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Zhigang Feng

*University of Nebraska at Omaha, [zfeng@unomaha.edu](mailto:zfeng@unomaha.edu)*

Kai Zhao

*The University of Connecticut*

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# Employment-based health insurance and aggregate labor supply<sup>☆</sup>

Zhigang Feng<sup>a,\*</sup>, Kai Zhao<sup>b</sup>

<sup>a</sup> Department of Economics, University of Nebraska at Omaha, NE 68106, United States

<sup>b</sup> Department of Economics, The University of Connecticut, Storrs, CT 06269-1063, United States

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## ABSTRACT

We study the impact of the U.S. employment-based health insurance system on the employment rate, the shares of full-time/part-time workers, and aggregate hours worked in a general equilibrium life cycle model with incomplete markets and idiosyncratic risks in both income and medical expenses. In contrast to most Europeans, who get universal health insurance from the government, most working-age Americans get health insurance through their employers. We find that the employment-based health insurance system provides Americans with an extra incentive to work and work full-time. In a calibrated version of the model, we assess the extent to which the different health insurance systems account for the differences in employment rate and full-time/part-time shares of workers between the U.S. and European countries. Our quantitative results suggest that the different health insurance systems can account for a significant fraction of the differences in employment rate and full-time/part-time shares of workers between the two regions. In addition, we find that the employment-based health insurance system is one of the reasons why many Americans work more than Europeans.

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## 1. Introduction

There are substantial differences in the labor supply behaviors of Americans and Europeans. For instance, using data from the OECD Labor Market Database (2000), we find that the employment rate for the working-age population in the United States is 76.9%, while it is only 66.8%, on average, in major European countries (see Table 1).<sup>1</sup> In addition, among the American workers, 91.1% of them are working *full-time*, while this number is only 84.0% in these European countries. These facts together imply that the share of the working-age population that is working *full-time* in the U.S. is much higher than

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\* Corresponding author.

E-mail addresses: [z.feng2@gmail.com](mailto:z.feng2@gmail.com) (Z. Feng), [kai.zhao@uconn.edu](mailto:kai.zhao@uconn.edu) (K. Zhao).

<sup>1</sup> Here the major economies include France, Germany, UK, and Italy, which are the four largest economies in Europe. As shown in Table 15 in the appendix, the statement remains true when the comparison is extended to include other developed European countries.

**Table 1**  
Employment rate and the full-time share: U.S. vs. major European countries.

	Employment rate (%)	Full-time workers (as % of all workers)	Full-time workers (as % of the working-age popu.)
U.S.	76.9	91.1	70.1
France	67.3	85.8	57.7
Germany	68.7	82.6	56.8
Italy	57.6	88.4	50.9
UK	73.7	79.2	58.4
Average(Major 4)	66.8	84.0	55.9

Data source: OECD labor market data (2000).

that in European countries: 70.1% versus 55.9%. On the other hand, it is well-noted that there exists significant difference between the U.S. and European countries regarding how health care is delivered, especially for the working-age population. In this paper, we quantitatively evaluate the extent to which the different health care systems can account for the different employment rates and full-time/part-time shares between the U.S. and Europe.

The U.S. features a unique employment-based health insurance system for its working-age population (hereafter EHI).<sup>2</sup> In contrast to most Europeans, who get universal health insurance from the government, most working-age Americans get health insurance through their employers. Since medical care expenses are quite sizable and volatile, and there is no good alternative health insurance available in the private market, EHI can be highly valuable to risk-averse agents (much more than its actuarially fair cost). In addition, the value of EHI is amplified by a unique feature of U.S. tax policy—its cost is exempted from income taxation. Since, for the most part, only full-time workers are offered EHI, working-age Americans have a stronger incentive than Europeans to work and to work full-time.<sup>3</sup>

What are the effects of EHI on worker's decision of working or not and the choice between working full-time and part-time? Can the different health insurance systems account for the different employment rates and full-time/part-time shares between the U.S. and Europe? To address these questions, we develop a general equilibrium life-cycle model with endogenous labor supply and idiosyncratic risks in both income and medical expenses.<sup>4</sup> In terms of modeling, this paper is closely related to a number of recent papers that study an extended incomplete-markets model with uncertain medical expenses.<sup>5</sup> We calibrate the model to the key moments of the current U.S. economy. In particular, our benchmark model economy captures the key feature of the U.S. health insurance system: EHI for the working-age population and the universal government-provided public health insurance for the elderly. Then, we construct a counterfactual economy by replacing EHI in the benchmark model with a government-financed universal health insurance program that mimics the European system.<sup>6</sup> We find that when EHI is replaced by a universal health insurance system financed by additional lump-sum taxes, the model-generated changes in the employment rate and the full-time/part-time shares of workers are fairly consistent with the empirical regularities documented for the U.S. and European countries. That is, as the health insurance system is changed, the employment rate decreases by 5%, and the share of workers that are working full-time drops by 5%. These changes together imply that the full-time employment rate declines by 8% in the model.

Our paper is related to a recently growing literature that uses quantitative macroeconomic models to account for the different aggregate hours worked in the U.S. and Europe.<sup>7</sup> It is well known that there is a substantial difference in aggregate hours worked between the US and Europe (see Prescott, 2004; Rogerson, 2006). For instance, the aggregate hours worked per person (aged 20–64) in the United States are approximately a third higher than in the major European economies (see Table 2).<sup>8</sup> Why do Americans work so much more than Europeans? This question has attracted increasing attention from macroeconomists, partly due to the importance of aggregate labor supply in the macroeconomy. While our analysis focuses on the cross-country differences in employment rate and full-time/part-time share of workers, it is worth noting that our findings also contribute to the understanding of the cross-country difference in aggregate hours worked. This is because the employment rate and the full-time/part-time share often play an important role in shaping the aggregate labor supply of

<sup>2</sup> Note that this paper focuses on the U.S. economy before the Affordable Care Act reform.

<sup>3</sup> For instance, Farber and Levy (2000) estimate that the chance of being provided with employer-sponsored health insurance was less than 10% for new jobs that require less than 35 hours of work per week.

<sup>4</sup> A contemporary paper by Laun and Wallenius (2013) also captures the role of health in understanding the cross-country difference in labor supply, but it features a very different model and, thus, emphasizes different mechanisms. In it, Laun and Wallenius develop a life-cycle model with endogenous health investment and study how public health insurance affects the level of health investment and, thus, the labor supply decision. In contrast, we emphasize the uncertainty of medical expenses in an incomplete market model with medical expense shocks, and we focus on the insurance value of EHI and its link to labor supply decisions.

<sup>5</sup> Such as Jeske and Kitao (2009), De Nardi et al. (2010), Kopecky and Koreschkova (2014), Hansen et al. (2014), Pashchenko and Porapakarm (2013), Janicki (2014) Nakajima and Tuzemen (2014), and Jung and Tran, 2016.

<sup>6</sup> In the U.S., over 90% of insured working-age people obtain health insurance from their employer. In Europe, while health care is provided through a wide range of different systems across countries, these systems are primarily publicly funded through taxation, which are in spirit similar to a universal health insurance system (Hsiao and Heller, 2007).

<sup>7</sup> (Chakraborty et al., 2015; Erosa et al., 2012; Gunner et al., 2012; Ohanian et al., 2008; Prescott, 2004; Rogerson, 2006; 2007; Wallenius, 2013), etc.

<sup>8</sup> As shown in Table 14 in the appendix, the statement remains true when the comparison is extended to include other developed European countries.

