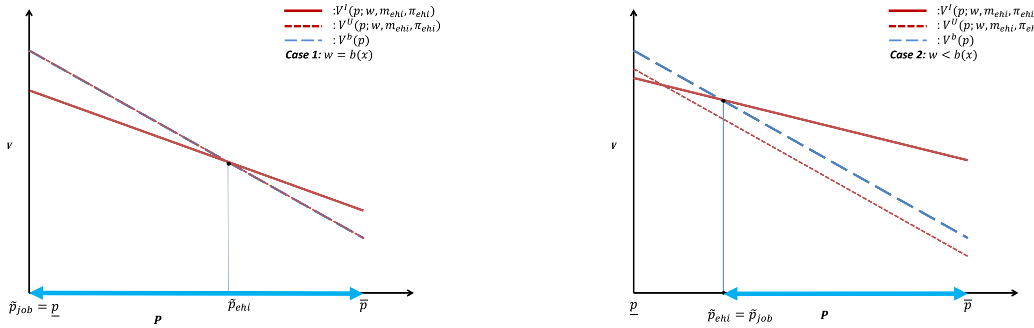
$$\begin{aligned}\Pi_1 = \max_{m_{ehi}} &\int_{\underline{p}}^{\bar{p}} [x - b(x)]\, dF(p) \\ &- \int_{\tilde{p}_{ehi}(w, m_{ehi}, \pi_{ehi}, b)}^{\bar{p}} (1 - \psi) \cdot (1 - \tau) \cdot \pi(w, m_{ehi}, b) dF(p).\end{aligned} \tag{12}$$

It is obvious that the firm will offer $m_{ehi} = 0$. However the restrictions imposed by the government, such as minimum level and affordability of EHI, may affect the firm decision. We postpone the discussion in next Section.

The other possibility is that the firm offers a wage $w(x) < b(x)$, and the marginal worker hired chooses EHI insured, see the right panel of Figure 1. Now we have $\tilde{p}_{job} = \tilde{p}_{ehi}$. The firm's profit is given as follows.

$$\Pi_2 = \max_{w, m_{ehi}} \int_{\tilde{p}_{ehi}(w, m_{ehi}, \pi_{ehi}, b)}^{\bar{p}} [x - w - (1 - \psi) \cdot (1 - \tau) \cdot \pi(w, m_{ehi}, b)]\, dF(p). \tag{13}$$

Figure 1: Possible equilibrium outcomes

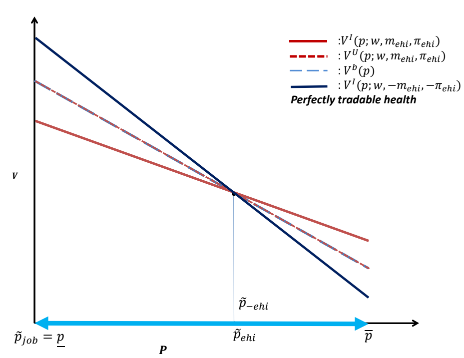


To understand how the equilibrium allocation changes with the worker's productivity x, we first examine properties of $\tilde{p}_{ehi}(w, m_{ehi}, \pi_{ehi}, b)$. The value of $\tilde{p}_{ehi}(w, m_{ehi}, \pi_{ehi}, b)$ is determined by

$$V^I(\tilde{p}_{ehi}, w, m_{ehi}, \pi_{ehi}) \quad = \quad V^H(\tilde{p}_{ehi}, b). \tag{14}$$

When the firm offers higher w or better m_{ehi}, the value of V^I rises. The value of V^H does not vary with (w, m_{ehi}). Hence the left hand side of the above equation shifts upward and it will cross V^H at a lower value of p. Consequently, the value of $\tilde{p}_{ehi}(w, m_{ehi}, \pi_{ehi}, b)$ will decrease. When the value of π_{ehi} increases, the left hand side of equation (14) shifts downward and it will cross V^H at a higher value of p. Hence $\tilde{p}_{ehi}(w, m_{ehi}, \pi_{ehi}, b)$ will increase.

Figure 2: Equilibrium with perfectly tradable health



The next two propositions establish the existence of EHI and the main property of the premium for EHI in equilibrium.

Proposition 1 *Suppose that the density function $\varphi_p(p)$ of worker types satisfies $\frac{d^2(\mathbb{E}(p|p\geq p^*))}{dp^{*2}} \geq 0$. The worker has prudence preference $u'''(c) > 0$. Then if the firm offers a compensation package with $w > \hat{w}$ and $m_{ehi} < \bar{m}(w)$, so that take-up of EHI is positive, there exists a unique $\tilde{\pi}_{ehi}(w, m_{ehi}, b)$ that clears the EHI market.*

Proof.