**Table 2**  
Aggregate hours worked: U.S. vs. four Major European countries.

	Annual hours worked per person (Age 20–64)	Compared to the US (US=1)
U.S.	1554	1
France	1253	0.80
Germany	1280	0.82
Italy	1123	0.72
UK	1410	0.90
Average (Major 4)	1267	0.81

Data source: OECD labor market data (2000).

the economy. For instance, we conduct a simple back-of-the-envelope decomposition calculation in the appendix, and find that over two thirds of the difference in aggregate hours worked between the U.S. and four major European countries can be attributed to the difference in their employment rates and full-time/part-time shares of workers.<sup>9</sup>

In our main quantitative exercise, we find that when EHI is replaced by a universal health insurance system financed by additional lump-sum taxes, the aggregate hours worked in the model decrease by 9%. This suggests that different health insurance systems can account for a significant portion of the difference in aggregate hours worked between the U.S. and the four major European countries. It is important to note that our study abstracts from explicitly modeling health status and its dynamics as an endogenous outcome of behavioral choices and policies.<sup>10</sup> While it greatly simplifies our analysis, this modelling strategy may miss another potential effect of health insurance on labor supply, that is, universal health insurance can improve health status of working-age individuals, which in turn increases their labor supply. If this effect is quantitatively significant, our finding on the impact of EHI on aggregate labor supply would be biased upward. Furthermore, we want to mention that there are other country specific institution and policy differences contributing to the observed cross-country variations in labor supply decision. For example, Erosa et. al (2012) consider a rich set of government programs including social security, disability insurance and taxation. By focusing on health insurance system, we are able to provide sharp intuition regarding to how EHI affects the worker's decision to work or not and their choice between full time and part time job. But this comes with a cost of missing the potential interactions between health insurance policies and other government program.<sup>11</sup>

There exists a large body of empirical literature that study the impacts of health insurance on individual's labor supply decisions. They find that the impacts are significant, and these effects vary with income level, age groups and other idiosyncratic characteristics.<sup>12</sup> For instance, Garthwaite et al. (2014) find that there is a 4.6 percentage-point increase in employment for childless adults in Tennessee following the TennCare disenrollment. Rust and Phelan (1997) estimate that retiree health insurance increases the probability of retiring before age 65 by 12 to 29%, while Blau and Gilleskie (2001) estimate effects ranging from 26 to 80%.

Our study indicates that the difference in health insurance systems is an important factors explaining the difference in aggregate labor supply between the U.S. and the four major European countries. In section 4.1, we report that the employment rate will decrease from 78% to 73% and the share of full-time workers drops from 86% to 81% when EHI is replaced with a universal health insurance system financed by additional lump-sum tax. We also find that the availability of health insurance has stronger impact on older worker's labor supply decision. The empirical studies aforementioned usually focus on one specific subgroup of the population. In contrast, we build up a large-scale general equilibrium life-cycle model featuring rich individual heterogeneities, such as age, education, persistent and transitory earning shocks and health risk. Hence, our analysis complements the existing empirical literature by providing an aggregate analysis of the labor market effects of EHI. In addition, as we argued previously, EHI may affect aggregate labor supply via several margins/mechanisms, such as labor participation decision, full-time/part-time choice, and the job lock effect. These mechanisms often overlap and interact with each other. Most of the existing empirical studies only focus on a subset of the mechanisms, and thus their

<sup>9</sup> The details of the decomposition calculation can be found in the appendix.

<sup>10</sup> Following the growing literature studying quantitative macro models with health risks, we model health expenditure as an exogenous shock, which is estimated from MEPS dataset. However, it is worth noting that the purchases of medical care services are to some extent individual choices. In particular, it is known that uninsured Americans may reduce their out of pocket medical expenses by postponing treatments, using cheaper but low-quality services, or abusing the emergency rooms, although all these options do not come without a cost. Furthermore, the provision of health insurance will affect individual's health behavior and hence the evolution of their health spending shock, see Cole, Kim and Kruger (2017) for EHI and individual health behavior, and Michaud and Wiczer (2018, 2018) for disability insurance and employment-related health problems. We abstract away from these issue due to the lack of quality data on cross country individual health behavior, and to maintain the tractability. We conjecture that incorporating health behavior and endogenous health expenditure shock will slightly weaken our results. Consider that the economy replaces the EHI with a universal health insurance. Based on Cole, Kim and Kruger (2017), better insurance coverage will induce unhealthy behavior. This implies that the actual health expenditure risk increases. Consequently, households respond with slightly higher labor supply than our model suggested. At the same time, there will be more workers take jobs with higher occupational hazard based on Michaud and Wiczer (2014, 2016).

<sup>11</sup> We thank a referee for commenting on this point.

<sup>12</sup> See Blau and Gilleskie (2006); Buchmueller and G.Valletta (1999); French and Jones (2011); Garthwaite et al. (2014); Rust and Phelan (1997), and among others.

findings cannot provide direct evidence on the aggregate impact of EHI. We capture all these mechanisms. Furthermore, our general equilibrium model allows factor prices and the price of health insurance to be endogenously determined and thus also captures the general equilibrium effects of EHI on labor market decisions. Moreover, our research provides the first evidence that EHI is an important factor to explain the cross-Atlantic labor supply difference.

The rest of the paper is organized as follows. In Section 2, we specify the model. We calibrate the model in Section 3 and present the main quantitative results in Section 4. We provide further discussion on related issues in Section 5 and sensitivity analysis in Section 6, and conclude in Section 7.

## 2. The model

### 2.1. The individuals

Consider an economy inhabited by overlapping generations of agents whose age is  $j = 1, 2, \dots, T$ . In each period, agents are endowed with one unit of time that can be used for either work or leisure. They face idiosyncratic labor productivity shocks, and medical expense shocks in each period over the life cycle.<sup>13</sup> An agent's state in each period can be characterized by a vector  $s = \{j, a, m, e_h, h, y, v, e\}$ , where  $j$  is age;  $a$  is assets;  $m$  is the current medical expense;  $\{y, v\}$  are the persistent and transitory productivity shocks;  $e$  is the education level;  $e_h$  indicates whether EHI is provided; and  $h$  indicates whether the agent is currently covered by EHI. Before the retirement age  $R$  ( $j \leq R$ ), agents simultaneously make consumption, labor supply, and health insurance decisions in each period to maximize their expected lifetime utility, and this optimization problem can be formulated recursively as follows:

(P1)

$$V(s) = \max_{c, l, h'} u(c, l) + \beta P_j E[V(s')] \tag{1}$$

subject to

$$\frac{a'}{1+r} + c + (1 - \kappa(h, m_d))m + ph' = a + \tilde{w}(l)e\epsilon l + tr - \tau(\tilde{w}(l)e\epsilon l - ph') \tag{2}$$

$$l \in \{0, l_p, l_f\}, c \geq 0, \text{ and } a' \geq 0$$

$$\begin{cases} h' \in \{0, 1\} & \text{if } l = l_f \text{ and } e_h = 1 \\ h' \in \{0\} & \text{otherwise.} \end{cases} \tag{3}$$

Here,  $V$  is the value function, and  $u(c, l)$  is the utility flow in the current period, which is a function of consumption  $c$  and labor supply  $l$ .  $\beta$  is the discounting factor, and  $P_j$  represents the conditional survival probability to the next period. Eq. (2) represents the budget constraint facing the agent. The right-hand side of the equation captures all the resources available—that is, assets held at the beginning of the period, welfare transfer  $tr$ , and labor earnings minus the tax payment  $\tau(\cdot)$ , which is a non-linear function of taxable income and will be discussed later.<sup>14</sup> The left-hand side of the equation shows that the resources are allocated among consumption, out-of-pocket medical expenses, insurance premium (if any), and saving for the next period.

We assume that there are three labor supply choices: full-time, part-time, and no work. Note that Eq. (3) captures the key feature of the model. That is, if the agent chooses to work full-time and the job comes with EHI ( $e_h = 1$ ), the agent would be eligible to buy EHI for the next period, which covers a fixed fraction of the total medical expenses and requires a premium payment  $p$ . Note that the premium payment is exempted from taxation (as shown in the right-hand side of the budget constraint above).<sup>15</sup> Following Jeske and Kitao (2009), we assume that the wage rate is simply  $\tilde{w}(l) = w(l) - c_e$  if EHI is offered and the agent works full-time, and  $\tilde{w}(l) = w(l)$  if otherwise. Here,  $c_e$  represents the fraction of the health insurance cost paid by the employer, which is transferred back to the worker via a reduced wage rate. In addition, we follow French (2005) and Rogerson and Wallenius (2013), and adopt the idea of non-linear wages. That is, the wage rate is increasing in hours worked,  $w(l) = w_0 l^\theta$ . The value of  $\theta$  will be calibrated to match the shares of full-time/part-time workers in the data.

The health insurance coinsurance rates facing working-age agents are represented by  $\kappa(h, m_d)$ , which depends on whether the agent is covered by EHI (denoted by  $h$ ) and whether she is qualified for Medicaid (denoted by  $m_d$ ). Specifically,  $\kappa(h, m_d) = \kappa_h$  if  $h = 1$  and  $m_d = 0$ ,  $\kappa(h, m_d) = 1$  if  $m_d = 1$ , and  $\kappa(h, m_d) = 0$  if otherwise. The eligibility of the Medicaid program will be specified in the next section. Note that, in this economy, agents face mortality risks in each period over the life cycle, thus, may die with positive assets—i.e., accidental bequests. We assume that they are equally redistributed back to the new-born agents in each period, which become their initial assets.

<sup>13</sup> Medical expense shocks are age-specific, and their detailed nature is specified in Section 3.3.

<sup>14</sup> The welfare transfer will be specified in details in Section 2.2.

<sup>15</sup> This is an important feature of the U.S. tax policy. For a detailed analysis of this issue, please see Jeske and Kitao (2009), Huang and Huffman (2018).

After retirement ( $j > R$ ), agents live on their own savings and Social Security payments  $SS(e)$ , which depend on their education level.<sup>16</sup> In each period, retirees make the consumption and saving decision to maximize their expected lifetime utility,

(P2)

$$V(s) = \max_c u(c, 0) + \beta P_j E[V(s')] \quad (4)$$

subject to

$$\frac{a'}{1+r} + c + (1 - \kappa_r(m_d))m = a + SS(e) + tr \quad (5)$$

$c \geq 0$ , and  $a' \geq 0$ .

Here the coinsurance rates facing retirees are captured by  $\kappa_r(m_d)$ . It is equal to  $\kappa_m$ , the coinsurance rate of the Medicare program, if the agent is not eligible for Medicaid. Otherwise the value of  $\kappa_r(m_d)$  is set to one.

The log of the idiosyncratic labor productivity shock  $\epsilon$  is determined by the following equation:

$$\ln \epsilon = b_j + y + v, v \sim N(0, \sigma_v^2), \quad (6)$$

where  $b_j$  is the deterministic age-specific component,  $v$  is the transitory shock, and  $y$  is the persistent shock that is governed by a three-state Markov chain. The Markov chain is approximated from the AR(1) process

$$y' = \rho y + u', u' \sim N(0, \sigma_u^2), \quad (7)$$

where  $\rho$  is the persistence coefficient. The medical expense shock  $m$  is age-specific and is assumed to be governed by a six-state Markov chain that will be calibrated using the Medical Expenditure Panel Survey (MEPS) dataset. Medical expense shocks are assumed to be independent of labor productivity shocks.<sup>17</sup>

The distribution of the individuals is denoted by  $\Phi(s)$ , and it evolves over time according to the equation  $\Phi' = R_\Phi(\Phi)$ . Here,  $R_\Phi$  is a one-period operator on the distribution, which is specified in the calibration section.

## 2.2. The government

There are four government programs: Social Security, Medicare, the consumption floor, and the Medicaid program.<sup>18</sup> The Social Security program provides agents with annuities after retirement, which are financed by payroll taxes. The Medicare program provides health insurance to the retirees by covering a  $\kappa_m$  portion of their medical expenses, and it is financed by payroll taxes.

The consumption floor program is financed by tax revenues and it guarantees a minimum consumption floor  $\underline{c}$  for everyone by conditioning the welfare transfer  $tr$  on each agent's total resources (net of medical expenses). That is,

$$\begin{cases} tr(s, l) = \max\{\underline{c} + (1 - \kappa(h, m_d))m - \tilde{w}(l)e \in l + \tau[\tilde{w}(l)e \in l] - a, 0\} & \text{if } j \leq R \\ tr(s) = \max\{\underline{c} + (1 - \kappa_r(m_d))m - SS(e) - a, 0\} & \text{if } j > R \end{cases}$$

The Medicaid program is a means-tested public health insurance program, and a working-age agent is qualified for this program (i.e.,  $m_d = 1$ ) if her income and assets are below certain thresholds. We assume that the agent is automatically enrolled in the Medicaid program if  $\tilde{w}e \in l(s) \leq \Theta_{income}$ ,  $a \leq \Theta_{asset}$ .

The government budget constraint is specified as follows:

$$\begin{cases} \int_1^R [tr(s, l(s)) + m_d(1 - \kappa_h)m] d\Phi(s) + \int_{R+1}^T [tr(s) + SS(e) + m_d(1 - \kappa_m)m + \kappa_m m] d\Phi(s) \\ + G_w = \int_1^R \tau[\tilde{w}(l)e \in l(s) - ph'(s)] d\Phi(s). \end{cases} \quad (8)$$

Here the first two terms on the left-hand side of the constraint are the aggregate spending on the four public programs, and  $G_w$  represents other government spending. The right-hand side of the constraint represents the aggregate tax revenues raised through  $\tau$ , which will be specified further in the calibration section.

## 2.3. The production technology

On the production side, the economy consists of two sectors: the consumption goods sector and the health care sector. Productions in these two sectors are governed by the same (Cobb-Douglas) production function but with sector-specific

<sup>16</sup> One reason that we include education heterogeneity in the model is to reduce the computational cost. More specifically, to capture the relationship between an individual's Social Security benefits and his/her lifetime earnings history, one has to keep track of each agent's average lifetime earnings in the model. However, this strategy would significantly increase the computational burden because the average lifetime earnings is a continuous state variable. We use education levels to approximate the average lifetime earnings of each agent in the model, which substantially reduces our computational burden.

<sup>17</sup> This assumption significantly simplifies the analysis here. It is supported by some empirical evidence. For instance, Feenberg and Skinner (1994) find a very low income elasticity of catastrophic health care expenditures, suggesting that expenditure (at least for large medical shocks) does not vary much with income. Livshits et al. (2007) find in the MEPS 1996/1997 dataset that income does not significantly decrease in response to a medical shock.

<sup>18</sup> We assume that the retirees are automatically enrolled in Medicare Part A and Part B.

total productivity factor (TFP). Assuming that production is taken in competitive firms and that factors can move freely between the two sectors, it becomes straightforward that the model can be aggregated into a one-sector economy and that the relative price of health care is inversely related to the relative TFPs in the two sectors.<sup>19</sup> For simplicity, we assume that the TFPs in both sectors are the same so that the relative price of health care is equal to one. Let the aggregate production function take the following form:

$$Y = AK^\alpha L^{1-\alpha}.$$

Here,  $\alpha$  is the capital share,  $A$  is the TFP,  $K$  is capital, and  $L$  is labor. Assuming that capital depreciates at a rate of  $\delta$ , the firm chooses  $K$  and  $L$  by maximizing profits  $Y - w_0L - (r + \delta)K$ . The profit-maximizing behaviors of the firm imply that

$$w_0 = (1 - \alpha)A\left(\frac{K}{L}\right)^\alpha$$

$$r = \alpha A\left(\frac{K}{L}\right)^{\alpha-1} - \delta.$$

#### 2.4. The EHI market

EHI is community-rated. Its premium is the same for everyone covered. In addition, we assume that it is operated by competitive insurance companies. Note that the employer and the employee share the total cost of EHI. Let  $\pi$  represent the fraction of the cost paid by the employee. Then, the price of the insurance paid by the employee,  $p$ , can be expressed as follows:

$$p = \pi \kappa_h \frac{\int P_j \left[ \int m'(s) ds' \right] \mathbf{1}_{h'=1} d\Phi(s)}{(1+r) \int \mathbf{1}_{h'=1} d\Phi(s)}. \tag{9}$$

The rest of the cost is paid by the firm with  $c_e$ ; that is,

$$c_e \int e \in l(s) I_{c_e} d\Phi(s) = (1 - \pi) \kappa_h \frac{\int P_j \left[ \int m'(s) ds' \right] \mathbf{1}_{h'=1} d\Phi(s)}{(1+r) \int \mathbf{1}_{h'=1} d\Phi(s)}. \tag{10}$$

Here  $I_{c_e}$  is the indicator function. It equals to one when the agent works full-time and the EHI is offered.

#### 2.5. Market-clearing conditions

The market-clearing conditions for the capital, labor and good markets are, respectively, as follows:

$$K' = \int a'(s) d\Phi(s) \tag{11}$$

$$L = \int e \in l(s)^{1+\theta} d\Phi(s) \tag{12}$$

$$Y = \int (c + m) d\Phi(s) + K' - (1 - \delta)K + G_w \tag{13}$$

#### 2.6. Stationary equilibrium

A stationary equilibrium is defined as follows:

Definition: A *stationary equilibrium* is given by a collection of value functions  $V(s)$ ; individual policy rules  $\{a', l, h'\}$ ; the distribution of individuals  $\Phi(s)$ ; aggregate factors  $\{K, L\}$ ; prices  $\{r, w_0\}$ ; Social Security, Medicare, Medicaid, and the consumption floor; and private health insurance contracts defined by pairs of price and coinsurance rate  $\{p, \kappa_h, c_e\}$ , such that

1. Given prices, government programs, and private health insurance contracts, the value function  $V(s)$  and individual policy rules  $\{a', l, h'\}$  solve the individual's dynamic programming problems (P1) and (P2).
2. Given prices,  $K$  and  $L$  solve the firm's profit maximization problem.
3. The capital, labor and good markets clear-that is, conditions (11)–(13) are satisfied.
4. The government budget constraint holds-that is, condition (8) is satisfied.
5. The health insurance companies are competitive, and, thus, the insurance contracts satisfy conditions (9) and (10).
6. The distribution  $\Phi(s)$ , evolves over time according to the equation  $\Phi' = R_\Phi(\Phi)$ , and satisfies the stationary equilibrium condition:  $\Phi' = \Phi$ .