For given w, m_{ehi}, b and any π, the decision to pick-up EHI is characterized by a cut-off strategy. So, suppose that given w, m_{ehi}, b, the health insurance company conjectures that the cutoff value for taking up EHI is $\hat{p}$. Then, the EHI premium will be $\tilde{\pi}(w, m_{ehi}, b; \hat{p}) = \frac{\int_{\hat{p}}^{\bar{p}} p \cdot m_{ehi} dF(p)}{\int_{\hat{p}}^{\bar{p}} dF(p)}$. To simplify notation, we write $V^I(\hat{p})$ and $V^U(\hat{p})$ for $V^I(\hat{p}, w, m_{ehi}, \pi_{ehi}(\hat{p}, m_{ehi}))$ and $V^U(\hat{p}, w)$, where $\pi_{ehi}(\hat{p}, m_{ehi}) = m_{ehi}\mathbb{E}(p|p \geq \hat{p})$. We have

$$\begin{aligned} V^I(\hat{p}) - V^U(\hat{p}) = {} & (1 - \hat{p}) \left[u(w - \psi m_{ehi} E(p|p \geq \hat{p})) - u(w)\right] \\ & + \hat{p} \left[u(w - \psi m_{ehi} E(p|p \geq \hat{p}) - m_I) - u(w - m_U)\right] \\ & + \hat{p} \left[\theta(\bar{h} - \bar{\epsilon} g(m_{ehi} + m_I) - \theta(\bar{h} - \bar{\epsilon} g(m_U)\right] \end{aligned} \tag{15}$$

We want to show that there is a unique $p^* \in [\underline{p}, \bar{p}]$ that sets (15) to zero, or that there is 100% takeup of EHI.

1. Existence of p^*.

   The first term is nagative and the third term is positive on the right side of (15). The second term is positive because $w > \hat{w}$ and $m_{ehi} < \bar{m}(w)$ ensure $\psi m_{ehi} E(p|p \geq \hat{p}) + m_I < m_U$. When $\hat{p} = \bar{p}$, we have $V^I(\hat{p}) - V^U(\hat{p})$ is positive so that there is positive EHI coverage.

   When $\hat{p} = \underline{p}$, there are two possibilities. First, $\underline{p}$ is sufficiently low and the first dominates the last two terms, which means $V^I(\underline{p}) - V^U(\underline{p}) < 0$. We have existence since both $V^I(\hat{p})$ and $V^U(\hat{p})$ are continuous in $\hat{p}$.

   The other possibility is that $V^I(\underline{p}) - V^U(\underline{p}) > 0$. If $V^I(\hat{p}) - V^U(\hat{p})$ is monotonic in term of $\hat{p}$, then this means everyone wants EHI. This is consistent with EHI being priced as if everyone takes up. When $V^I(\hat{p}) - V^U(\hat{p})$ is not monotonic. It either equals to zero for some $p \in [\underline{p}, \bar{p}]$, then we have existence, or it is always greater than zero, which implies 100% takeup as discussed above.

2. Uniqueness of p^*.

   When $m_I = 0$, (15) simplifies to $u(w - \psi\pi(\hat{p})) + \hat{p}A$, where $A = \theta(\bar{h} - \bar{\epsilon} g(m)) - \theta(\bar{h} - \bar{\epsilon} g(m_I)) + u(w) - u(w - m_I)$ is a constant.

   It suffices to establish that this net utility is a single-peaked function of $\hat{p}$, because we have established that it is positive for $\hat{p}$ sufficiently high. The derivative of net utility with respect to $\hat{p}$ is

$$-u'(w-\psi\pi(\hat{p}))\frac{d\pi(\hat{p})}{d\hat{p}}\psi + A = -u'(w-\psi\pi(\hat{p}))m_{ehi}\frac{dE[\tilde{p}|\tilde{p}\geq\hat{p}]}{d\hat{p}} + A.$$

If this derivative is positive for all $\hat{p}$ then we are done. So suppose it becomes zero at $\hat{p}=\dot{p}$. Then it is declining in $\hat{p}$ for $\hat{p}>\dot{p}$ if $u'(w-\psi\pi(\hat{p}))m\frac{dE[\tilde{p}|\tilde{p}\geq\hat{p}]}{d\hat{p}}$ is increasing in $\hat{p}$. But $\frac{dE[\tilde{p}|\tilde{p}\geq\hat{p}]}{d\hat{p}}$ is weakly increasing by convexity, and $u'(w-\psi\pi(\hat{p}))$ is increasing by concavity (since $\pi(\hat{p})$ is increasing in $\hat{p}$). The result follows.

When $m_I>0$, the derivative of net utility in (15) with respect to p becomes

$$\begin{aligned}
&-\left[u(w-\psi m_{ehi}E(p|p\geq\hat{p}))-u(w)\right]-(1-\hat{p})\psi m_{ehi}\frac{dE[\tilde{p}|\tilde{p}\geq p]}{dp}u'(w-\psi m_{ehi}E(p|p\geq\hat{p}))\\
&+\left[u(w-\psi m_{ehi}E(p|p\geq\hat{p})-m_I)-u(w-m_U)\right]\\
&-\hat{p}\left(\psi m_{ehi}\frac{dE[\tilde{p}|\tilde{p}\geq p]}{dp}+\frac{dm_I}{dp}\right)u'(w-\psi m_{ehi}E(p|p\geq\hat{p})-m_I)\\
&+\left[\theta(\bar{h}-\bar{\epsilon}g(m_{ehi}+m_I))-\theta(\bar{h}-\bar{\epsilon}g(m_U)\right]-\hat{p}\left(\bar{\epsilon}g'(m_{ehi}+m_I)\frac{dm_I}{dp}\right)\theta'(\bar{h}-\bar{\epsilon}g(m_{ehi}+m_I))
\end{aligned}$$