<sup>19</sup> Specifically, the relative price of health care  $q$  is equal to  $\frac{A_c}{A_m}$ , where  $A_c$  and  $A_m$  are the sector-specific TFPs.



**Table 3**  
Health expenditure grids.

Health exp. shock	1	2	3	4	5	6
Ages 21–35	0	143	775	2696	6755	17862
Ages 36–45	5	298	1223	4202	9644	29249
Ages 46–55	46	684	2338	6139	12596	33930
Ages 56–65	204	1491	3890	9625	20769	58932
Ages 66–75	509	2373	5290	11997	21542	50068
Ages 76–80	750	2967	7023	16182	30115	53549

Data source: MEPS.

7. The amount of bequest transfers received by the new-born agents is equal to the amount of accidental bequests from the terminal period.

We focus on stationary equilibrium analysis in the rest of the paper, using numerical methods to solve the model, as analytical results are not obtainable. Since agents can live only up to  $T$  periods, the dynamic programming problem can be solved by iterating backwards from the last period.

### 3. Calibration

We calibrate the benchmark model to match the current U.S. economy. The calibration strategy adopted here is the following: The values of some standard parameters are predetermined based on previous studies, and the values of the rest of the parameters are then *simultaneously* chosen to match some key moments in the current U.S. economy.

#### 3.1. Demographics and preferences

One model period is one year. Individuals enter the economy at age 21 ( $j = 1$ ), retire at age 65 ( $R = 45$ ), and die at age 85 ( $T = 65$ ).

The utility function is assumed to take the following form:

$$u(c, l) = \frac{c^{1-\sigma}}{1-\sigma} + \zeta \frac{(1-l)^{1-\gamma}}{1-\gamma}.$$

The value of  $\sigma$  is set to two in the benchmark calibration, which falls in the middle of the range of values used in the literature studying incomplete-markets models with medical expense shocks.<sup>20</sup> The value of  $\gamma$  is set to two in the benchmark following the recent literature on labor elasticity (see Chetty, 2012). We also explore a variety of other values for  $\sigma$  and  $\gamma$  in the sensitivity analysis. The disutility parameter for labor supply  $\zeta$  is calibrated to match the employment rate in the data: 76.9%. The discount factor  $\beta$  is set to match an annual interest rate of 4%, and the resulting value is  $\beta = 0.98$ .

#### 3.2. Production

The capital share  $\alpha$  in the production function is set to 0.36, and the depreciation rate  $\delta$  is set to 0.06. Both are commonly-used values in the macro literature. The labor-augmented technology parameter  $A$  is calibrated to match the current per capita GDP in the U.S.

#### 3.3. Medical expense shock and EHI

We use the Medical Expenditure Panel Survey (MEPS) dataset to calibrate the health expenditure process and the probabilities of being offered EHI. The data on total medical expenses are used to calibrate the distribution of medical expenses, and six states are constructed with bins of the size (25%, 25%, 25%, 15%, 5%, 5%) for the medical expense shock  $m$ . To capture the life-cycle profile of medical expenses, we assume that the medical expense shock  $m$  is age-specific and calibrate the distribution of medical expenses for each ten- or 15-year group. Table 3 reports the medical expense grids, and the transition matrices for  $m$  are reported in the appendix.

The value of  $e_h$  determines whether EHI is available when the agent chooses to work full-time. We assume that this variable follows a two-state Markov chain. Since higher-income jobs are more likely to provide EHI, we assume that the transition matrix for  $e_h$  is specific to each education level.<sup>21</sup> The transition matrices are calibrated using the MEPS dataset and are reported in the appendix.

The value of  $\kappa_h$  represents the fraction of medical expenses covered by EHI. We set its value to 0.8 in the benchmark calibration because the coinsurance rates of most private health insurance policies in the U.S. fall into the 65% – 85% range.

<sup>20</sup> See Jeske and Kitao (2009), De Nardi et al. (2010), Kopecky and Koreshkova (2014), Pashchenko and Porapakarm (2013), etc.

<sup>21</sup> That is, each new-born has a random draw for  $e_h$  from the initial invariant distribution specific to her education level, and then the value of  $e_h$  follows the education-specific transition matrix over the life-cycle.



### 3.4. Labor productivity parameters

Since a full-time job requires approximately 2000 hours of work per year, and hours available per year (excluding sleeping time) total about 5000 h, we set the value of  $l_f = 0.4$ . The number of working hours for a part-time job is approximately half of that for a full-time job; therefore, we set the value of  $l_p$  to 0.2.

There are three education levels in the model— $e \in \{e^1, e^2, e^3\}$ —which represent agents with no high school, high school graduates, and college graduates, respectively. The value of  $e^2$  is normalized to one, and the values of  $e^1$  and  $e^3$  are calibrated to match the relative wage rates for individuals with no high school and college graduates in the data. The resulting values are  $e^1 = 0.70$  and  $e^3 = 1.73$ .

The age-specific deterministic component  $b_j$  in the labor productivity process is calibrated using the average wage income by age in the MEPS dataset. The transitory and persistent productivity shocks,  $\nu$  and  $y$ , follow the process specified by Eqs. (6) and (7). We discretize the process using the method described in Tauchen (1986). As for the three parameters in the process  $\{\rho, \sigma_\mu^2, \sigma_\nu^2\}$ , we use the values provided in Krueger, Mitman, and Perri (2016) who estimate the same process using the PSID dataset, that is,  $(\rho, \sigma_\mu^2, \sigma_\nu^2) = (0.9695, 0.0384, 0.0522)$ .<sup>22</sup>

As for the parameter in the non-linear wage schedule,  $\theta$ , we calibrate its value to match the part-time/full-time share of workers in the data. The resulting value for  $\theta$  is 0.37, which implies that the wage rate for part-time workers is approximately 80% of that for full-time workers. This value is also very close to the estimates provided in the literature.<sup>23</sup>

### 3.5. Government

The tax function  $\tau(\cdot)$  includes two components, a proportional social security tax and the income tax. Following [Jeske and Kitao \(2009\)](#), the income tax is modeled as a combination of a progressive part and a proportional part. The progressive part takes the functional form proposed by [Gruber and Madrian \(1994\)](#).

$$\tau(x) = \tau_s x + a_0 [x - (x^{-a_1} + a_2)^{-1/a_1}] + \bar{\tau} x.$$

Here  $x$  is the taxable income. The first term in the tax function is the social security tax, in which  $\tau_s$  is set to 12.4% according to the Social Security Administration. The second term is the progressive income tax, which is simply the function form studied by [Gouveia and Strauss \(1994\)](#). We use their estimates for  $\{a_0, a_1\}$ , that is,  $a_0 = 0.258$  and  $a_1 = 0.768$ . Following [Jeske and Kitao \(2009\)](#), the value of  $a_2$  is calibrated to match the share of income tax revenues from the progressive part, that is, 65%. The last term is the proportional income tax, where the value of  $\bar{\tau}$  is chosen so that the average tax rate (including both the social security tax and the income tax) in the model is consistent with the estimation in [Prescott \(2004\)](#), that is, 40%.

Social Security in the model is designed to capture the main features of the U.S. Social Security program. We assume that the Social Security payments are conditional on the agent's education level, which approximates her lifetime earnings history.<sup>24</sup> Specifically, we choose the values of  $SS(\cdot)$  so that the Social Security marginal replacement rates are consistent with the estimates in [Fuster et al. \(2007\)](#). In addition, we rescale every beneficiary's payments so that the Social Security program is exactly self-financed.

Medicare is a public health insurance program that provides health insurance to individuals aged 65 and older by covering a  $\kappa_m$  fraction of their medical expenses. Here, we assume that Medicare and EHI provide the same coinsurance rate—i.e.,  $\kappa_m = \kappa_h$ .

The means-tested Medicaid program provides free health insurance to the poor whose assets and income are below certain thresholds. By law, it is the payer of last resort, that is, it covers the remaining medical costs that are not covered by the other payers for the eligible individual. Before the Affordable Care Act reform, the eligibility requirements for Medicaid differed substantially across the states. According to [Pashchenko and Porapakkarm \(2013\)](#), the income thresholds vary from below 50% to over 100% of the Federal Poverty Level (FPL). In the benchmark, we set the income threshold,  $\Theta_{income}$ , to 100% of the FPL, and we explore alternative values for  $\Theta_{income}$  in the sensitivity analysis.<sup>25</sup> The asset threshold,  $\Theta_{asset}$ , is set to \$2000 because this is the maximum amount of cash allowed for the Medicaid program among a majority of the states (see [Pashchenko and Porapakkarm, 2013](#)).

The consumption floor captures a variety of welfare programs available to the U.S. population, such as AFDC/TANF, SNAP (formerly food stamps), SSI, etc. It insures the poor against large negative shocks by guaranteeing a minimal level of consumption. The existing estimates for this floor vary substantially, from \$2000 to over \$7000.<sup>26</sup> We calibrate the value of

<sup>22</sup> Note that by using a labor productivity process standardly estimated from the actual wage data, we implicitly assume that individuals out of the labor force face the same productivity process as those in the labor force. It is likely that this assumption may be violated due to endogenous selection issues. It would be valuable and better if one can recover the underlying productivity process for the entire working-age population. We leave this for future research as it is out of the scope of this paper.

<sup>23</sup> Please see [Rogerson and Wallenius \(2013\)](#) for a discussion of this parameter value.

<sup>24</sup> Note that it may be more accurate to keep track of each agent's average past earnings, but doing so adds another continuous state variable to the model and makes the computation challenging.

<sup>25</sup> The federal poverty level in 2000 was \$8959 for one-person families according to U.S. Census Bureau.

<sup>26</sup> See [Kopecky and Koreshkova \(2011\)](#) for a review on these studies.

**Table 4**  
The benchmark calibration.

Parameter	Value	Source/Moment to match
$\sigma$	2	Macro literature
$\alpha$	0.36	Macro literature
$\delta$	0.06	Macro literature
$\gamma$	2	Chetty (2012)
$A$	1100	U.S. GDP per capita: \$36467
$\{a_0, a_1\}$	{0.258, 0.768}	Gouveia and Stauss (1994)
$\tau_s$	12.4%	U.S. Social Security tax rate
$\kappa_h, \kappa_m$	0.8	U.S. data
$\beta$	0.98	Annual interest rate: 4.0%
$\pi$	0.2	Sommers(2002)
$\underline{c}$	\$3700	EHI take-up rate: 96%
$\zeta$	0.9-E04	Employment rate: 76.9%
$\theta$	0.37	Full-time worker share: 91.1%
$\rho$	0.9695	Krueger, Mitman and Perri (2016)
$\sigma_h^2$	0.0384	"
$\sigma_v^2$	0.0522	"

**Table 5**  
Key statistics of the benchmark economy.

Statistics	Model	Data
Output per person	\$35833	\$36467
Interest rate	3.9%	4.0%
Employment rate	78.1%	76.9%
Full-time share of workers	86.1%	91.1%
Full-time employment rate	67.2%	70.1%
Aggregate hours worked	1450 h	1554 h
% of working-age popu. with EHI	55.1%	59.4%
EHI take-up rate	97%	96%
% of working-age popu. in Medicaid	6.2%	9.8%

$\underline{c}$  within the model. As (Zhao, 2017) points out, the minimum consumption floor also provides implicit insurance against potential large health shocks for agents who are currently not on the floor, and thus it has a crowding out effect on their demand for other health insurance policies. We make use of this result and calibrate the value of the consumption floor  $\underline{c}$  to match the take-up rate for employment-based health insurance, that is, 96% according to the MEPS data.

The revenues from the Social Security tax is used to finance the Social Security program, and the income tax revenues are used to finance the other three government programs: Medicare, Medicaid, and the consumption floor. Note that the income tax revenues are more than enough to finance the other three public programs. We assume that the extra tax revenues, denoted by  $G_w$ , are thrown away in each period.

### 3.6. Baseline economy

The key results of the benchmark calibration are summarized in Table 4. Our model succeeds in matching several aspects of the macroeconomy, including consumption, hours worked, and the patterns of health insurance coverage over the life cycle. Table 5 summarizes the key statistics of the benchmark model. The employment rate is 78.1%, and the share of workers that are working full-time in the model is 86.1%—both consistent with the data. The implied full-time employment rate is 67.2%, compared to 70.1% in the data.<sup>27</sup> In addition, the average hours worked are approximately 1450 h per year (29 h per week), compared to 1554.7 h per year in the data. On the health insurance side, 55.1% of the working-age population are covered by EHI, and the EHI take-up rate is 97%. Both are close to what we observe in the data. The fraction of working-age population in Medicaid generated in the benchmark model is 6.2%, which falls a bit on the low side, compared to its data counterpart.

Figs. 1 and 2 plot the life-cycle profiles of the key variables in the model. The life-cycle profile of assets in the baseline economy is hump shaped, which is a standard result in life-cycle models. As shown in Fig. 2 (a), the employment rate generated in the model increases as agents move into their 30s and declines as the mandatory retirement age approaches, which is fairly close to its empirical counterpart. Fig. 2 (b) plots the full-time share of workers by age, which is also consistent with the data.

Our model features rich individual heterogeneity. We also evaluate labor supply decisions by various of individual characteristics in the baseline economy. In particular, we show in Table 6 that the labor supply decisions by EHI status in the

<sup>27</sup> Here the full-time employment rate is defined as the share of the working-age population that is working full-time.

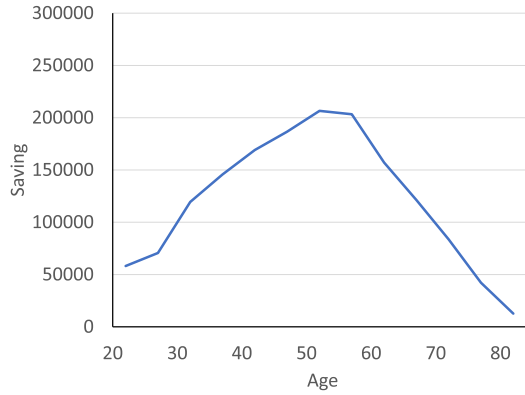
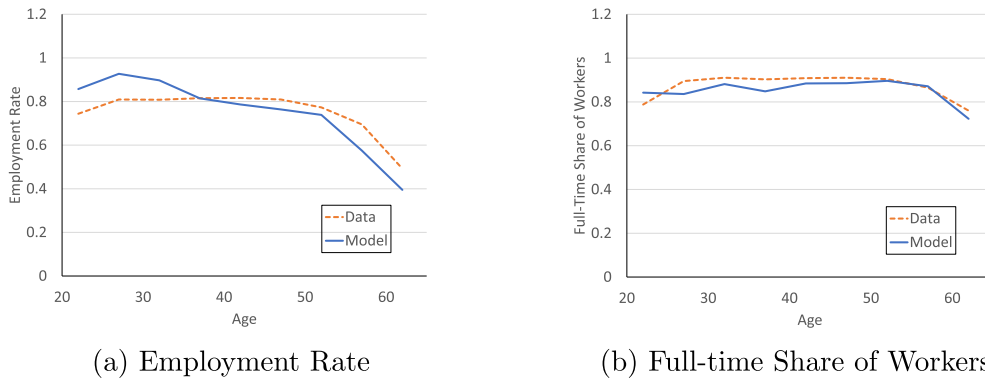


Fig. 1. Life-cycle profile in the benchmark economy: assets.



(a) Employment Rate

(b) Full-time Share of Workers

Fig. 2. Life-cycle profile in the benchmark economy: labor supply note: the data is from 2001 Survey of Income and Program Participation (SIPP), and the values plotted are 5-year averages.

Table 6  
Labor supply by health insurance status: baseline model vs. data.