Since m_I solves the worker's optimization problem, this derivative simplifes to

$$\begin{aligned}
&-\psi m_{ehi}\frac{dE[\tilde{p}|\tilde{p}\geq p]}{dp}u'(w-\psi m_{ehi}E(p|p\geq\hat{p}))\\
&-p\psi m_{ehi}\frac{dE[\tilde{p}|\tilde{p}\geq p]}{dp}\left[u'(w-\psi m_{ehi}E(p|p\geq\hat{p})-m_I)-u'(w-\psi m_{ehi}E(p|p\geq\hat{p}))\right]\\
&+\left[\theta(\bar{h}-\bar{\epsilon}g(m_{ehi}+m_I))+u(w-\psi m_{ehi}E(p|p\geq\hat{p})-m_I)-u(w-\psi m_{ehi}E(p|p\geq\hat{p}))\right]\\
&+\left[u(w)-u(w-m_U)-\theta(\bar{h}-g(m_U))\right].
\end{aligned}$$

Similar to the argument in the case of $m_I=0$, suppose that this derivative becomes zero at $\dot{p}$. The last term is a constant. When p increases, the first term of the derivative decreases as $E(p|p\geq\hat{p})$ increases in p, $\frac{dE[\tilde{p}|\tilde{p}\geq p]}{dp}$ is weakly increasing by convexity, and the utility function is strictly concave.

In the second term, the value of $u'(w-\psi m_{ehi}E(p|p\geq\hat{p})-m_I)$ increases more than $u'(w-\psi m_{ehi}E(p|p\geq\hat{p}))$ with p, as $u'''>0$. Hence the second term decreases with p as well.

Next we prove that the thrid term decreases with p by showing its derivative with respect to p, given as below, is negative.

$$-\psi m_{ehi}\frac{dE[\tilde{p}|\tilde{p}\geq p]}{dp}\left[u'(w-\psi m_{ehi}E(p|p\geq\hat{p})-m_I)-u'(w-\psi m_{ehi}E(p|p\geq\hat{p}))\right]$$
$$-\bar{\epsilon}g'(m_{ehi}+m_I)\frac{dm_I}{dp}\theta'\left(\bar{h}-\bar{\epsilon}g(m_{ehi}+m_I)\right)$$
$$-\left(\psi m_{ehi}\frac{dE[\tilde{p}|\tilde{p}\geq p]}{dp}+\frac{dm_I}{dp}\right)u'(w-\psi m_{ehi}E(p|p\geq\hat{p})-m_I)$$

The second and third term cancel out due to the envelope theorem. The first term is negative by concavity of utility function.

■

Proposition 2 *The premium of EHI $\tilde{\pi}_{ehi}(w,m_{ehi},b)$ decreases when the firm offers higher wage w.*

Proof.

We calculate the premium of EHI when there is a marginal increase of Δ in w.

$$\begin{aligned}
&\tilde{\pi}_{ehi}(w+\Delta,m_{ehi},b)\\
=\;&\frac{\int_{\tilde{p}_{ehi}(w+\Delta,m_{ehi},\tilde{\pi},b)}^{\bar{p}}p\cdot m_{ehi}dF(p)}{\int_{\tilde{p}_{ehi}(w+\Delta,m_{ehi},\tilde{\pi},b)}^{\bar{p}}dF(p)}\\
=\;&\frac{\int_{\tilde{p}_{ehi}(w+\Delta,m_{ehi},\tilde{\pi},b)}^{\tilde{p}_{ehi}(w,m_{ehi},\tilde{\pi},b)}p\cdot m_{ehi}dF(p)+\int_{\tilde{p}_{ehi}(w,m_{ehi},\tilde{\pi},b)}^{\bar{p}}p\cdot m_{ehi}dF(p)}{\int_{\tilde{p}_{ehi}(w+\Delta,m_{ehi},\tilde{\pi},b)}^{\tilde{p}_{ehi}(w,m_{ehi},\tilde{\pi},b)}dF(p)+\int_{\tilde{p}_{ehi}(w,m_{ehi},\tilde{\pi},b)}^{\bar{p}}dF(p)}\\
<\;&\frac{\tilde{p}_{ehi}(w,m_{ehi},\tilde{\pi},b)m_{ehi}\cdot\int_{\tilde{p}_{ehi}(w+\Delta,m_{ehi},\tilde{\pi},b)}^{\tilde{p}_{ehi}(w,m_{ehi},\tilde{\pi},b)}dF(p)+\int_{\tilde{p}_{ehi}(w,m_{ehi},\tilde{\pi},b)}^{\bar{p}}p\cdot m_{ehi}dF(p)}{\int_{\tilde{p}_{ehi}(w+\Delta,m_{ehi},\tilde{\pi},b)}^{\tilde{p}_{ehi}(w,m_{ehi},\tilde{\pi},b)}dF(p)+\int_{\tilde{p}_{ehi}(w,m_{ehi},\tilde{\pi},b)}^{\bar{p}}dF(p)}\\
<\;&\frac{\frac{\int_{\tilde{p}_{ehi}(w,m_{ehi},\tilde{\pi},b)}^{\bar{p}}p\cdot m_{ehi}dF(p)}{\int_{\tilde{p}_{ehi}(w,m_{ehi},\tilde{\pi},b)}^{\bar{p}}dF(p)}\cdot\int_{\tilde{p}_{ehi}(w+\Delta,m_{ehi},\tilde{\pi},b)}^{\tilde{p}_{ehi}(w,m_{ehi},\tilde{\pi},b)}dF(p)+\int_{\tilde{p}_{ehi}(w,m_{ehi},\tilde{\pi},b)}^{\bar{p}}p\cdot m_{ehi}dF(p)}{\int_{\tilde{p}_{ehi}(w+\Delta,m_{ehi},\tilde{\pi},b)}^{\tilde{p}_{ehi}(w,m_{ehi},\tilde{\pi},b)}dF(p)+\int_{\tilde{p}_{ehi}(w,m_{ehi},\tilde{\pi},b)}^{\bar{p}}dF(p)}\\
=\;&\frac{\frac{\int_{\tilde{p}_{ehi}(w,m_{ehi},\tilde{\pi},b)}^{\bar{p}}p\cdot m_{ehi}dF(p)}{\int_{\tilde{p}_{ehi}(w,m_{ehi},\tilde{\pi},b)}^{\bar{p}}dF(p)}\cdot\int_{\tilde{p}_{ehi}(w+\Delta,m_{ehi},\tilde{\pi},b)}^{\tilde{p}_{ehi}(w,m_{ehi},\tilde{\pi},b)}dF(p)+\int_{\tilde{p}_{ehi}(w,m_{ehi},\tilde{\pi},b)}^{\bar{p}}p\cdot m_{ehi}dF(p)\cdot\frac{\int_{\tilde{p}_{ehi}(w,m_{ehi},\tilde{\pi},b)}^{\bar{p}}dF(p)}{\int_{\tilde{p}_{ehi}(w,m_{ehi},\tilde{\pi},b)}^{\bar{p}}dF(p)}}{\int_{\tilde{p}_{ehi}(w+\Delta,m_{ehi},\tilde{\pi},b)}^{\tilde{p}_{ehi}(w,m_{ehi},\tilde{\pi},b)}dF(p)+\int_{\tilde{p}_{ehi}(w,m_{ehi},\tilde{\pi},b)}^{\bar{p}}dF(p)}\\
=\;&\frac{\int_{\tilde{p}_{ehi}(w,m_{ehi},\tilde{\pi},b)}^{\bar{p}}p\cdot m_{ehi}dF(p)}{\int_{\tilde{p}_{ehi}(w,m_{ehi},\tilde{\pi},b)}^{\bar{p}}dF(p)}\cdot\frac{\int_{\tilde{p}_{ehi}(w+\Delta,m_{ehi},\tilde{\pi},b)}^{\tilde{p}_{ehi}(w,m_{ehi},\tilde{\pi},b)}dF(p)+\int_{\tilde{p}_{ehi}(w,m_{ehi},\tilde{\pi},b)}^{\bar{p}}p\cdot m_{ehi}dF(p)}{\int_{\tilde{p}_{ehi}(w+\Delta,m_{ehi},\tilde{\pi},b)}^{\tilde{p}_{ehi}(w,m_{ehi},\tilde{\pi},b)}dF(p)+\int_{\tilde{p}_{ehi}(w,m_{ehi},\tilde{\pi},b)}^{\bar{p}}dF(p)}\\
=\;&\frac{\int_{\tilde{p}_{ehi}(w,m_{ehi},\tilde{\pi},b)}^{\bar{p}}p\cdot m_{ehi}dF(p)}{\int_{\tilde{p}_{ehi}(w,m_{ehi},\tilde{\pi},b)}^{\bar{p}}dF(p)}=\tilde{\pi}_{ehi}(w,m_{ehi},b).
\end{aligned}$$

The first inequality comes from the fact that $\tilde{p}_{ehi}(w+\Delta,m_{ehi},\tilde{\pi}_{ehi},b)<\tilde{p}_{ehi}(w,m_{ehi},\tilde{\pi}_{ehi},b)$, since $\tilde{p}_{ehi}(w, m_{ehi}, \pi_{ehi}, b)$ decreases with w. The second inequality comes from the fact that type $\tilde{p}_{ehi}(w, m_{ehi}, \tilde{\pi}_{ehi}, b)$ is the most healthy type among workers $[\tilde{p}_{ehi}(w, m_{ehi}, \tilde{\pi}_{ehi}, b), \bar{p}]$.

■

Proposition 3 *Consider a match between the firm and worker with $x > b(x)$. If the productivity x is sufficiently low, there exists k^*. The firm will offer m_{ehi} such that $\frac{\psi \pi_{ehi}}{w} = k$, if $k > k^*$.*

Proof.

Based on the discussion above, the firm either offers $w = \max\{\underline{w}, b(x)\}$, or $w < b(x)$. Consider that the firm initially offers $w = b(x)$. When there is no regulations on firm's EHI provision decision, its profit is given by Π_1 defined in equation (12). The firm will offer $m_{ehi} = 0$ to minimize the cost of EHI.