	Model	
	No EHI	With EHI
Health insurance status	No EHI	With EHI
Employment rate	64.1%	89.5%
Full-time share of workers	76.4%	91.8%
Hours worked	22.6	34.3
	Data	
	No EHI	With EHI
Health insurance status	No EHI	With EHI
Employment rate	62.0%	93.0%
Full-time share of workers	73.8%	93.4%
Hours worked	20.0	37.5

Data source: SIPP (2001).

baseline economy are consistent with what we have documented in the 2001 Survey of Income and Program Participation (SIPP) Panel Data. That is, individuals with EHI are more likely to work and work full-time than those without EHI. In the model, the employment rate is 90% and the full-time share of workers is 92% among individuals with EHI, while these numbers are 64% and 76% for those without EHI. Based on 2001 SIPP, both the employment rate and the full-time share are 93% among individuals with EHI. While for those without EHI, the employment rate is only 62% and 74% of workers are working full-time. In the appendix, we present additional heterogeneous labor supply decisions by other individual characteristics in the baseline economy (see Table 16).

#### 4. Quantitative results

In this section, we use the calibrated model to assess the quantitative importance of the effects of different health insurance systems on the decisions of working and working full-time. Specifically, we answer the following quantitative question:

**Table 7**  
The main quantitative results.

Statistics	Benchmark (U.S. HI)	Experiment I (Eur HI)	Inter. I (no link to job)	Inter. II (no tax exemp.)
Output per person	\$35833	\$34285	\$34859	\$34105
Interest rate	3.9%	3.9%	3.9%	4.4%
Employment rate	78.1%	73.2%	81.5%	79.2%
Full-time share of workers	86.1%	81.2%	71.4%	76.2%
Full-time employment rate	67.2%	59.4%	58.2%	60.4%
Aggregate hours worked	29.1	26.5	27.9	27.9
Aggregate effective labor	42.0	40.2	40.8	41.0
% of working-age popu. (with EHI)	55.1%	..	65.7%	34.1%
EHI take-up rate	97%	..	80%	69%
EHI premium	\$3010	..	\$2918	\$4191

To what extent can different health insurance systems account for the difference in the employment rate and the full-time share of workers between the U.S. and the four major European countries?

#### 4.1. EHI v.s. Universal Health Insurance

We run the following thought experiment. We construct a counterfactual economy (experiment I) by replacing EHI in the benchmark model with a universal health insurance financed by additional lump-sum taxes.<sup>28</sup> Then, we compare this counterfactual economy to the benchmark economy to identify the effects of different health insurance systems on labor supply and on other variables of interest. Table 7 displays the comparison of the key statistics in the two model economies.

We find that the health insurance system has substantial effects on labor supply decisions. When EHI is replaced with a universal health insurance system financed by additional lump-sum taxes, the employment rate decreases from 78% to 73% and the share of full-time workers drops from 86% to 81%. These changes together imply that the full-time employment rate declines from 67.2% to 59.4%.

In addition, the aggregate hours worked also decrease substantially after EHI is replaced with the universal government-financed health insurance. The average annual hours worked (aggregate labor supply) in the economy with the European system is only 91% of that in the benchmark economy. Since the data show that the average annual hours worked in four major European countries is, on average, 78.9% of that in the U.S., the quantitative result obtained here suggests that more than one third of the difference in aggregate labor supply between the U.S. and the four major European countries is due to the different health insurance systems.

The intuition for the labor supply effects of EHI is as follows. Since medical care expenses are sizable and volatile, and there is no good alternative health insurance available for working-age Americans, EHI can be highly valuable to risk-averse individuals (much more than its actuarially fair cost). For the most part, only full-time workers are offered with EHI, working-age Americans have extra incentive both to work and to work full-time. Because the European system offers universal health insurance coverage to the entire working age population, and thus it does not provide such incentive.

We conduct further analysis of some intermediate cases in the following section to provide additional insights into the way EHI affects labor supply decisions.

#### 4.2. Intermediate economies

In order to better understand the different labor supply results in the two economies—the benchmark versus the counterfactual with the European system—we analyze several intermediate economies in this section.

In the first intermediate economy, we remove the linkage between job status and availability of EHI but keep the rest of the economy the same as in the benchmark. That is, regardless of their labor supply choices, individuals are allowed to purchase EHI as long as  $e_{it} = 1$ . Table 7 presents the key statistics of the intermediate economy. The employment rate and the full-time share of workers decline substantially after the linkage between EHI and labor supply choices is removed. The share of the working-age population that is working full-time in this intermediate case is about the same as in the counterfactual economy with a universal health insurance system. In addition, the average annual hours worked (aggregate labor supply) in this intermediate case is only 96% of that in the benchmark economy. These results highlight the key

<sup>28</sup> While we change the health insurance policy, we keep the rest of the parameter values the same as in the benchmark. Thus, any changes in labor supply should be attributed to the policy change with regard to health insurance. For the same reason, we use additional lump-sum taxes to finance the universal health insurance so that the labor supply effect obtained here does not include the labor supply distortions from income taxation, which helps us better identify the impact of employment-based health insurance on the labor supply decisions.

**Table 8**  
Labor supply late in the life cycle: U.S. vs. Europe.

	All working-age popu.	Ages 55–64
Hours worked (relative to U.S.)		
U.S.	1	1
France	0.80	0.46
Germany	0.82	0.59
Italy	0.72	0.47
UK	0.90	0.76
Average (Major 4)	0.81	0.57
Employment rate		
U.S.	76.9%	57.8%
France	67.3%	29.4%
Germany	68.7%	37.6%
Italy	57.6%	27.7%
UK	73.7%	50.4%
Average (Major 4)	66.8%	36.3%

Data source: Authors' own calculations based on OECD Labor Market Data.

**Table 9**  
Labor supply late in the life cycle: model vs. data.

	All working-age popu.	Age 55–64
Hours worked (relative to benchmark)		
Benchmark	1	1
Counterfactual (with Eur HI)	0.91	0.84
Employment Rate		
Benchmark	78.1%	59.0%
Counterfactual (with Eur HI)	73.2%	52.7%

mechanism of the paper, that is, many individuals in the U.S. economy work full-time primarily to secure health insurance. When the availability of health insurance is not tied to the job status, many of them stop working full-time.<sup>29</sup>

It is noteworthy that the cost of EHI is exempted from taxation in the U.S. What impact does this unique feature of the U.S. tax policy have on labor supply? To address this question, we consider the second intermediate case, in which we remove the tax exemption policy for EHI and keep the rest of the economy the same as in the benchmark. The key statistics of the second intermediate economy are also reported in Table 7, which shows that the tax exemption policy also has significant effects on labor supply decisions. Both the employment rate and the full-time share of workers decline, and the average annual hours worked (aggregate labor supply) in this intermediate case is about 96% of that in the benchmark economy. The removal of the tax exemption policy discourages labor supply because it reduces the attractiveness of EHI. Note that there are two channels through which the tax exemption policy affects the value of EHI. First, it provides tax benefits to individuals with EHI and, thus, implicitly increases its value. Second, the policy helps overcome the adverse selection problem in the group insurance market and, thus, increases the attractiveness of the insurance policy.<sup>30</sup> The adverse selection problem is very limited in the benchmark economy mainly due to the tax exemption policy. The take-up rate for EHI is near 100% (97%) in the benchmark, but it drops to 69% when the tax exemption policy is removed. As a result, the health insurance premium increases from \$2918 to \$4191, and the share of the working-age population with EHI drops from 55% to 34%.

It is interesting to compare the second intermediate case to Jeske and Kitao (2009) who analyze the impact of the tax exemption policy in a similar model. Our results from the second intermediate case are consistent with their findings. Jeske and Kitao (2009) found that if the tax exemption policy was abolished, the EHI take-up rate would drop substantially due to adverse selection, and meanwhile the EHI premium would jump up. However, they assume exogenous labor supply in their model, and thus cannot capture the labor supply implications of the tax exemption policy.

## 5. Further Discussion

### 5.1. Labor Supply Late in the Life Cycle

It is known that the cross-country differences in labor supply decisions are larger among individuals near retirement. In this section, we investigate whether our model is consistent with this life-cycle pattern with regard to the labor supply

<sup>29</sup> Note that individuals in the benchmark economy face more risks than in the counterfactual economy. For instance, approximately over one third of the working-age population is without health insurance in the benchmark economy, and, thus, they face extra medical expense risks. The extra risk is the other important reason why agents work more in the benchmark economy.