If the firm offers $w' < b(x)$, the firm has to offer $m'_{ehi} > 0$, otherwise it will lose all workers. Its profit will be given by Π_2. The additional profit from offering $\{w', m'_{ehi}\}$ is given as follows.

$$\begin{aligned}
\Pi_2 - \Pi_1 = &\max_{w, m_{ehi}} \int_{\tilde{p}_{ehi}(w', m'_{ehi}, \pi'_{ehi}, b)}^{\bar{p}} \left[x - w' - (1-\psi) \cdot (1-\tau) \cdot \pi(w, m'_{ehi}, b)\right] dF(p) \\
&- \int_{\underline{p}}^{\bar{p}} [x - b(x)]\, dF(p) \\
= &- \int_{\underline{p}}^{\tilde{p}_{ehi}(w', m'_{ehi}, \pi'_{ehi}, b)} [x - b(x)]\, dF(p) \\
&+ \int_{\tilde{p}_{ehi}(w', m'_{ehi}, \pi'_{ehi}, b)}^{\bar{p}} \left[b(x) - w'\right] dF(p) \\
&- \int_{\tilde{p}_{ehi}(w', m'_{ehi}, \pi'_{ehi}, b)}^{\bar{p}} \left[(1-\psi) \cdot (1-\tau) \cdot \pi(w', m'_{ehi}, b)\right] dF(p).
\end{aligned}$$

The first term in the above expression captures the profit loss due to the departure of some healthy workers. They don't value EHI as much since the reduced wage pushes up their marginal utility from consumption. The second term represents the gain from lower wage rate. While the third term defines the cost associated with offering EHI of m'_{ehi}.

When x is sufficiently low, the wage rate decreases since $b'(x) > 0$. Due to the imperfectly tradability of health, the worker's optimal health spending approaches to zero once health shock hits. In such case, the value of $\tilde{p}_{ehi}(w', m'_{ehi}, \pi'_{ehi}, b)$ goes to $\bar{p}$. When the density of $\varphi_p(p)$ declines with p, the first and third terms in the above expression dominate the second one. It implies that the firm is better off by offering $w = b(x)$ with a profit of Π_1.

Now consider that the the firm is subject to both a minimum quality standard $m_{ehi} \geq \underline{m} > 0$, and an affordability standard $k > 0$ limiting the share of a worker's wage that EHI premia payments comprise, $\frac{\psi \pi_{ehi}}{w} \leq k$. There are tax penalties τ_{min} and τ_{max} when the firm violates these regulations. The firm's problem is to minimize the cost of EHI, since a wage of $w = b(x)$

will attract all workers.

$$\min_{m_{ehi}} \int_{\tilde{p}_{ehi}(w,m_{ehi},\pi_{ehi},b)}^{\bar{p}} [(1-\psi)\cdot(1-\tau)\cdot\pi(w,m_{ehi},b)]\,dF(p)$$
$$+\tau_{min}\cdot\mathbf{1}_{m_{ehi}<\underline{m}}+\tau_{max}\cdot\mathbf{1}_{\frac{\psi\pi_{ehi}}{w}>k}$$

In the absence of penalties τ_{min} and τ_{max}, the firm's cost of offering EHI presents a hump shape in terms of m_{ehi}. When the firm gradually increase the amount of EHI offered m_{ehi}, the unit cost of insurance rises. It also leads to a lower EHI takeup ratio. This is because $\tilde{p}_{ehi}(w, m_{ehi}, \pi_{ehi}, b)$ increases with π_{ehi}. When the value of m_{ehi} becomes sufficiently large, the raising premium π will push $\tilde{p}_{ehi}(w, m_{ehi}, \pi_{ehi}, b)$ toward to $\bar{p}$, which reduces the total cost of EHI.

Given $\underline{m}$, there must exist k^* such that the total cost of offering EHI with $\frac{\psi\pi_{ehi}}{w} = k^*$ is equivalent to offering $m_{ehi} = \underline{m}$. If $k > k^*$, the firm will offer m_{ehi} such that $\frac{\psi\pi_{ehi}}{w} = k$. By doing so, the firm induces $\tilde{p}_{ehi}(w, m_{ehi}, \pi_{ehi}, b) \to \bar{p}$. Hence it minimizes the direct cost of offering EHI and avoids the tax penalty τ_{max}.

■

Proposition 4 *As x increases, there will exist a $x(k)$ such that for $x < x(k)$, the firm will offer $w = b(x)$ and set $\frac{\psi\pi_{ehi}}{w} = k$. There will be increased take-up of EHI. At $x = x(k)$, there will be a switch to either $\underline{m}$ or to interior offer, where marginal hire takes EHI.*

Proof.

For the firm with productivity x sufficiently low, it follows immediately the argument in previous proposition that the firm will offer $w = b(x)$ and set $\frac{\psi\pi_{ehi}}{w} = k$.

As x increases, the wage rate increases as well since $b'(x) > 0$. Accordingly the value of $\tilde{p}_{ehi}(w, m_{ehi}, \pi_{ehi}, b)$ decreases, which raises the cost of offering EHI. There must exist a threshold value of $x(k)$ such that the total cost of EHI is sufficiently large. It becomes cheaper to offer $m_{ehi} = \underline{m}$, or interior offer, where marginal hire takes EHI, see Proposition below.

■

Proposition 5 *Consider a match between the firm and worker with $x > b(x)$. If the productivity x is sufficiently high, the firm will offer $w < b(x)$ and $m_{ehi} > 0$.*

Proof.

We want to show that the firm can gain some profit by offering $w = b(x) - \varepsilon$ and $m_{ehi} \in (0, \varepsilon)$, where $\varepsilon > 0$, compared with offering a compensation $w' = b(x)$ and $m'_{ehi} = 0$. The firm's additional profit is specified as follows

$$\begin{aligned}\Pi_2 - \Pi_1 \geq & - \int_{\underline{p}}^{\tilde{p}_{ehi}(w,m_{ehi},\pi_{ehi},b)} [x - b(x)]\, dF(p) \\ & + \int_{\tilde{p}_{ehi}(w,m_{ehi},\pi_{ehi},b)}^{\bar{p}} \varepsilon dF(p) \\ & - \int_{\tilde{p}_{ehi}(w,m_{ehi},\pi_{ehi},b)}^{\bar{p}} [(1-\psi)\cdot(1-\tau)\cdot\pi(w, m_{ehi}, b)]\, dF(p)\end{aligned}$$

where the inequality comes from the fact that the firm chooses optimal combination of w and m_{ehi}. When $\varepsilon \to 0$, the value of $\tilde{p}_{ehi}(w, m_{ehi}, \pi_{ehi}, b)$ is approximately equal to $\frac{u'(b)}{u'(b)+u'(b-m_b^*)}$, which gets sufficiently small as b increases with x. Now the second term will dominate and we have $\Pi_2 > \Pi_1$. The firm will prefer to offer wage rate $w < b(x)$.

■

Proposition 6 *When the productivity x is sufficiently high, and tax subsidy to EHI τ is sufficiently generous, the firm may offer excessive m_{ehi}.*

Proof.

When the productivity x is sufficiently high, the firm's problem is given by equation (13). We can derive the firm's FOC w.r.t w and m_{ehi} as follows.

$$\int_{\tilde{p}_{ehi}(w,m_{ehi},\pi_{ehi},b)}^{\bar{p}} (1-\psi)(1-\tau)\frac{\partial \pi_{ehi}}{\partial w} dF(p) = -\left[x - w - (1-\psi)(1-\tau)\pi_{ehi}\right] \varphi_p(\tilde{p}_{ehi})\frac{\partial \tilde{p}_{ehi}}{\partial w}. \tag{16}$$

$$\int_{\tilde{p}_{ehi}(w,m_{ehi},\pi_{ehi},b)}^{\bar{p}} (1-\psi)(1-\tau)\frac{\partial \pi_{ehi}}{\partial m_{ehi}} dF(p) = -\left[x - w - (1-\psi)(1-\tau)\pi_{ehi}\right] \varphi_p(\tilde{p}_{ehi})\frac{\partial \tilde{p}_{ehi}}{\partial m_{ehi}}. \tag{17}$$

Assume that the social planner assigns equal weights to both the firm and workers, we have the social planner's FOC w.r.t w^s and m^s_{ehi} below.

$$\begin{aligned}&\int_{\tilde{p}_{ehi}(w^s,m^s_{ehi},\pi^s_{ehi},b)}^{\bar{p}} (1-\psi)(1-\tau)\frac{\partial \pi_{ehi}}{\partial w^s} dF(p) + \left[x - w^s - (1-\psi)(1-\tau)\right] \varphi_p(\tilde{p}_{ehi})\frac{\partial \tilde{p}_{ehi}}{\partial w^s} \\ =&\mathbf{E}u(\tilde{p}_{ehi})\varphi_p(\tilde{p}_{ehi})\frac{\partial \tilde{p}_{ehi}}{\partial w^s} - \int_{\tilde{p}_{ehi}(w^s,m^s_{ehi},\pi^s_{ehi},b)}^{\bar{p}} \frac{\partial\left[\mathbf{E}u(p)\right]}{\partial w^s} dF(p)\end{aligned} \tag{18}$$

$$\begin{aligned}&\int_{\tilde{p}_{ehi}(w^s,m^s_{ehi},\pi^s_{ehi},b)}^{\bar{p}} (1-\psi)(1-\tau)\frac{\partial \pi_{ehi}}{\partial m^s_{ehi}} dF(p) + \left[x - w^s - (1-\psi)(1-\tau)\right] \varphi_p(\tilde{p}_{ehi})\frac{\partial \tilde{p}_{ehi}}{\partial m^s_{ehi}} \\ =&\mathbf{E}u(\tilde{p}_{ehi})\varphi_p(\tilde{p}_{ehi})\frac{\partial \tilde{p}_{ehi}}{\partial m^s_{ehi}} - \int_{\tilde{p}_{ehi}(w^s,m^s_{ehi},\pi^s_{ehi},b)}^{\bar{p}} \frac{\partial\left[\mathbf{E}u(p)\right]}{\partial m^s_{ehi}} dF(p).\end{aligned} \tag{19}$$

From equations (16, 17), we observe that the firm trade-off between extra cost of better wage

/ EHI and additional profit from marginal workers who accept the job offer. By comparing equation (16) with (18), the competitive firm does not take into account two effects when it offers more generous m_{ehi} or w. First, it benefit the marginal workers with health type $\tilde{p}_{ehi}$. Secondly, it also benefit existing workers.

Note in equilibrium, when the firm (or the government) offer better wage w, it must reduce EHI m_{ehi}. When the tax subsidy is sufficiently high, the firm would rather offer better m_{ehi} as it cost $(1-\psi)(1-\tau)\pi_{ehi}$ per unit of m_{ehi}. Since the firm does not internalize the social benefit of higher wage, w offered by the firm must lower than w^s from the social planner. Conversely, the EHI m_{ehi} offered by the firm must be more generous than m^s_{ehi} from the social planner.