<sup>30</sup> Note that EHI is group-rated, and, thus, it may suffer from adverse selection.

decisions across countries. As documented in Table 8, the U.S.-Europe differences in labor supply decisions are larger among individuals aged 55–64. For instance, for those aged 55–64, the hours worked in the four major European countries are only 57% of those in the U.S., while the ratio is 81.4% for the whole working-age population.<sup>31</sup> As for the employment rate, the difference between the U.S. and these European countries is 21 percentage points for individuals aged 55–64, while the difference is only 10.1 percentage points for the whole working-age population.

In Table 9, we compare our model implications to these life-cycle patterns. As can be seen, our model is fairly consistent with the labor supply decisions late in the life cycle documented in the data. In particular, the difference in hours worked between the two model economies is substantially larger for agents aged 55–64. The intuition behind this result is simple. The quantitative importance of the mechanisms we emphasize here is largely dependent on the size of the medical expenditure shock. As medical expenditures increase rapidly as agents approach retirement, the labor supply decisions near retirement are affected more by EHI. However, it is worth noting that while the model implications are qualitatively consistent with the life cycle patterns documented in the data, the model cannot quantitatively match the entire cross-country difference in labor supply decisions among agents near retirement. This may be due to the fact that our model abstracts from another important factor for the labor supply decisions late in the life cycle, the different public pension rules in the U.S. and European countries. We refer to (Erosa et al., 2012) for a detailed analysis of the impact of the different rules with regard to public pension and disability insurance on the labor supply behaviors late in the life cycle. It would be interesting to study a model incorporating the different rules with regard to both public pension and health insurance, and analyze their interactions. However, this goes beyond the scope of the current paper and thus we leave it for future research.

### 5.2. Difference in aggregate effective labor

Our quantitative results also provide an interesting implication for the difference in aggregate effective labor between the U.S. and Europe. It is well known that output per person in the U.S. is also significantly higher than in Europe. For instance, the average GDP per capita in four major European countries is only approximately 71% of that in the US. This fact has led people wonder whether Americans are richer than Europeans simply because they work much more. We argue that this may not be the case according to our quantitative results.

We find that most of the decrease in aggregate hours worked is from low-productivity agents who choose to work primarily to secure health insurance.<sup>32</sup> This result suggests that the extra hours that Americans work may not add much to aggregate effective labor in the US. As shown in Table 7, when EHI is replaced by a universal health insurance system, aggregate raw labor (aggregate hours worked) decreases by 9%, but aggregate effective labor drops by only 4%, and, thus, the output per person also drops by 4%. These quantitative results suggest that though Americans work much more, the difference in effective labor supply between the U.S. and Europe may be much smaller. Therefore, the difference in output per capita between the U.S. and Europe may not be mainly due to the different hours worked between the two regions.

The different implications for effective labor supply or labor productivity is also related to the existing literature emphasizing the negative aspect of EHI such as the job-lock effect.<sup>33</sup> This literature finds that EHI reduces the job mobility and thus is detrimental to labor productivity.

### 5.3. Difference in Aggregate hours worked over time

Some recent studies in the literature on the U.S.-Europe difference in aggregate labor supply have focused on a closely related empirical observation: the different trends on hours worked over time (e.g., Rogerson, 2008, McDaniel, 2011). That is, the U.S.-Europe difference in aggregate hours worked was small before the 1970s, and this difference has gradually increased over the last several decades.<sup>34</sup> It is worth noting that while this paper is mainly concerned with the current level difference in labor supply decisions between the U.S. and Europe, it also has important implications for the different trends of hours worked over the last half-century. This is because the quantitative importance of our mechanisms is largely dependent on the magnitude of the medical expense shocks. It is well known that U.S. medical expenditures have risen dramatically over the last half-century.<sup>35</sup> Therefore, while the health insurance systems in the U.S. and Europe have not dramatically changed over time, the rising medical expenditures would generate a widening gap in aggregate labor supply between the two regions according to our hypothesis.

To shed some lights on this hypothesis, we replicate our comparison of the two health insurance systems in model economies with different levels of health expenditures. As shown in Zhao (2014), the U.S. aggregate health expenditure

<sup>31</sup> The hours worked per person by different age groups are constructed by the authors based on OECD labor market data (2000). Note that since the hours worked per worker are not available for each age group in OECD labor market data, we construct them by using the distribution of employment by hour bands. In the calculations, we set the average hours worked for each hour band to its middle value. We do not present full-time/part-time shares here because of the lack of the data available.

<sup>32</sup> Chivers et al. (2017) study the impact of EHI on entrepreneurship. Similarly, they find that EHI induces more agents with mediocre managerial ability enter entrepreneurship, which reduces the aggregate productivity.

<sup>33</sup> See Madrian (1994), Gruber and Madrian (1994, 2002), etc.

<sup>34</sup> This is mainly due to that in the U.S. the hours worked have remained roughly constant since 1970s, whereas the hours worked in Europe have gradually declined ever since.

<sup>35</sup> Please see Zhao (2014) for the details of the rising medical expenditure in developed countries over the last half century and its causes.



**Table 10**  
Health expenditures and aggregate hours worked over time.

	Benchmark (with EHI)	Counterfactual (with universal HI)
2000 Health expenditures(13% of GDP) (Relative to benchmark)	29.1	26.5 (91%)
1970 Health expenditures(6% of GDP) (Relative to benchmark)	28.4	27.2 (96%)
No Health expenditures (Relative to benchmark)	27.2	27.2 (100%)

has increased dramatically since WWII, i.e., from below 4% of GDP in 1950 to over 6% of GDP in 1970, and then to about 13% of GDP in 2000. The health expenditure level in 1970 was approximately half of that in 2000. Therefore, here we consider an alternative case in which we exogenously scale down the health expenditures by 50%. In addition, we consider another case in which health expenditures are completely assumed away. The results from these two cases are reported in Table 10. As can be seen clearly, the level of health expenditures matters for the magnitude of the impact of EHI on aggregate labor supply. When health expenditures are scaled down by 50%, the difference in aggregate hours worked shrinks substantially, from 9% to 4%. If health expenditures are completely assumed away, the difference between the aggregate hours worked in the two health insurance systems disappear. These results suggest that our theory (together with the rising health expenditure in the U.S.) is not inconsistent with the times series data on aggregate hours worked. However, to account for the different trends in hours worked, we would need to extend our model to incorporate additional forces that are relevant for the times paths of aggregate hours worked in the U.S. and Europe. For instance, the different labor market regulations implemented over this period in the two regions, that influence work hours differentially.<sup>36</sup> Clearly the different trends in hours worked are important for understanding the determinants of aggregate labor supply. We leave this issue for future research and concentrate on the contemporary cross-country comparisons in this paper.<sup>37</sup>

## 6. Sensitivity analysis

### 6.1. Alternative options

#### 6.1.1. Individual health insurance

We assume that there is no individual health insurance available in the benchmark model because only a tiny fraction of working-age Americans purchase individual health insurance from the private market. The availability of individual health insurance may weaken the impact of EHI as individuals without EHI can buy insurance from the private market as a substitute. However, we argue that this effect is not quantitatively important because the individual health insurance market in the U.S. does not function well. Individual health insurance features high administrative costs and premiums, and it is affected by pre-existing conditions. In addition, it does not have the same tax benefits as EHI. Consequently, most working-age Americans without EHI do not buy individual health insurance as a substitute.

To assess the sensitivity of our results to the availability of individual health insurance, we conduct an additional computational experiment in which we introduce a private market for individual health insurance in the same fashion as in [Jeske and Kitao \(2009\)](#).<sup>38</sup> That is, the individual health insurance premium is conditioned on age  $j$  and the current health shock  $m$ . In addition, the health insurance companies are operating competitively with some administrative costs covered by a markup,  $\lambda_{ih}$ , to the premium. The individual health insurance premium,  $p_{ih}$ , can be specified as follows:

$$p_{ih}(j, m) = (1 + \lambda_{ih}) \frac{\kappa_{ih} P_j E[m'|j, m]}{1 + r}, \forall m, j. \quad (14)$$

Here we assume that the individual health insurance provides the same coinsurance rate as the EHI, that is,  $\kappa_{ih} = 0.8$ . We consider two values for  $\lambda_{ih}$ : zero and 11 percentages. The first value represents the case with no administrative costs, and the second value is based on the estimation of [Kahn et al. \(2005\)](#) in the data. As shown in Table 11, when we introduce individual health insurance into the model, the labor supply decisions change but the magnitude of the changes are negligible. For instance, aggregate hours worked decreases by approximately 0.1% in the case with zero administrative costs.