■

4.1 Numerical illustration

We consider a parametric example to illustrate our results. We consider a CRRA preference: $u(c)+\theta(h)=\frac{c^{1-\sigma_1}}{1-\sigma_1}+\gamma\frac{h^{1-\sigma_2}}{1-\sigma_2}$. The health production function takes the form: $g(m)=\frac{1}{1+a_m\frac{m}{\bar{\epsilon}}}$. The health type follows a Beta distribution with density function $\varphi_p=\frac{\Gamma(\alpha+\beta)}{\Gamma(\alpha)\Gamma(\beta)}p^{\alpha-1}(1-p)^{\beta-1}$.

Figure 3 plots the profit curve of the firm as a function of EHI (m_{ehi}) offered in equilibrium. When the worker's productivity is sufficiently low, shown in the upper panel, the firm's profit decreases with the EHI offered initially. When EHI offered gets sufficiently generous, the cost of EHI becomes burdensome to the worker and the take-up rate of EHI drops. Then the cost of offering EHI decreases and the firm's profit eventually pick up. On the other hand, when the worker's productivity becomes sufficiently high, the firm's profit increases with EHI offered and the wage rate drops. Eventually the cost of offering EHI picks up and the profit decreases.

Figure 3: Profit, by firm type

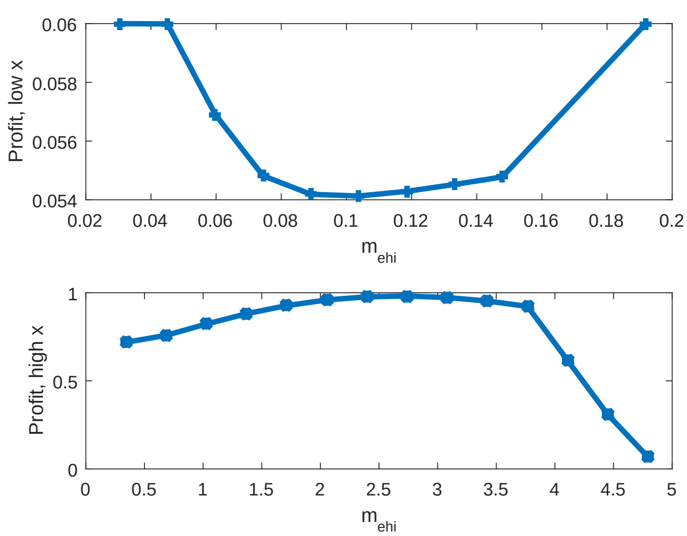


Figure 4: Wage rate, by firm type

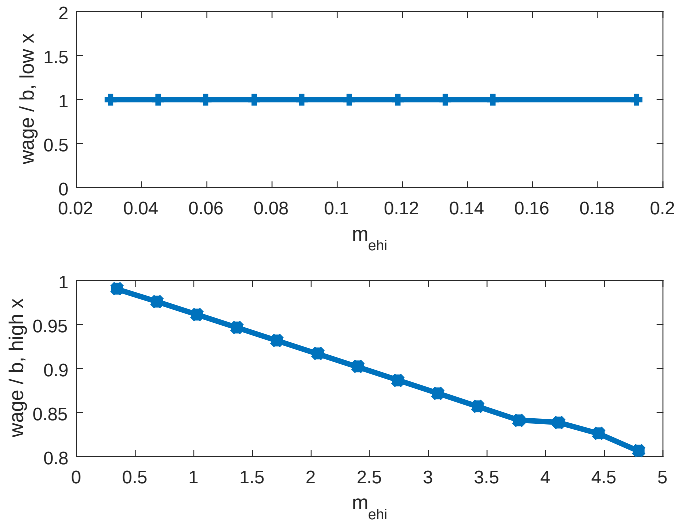
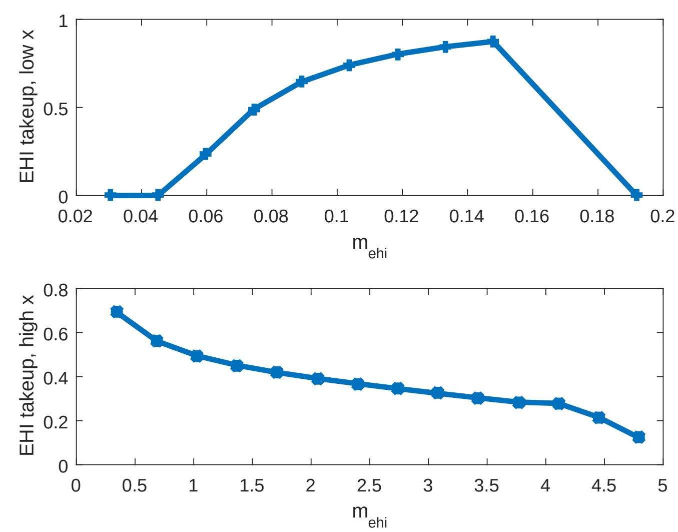


Figure 5: EHI take-up, by firm type



5 Empirical analysis

The model we developed above generates sharp predictions regarding to the firm's EHI offering decision and worker's insurance take up behavior. In this section, we test the main implications of the model. We use the Survey of Income and Program Participation (SIPP), which collects information from the non institutionalized resident population living in the United States. For the purpose of our study, we use data collected in wave 6 of the 2008 panel of the SIPP, which was fielded between May and August 2010 and included a topical module on employment based health insurance, labor force, earning, etc.[5] After dropping data point with missing value, our dataset has 88,155 observations. In what follows, we first present the theoretical predictions of the model and then summarize the findings from data.

Prediction 1: Larger firms are more likely to offer EHI to their employees.[6]

From the data set we use, we find that of individuals who worked for employers with fewer than 25 employees, 27.8 percent had health insurance coverage through their current employers. In comparison, the participation rates increased with firm size, with 63.6 percent for firms with 1,000 or more employees. Among the smallest private sector establishments, 32 percent of workers participating in medical care plans were covered by high-deductible plans in 2011. In contrast, only 12 percent of workers in the largest establishments were covered by such plans.

Prediction2: Low skilled workers are less likely to be offered with EHI.

The data suggest that 42.9 percent of individuals who did not complete high school worked for an employer that offered health insurance to any of its employees. While there are 78.9 individuals with a college degree worked for an employer does offer EHI.

We also find that management and professional workers were the most likely to be offered (89.4 percent) and covered (76.8 percent) by EHI. In contrast, service occupations had only moderate offer (61.1 percent) and coverage (55.0 percent) rates.

Prediction 3: Low skilled workers are more likely to decline EHI offers.

Among workers whose employer offered health insurance benefits to any of its employees, a smaller proportion of workers with a college degree or higher (18.5 percent) were uninsured than high school graduates (33.3 percent) or workers with less than a high school diploma (43.6 percent).

5.1 Implications for the ACA

The Affordable Care Act (hereafter, ACA), signed into law by President Barack Obama in March 2010, represents the most significant reform to the U.S. health insurance and health care markets since the establishment of Medicare in 1965. One of the most significant changes of ACA is "Employer Mandate". After 2014, employers with 50 or more full-time employees will be required to provide health insurance or pay a fine of $2,000 per worker each year if they do not offer health insurance, where the fines would apply to the entire number of employees minus some allowances. Coverage must be of minimum value, which is defined as "at least 60% of

[5]The 2008 SIPP Panel is the most recent data available. The 2014 Panel began to collect data in February 2014. Once this new panel is released, we can test the model's implications for the ACA.

[6]Here the size of the firm is an imperfect proxy to the productivity of the firm as in our theoretical model.

the total cost of medical services for a standard population." In addition, employer-sponsored plans have to include "substantial coverage" for "inpatient hospital and physician services." As long as a company adheres to the minimum value requirement for its full-time staff, it won't be charged a penalty fee. Based on our theoretical framework developed and the Propositions we established in previous sections, we generate some interesting testable hypothesis.

Hypothesis 1: Consider firms with sufficiently low x, the rejection rate of EHI will rise with more extensive EHI (to meet the minimum value requirement of the ACA) offered by the firm.

Hypothesis 2: Firms with sufficiently low x may have incentive to offer more extensive EHI as a response to employer mandate and minimum value of EHI required by the ACA.

Hypothesis 3: Firms with sufficiently high x may over-provide EHI to benefit from the tax subsidy.

Hypothesis 4: Health insurance exchange may suffer from server adverse selection problem as more lower skilled workers reject EHI.

Hypothes 1 and 2 follow the argument in Proposition 3. Hypothese 3 comes from Proposition 4 and 5. We leave it as future research to testing these hypothesis once the post-ACA data becomes available.

6 Conclusion

In this paper, we formulate the notion of imperfectly tradability of health. This is very different from the tradability discussed in traditional trade and international finance literature. More specifically, consumer can "buy" health, but not "sell" it. The fundamental reasons are due to the lack of legal market and the limitation of the current medical technology. First, there does not exist legal market that allows agents to buy and sell human organs. Second, there is no such technology that allows one person to improve the other person's health (reducing the other's BMI, blood pressure, cholesterol levels, etc.) by transferring some of his/her health (increasing his/her own BMI, blood pressure, cholesterol levels, etc.) directly.

This imperfectly tradability of health has significant impact on consumer's health insurance decision. When the health insurance becomes part of the compensation package offered by the firm as in the US economy, the imperfect tradability of health will affect the firm and worker's labor market decision and health insurance choice. In order to understand these effects, we build up a matching model with heterogeneous firms and workers with heterogeneous productivities. Workers are also subject to an idiosyncratic health shock, which is unobservable to the firm. We abstract away from any other frictions so that we can focus on the impacts of imperfectly tradability of health on firm and worker's labor market decisions. Our model provides sharp theoretical predictions: when the firm's productivity goes up, then wage rate goes up, the amount of EHI offered goes up, and the fraction of workers accept EHI goes up. We test our model using the sixth wave of the 2008 Survey of Income and Program Participation (SIPP) panel. Our model reconciles a host of empirical regularities.

We also apply our theory to analyze the potential impact of the ACA on labor market allocation. Our theory suggested that firms with sufficiently low productivity may have incentive to offer more extensive EHI as a response to employer mandate and minimum value of EHI required by the ACA. While firms with sufficiently high productivity may over-provide EHI to benefit from the tax subsidy. Finally, the health insurance exchange may suffer from server adverse selection problem as more lower skilled workers reject EHI. We leave the testing of these hypotheses as future research when more post-ACA data become abundant.

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