<sup>36</sup> See [Siebert \(2006\)](#) for a discussion of the details of some labor market regulations in a group of OECD countries.

<sup>37</sup> Specifically, to account for the different trends in hours worked observed in the data, we would need to extend our model to incorporate additional forces that would drive labor supply down over time in both regions. That is, while these downward forces reduce the hours worked in Europe over time, they are offset by the interaction of employment-based health insurance and the rising medical expenditures in the U.S.. We leave these ideas for future research as they are out of the scope of this paper.

<sup>38</sup> Note that the individual health insurance policies assumed in [Jeske and Kitao \(2009\)](#) are one-year contracts. An alternative approach is to allow for certain level of guaranteed renewability of individual health insurance. Which modelling strategy is a better description of the data is an interesting empirical question. We leave this for future research.



**Table 11**  
Sensitivity analysis: alternative options.

Statistics	Benchmark	Sens. I (IH, $\lambda_{ih} = 0.11$ )	Sens.II (IH, $\lambda_{ih} = 0$ )	Sens.III (default)
Employment rate	78.1%	78.1%	78.1%	77.5%
Full-time share of workers	86.1%	86.1%	85.8%	85.8%
Hours worked	29.1	29.1	29.0	28.8
% of popu. with EHI	55.1%	55.1%	54.9%	54.1%
% of popu. with IHI	..	2.6%	29.0%	..
EHI take-up rate	97%	97%	97%	96%

**Table 12**  
Sensitivity analysis: medicaid eligibility.

Statistics	Benchmark (US)	Counterfactual (Eur.)
$\Theta_{income} = 75\%$ of FPL		
Employment rate	78.0%	72.9%
Full-time share	86.0%	81.1%
Aggregate hours worked	29.0	26.4
$\Theta_{income} = 50\%$ of FPL		
Employment rate	77.7%	72.9%
Full-time share	85.9%	81.0%
Aggregate hours worked	28.9	26.4

**Table 13**  
Sensitivity analysis: some key parameters.

Statistics	Benchmark (US)	Counterfactual (Eur.)
$\sigma = 1$ (log utility)		
Employment rate	76.8%	72.4%
Full-time share	90.0%	86.3%
Aggregate hours worked	29.3	27.0
$\sigma = 3$		
Employment rate	77.2%	72.3%
Full-time share	87.7%	85.8%
Aggregate hours worked	29.0	26.9
$\gamma = 1$		
Employment rate	78.3%	72.8%
Full-time share	86.1%	82.3%
Aggregate hours worked	29.1	26.5
$\gamma = 3$		
Employment rate	77.4%	72.4%
Full-time share	86.0%	81.0%
Aggregate hours worked	28.8	26.2

This confirms our intuition that the availability of individual health insurance may weaken our results, but its quantitative importance should be small.<sup>39</sup>

## 6.2. Alternative options for uninsured Americans

It is worth noting that the uninsured Americans may reduce their out of pocket medical expenses by postponing treatments, using cheaper but low-quality services, or defaulting on medical bills. However, these options are not cost-free. By using them, agents may also suffer significant utility loss, either because of their negative impacts on health or due to the loss of access to future financial markets. Though they are relatively extreme, the availability of these options may provide implicit insurance against medical expense risks.

To assess the sensitivity of our results to the availability of these alternative options, we conduct another computational experiment in which the uninsured agents are given an additional option that allows them to pay a utility cost instead of paying the medical bill. We calibrate the value of the utility cost to match the personal bankruptcy rate in the U.S., which is slightly below 1% of the whole population, according to Livshits et al. (2007). The results from this experiment are also

<sup>39</sup> It is worth noting that the individual health insurance market would become relevant after the creation of health insurance exchanges with the passage of the Patient Protection and Affordable Care Act (ACA), which prohibits price discrimination.

**Table 14**  
Aggregate labor supply: decomposition.

	Actual annual hours worked: $h$ (Relative to the U.S.)	Constructed annual hours worked: $\hat{h}$ (Relative to the U.S.)
U.S.	1	1
France	0.80	0.82
Germany	0.82	0.86
Italy	0.72	0.73
UK	0.90	0.92
Average (Major four)	0.81	0.83

Data source: OECD Labor Market Data (2000).

**Table 15**  
Aggregate hours worked and full-time workers: U.S. vs. Europe.

	Employment rate (%)	FT worker (% of all workers)	FT employment rate (Relative to the U.S.)	Annual hours worked (relative to the U.S.)
U.S.	76.9	91.1	70.1% (1.00)	1554 (1.00)
France	67.3	85.8	57.7% (0.82)	1253 (0.80)
Germany	68.7	82.6	56.8% (0.81)	1280 (0.82)
Italy	57.6	88.4	50.8% (0.72)	1123 (0.72)
UK	73.7	79.2	58.4% (0.83)	1410 (0.91)
Average(Major 4)	66.8	83.9	55.9% (0.79)	1267 (0.81)
Austria	71.2	88.0	62.7% (0.89)	1370 (0.90)
Belgium	65.8	80.9	53.2% (0.76)	1221 (0.80)
Ireland	70.4	83.3	58.7% (0.83)	1345(0.88)
Netherlands	73.6	71.4	52.6% (0.75)	1196 (0.79)
Spain	60.7	92.6	56.3% (0.80)	1219 (0.80)
Switzerland	80.9	68.1	55.1% (0.78)	1471 (0.97)
Portugal	73.4	92.7	68.1% (0.96)	1478 (0.97)
Greece	61.8	94.9	58.7% (0.84)	1334 (0.88)
Norway	77.9	79.8	62.0% (0.95)	1258 (0.83)
Sweden	74.3	86.0	63.9% (0.98)	1364 (0.90)
Finland	67.5	89.6	60.7% (0.93)	1318 (0.87)
Denmark	76.4	83.9	64.1% (0.98)	1349 (0.89)
Average (exclude Scan.)	68.7	84.0	57.4% (0.82)	1308 (0.85)
Average (all)	70.1	84.2	58.7% (0.84)	1321 (0.86)

Data source: OECD Labor Market Data (2000).

**Table 16**  
Labor supply by other characteristics in the baseline economy.

EHI offer	w/ offer	w/o offer				
Hours worked	27.3	29.4				
Medical expense grid	1	2	3	4	5	6
Hours worked	26.8	28.3	29.8	31.3	32.2	33.2
Transitory shock grid	Low	High				
Hours worked	22.2	35.9				
Permanent shock grid	Low	Middle	High			
Hours worked	32.4	32.5	19.4			

Note: Medical expense grid 1 means the lowest expenditure shock, while 5 represents the highest expenditure shock.

**Table 17**  
Transition matrices for  $e_h$  by education level.

High-school dropouts ( $e = 1$ )	$e_h = 0$	$e_h = 1$
$e_h = 0$	0.8583	0.1417
$e_h = 1$	0.0848	0.9152
High-school graduates( $e = 2$ )	$e_h = 0$	$e_h = 1$
$e_h = 0$	0.7865	0.2135
$e_h = 1$	0.0415	0.9585
College graduates ( $e = 3$ )	$e_h = 0$	$e_h = 1$
$e_h = 0$	0.7717	0.2283
$e_h = 1$	0.0207	0.9793

**Table 18**  
Transition matrices for  $m$  by Age groups.

Age 20–35	$m = 1$	2	3	4	5	6
$m = 1$	0.3665	0.3665	0.1656	0.0653	0.0183	0.0178
2	0.3665	0.3665	0.1656	0.0653	0.0183	0.0178
3	0.2005	0.2005	0.3139	0.1581	0.0722	0.0550
4	0.1138	0.1138	0.2830	0.2581	0.0956	0.1358
5	0.1648	0.1648	0.2784	0.2045	0.0625	0.1250
6	0.0891	0.0891	0.2529	0.1897	0.1149	0.2644
Age 36–45	$m = 1$	2	3	4	5	6
$m = 1$	0.6564	0.2091	0.0843	0.0324	0.0081	0.0097
2	0.2896	0.3819	0.2104	0.0874	0.0243	0.0065
3	0.1343	0.2718	0.3333	0.2039	0.0372	0.0194
4	0.0838	0.1486	0.2595	0.3135	0.1108	0.0838
5	0.0565	0.0645	0.1210	0.3710	0.1935	0.1935
6	0.0732	0.1220	0.0732	0.2195	0.1301	0.3821
Age 46–55	$m = 1$	2	3	4	5	6
$m = 1$	0.6622	0.2230	0.0726	0.0287	0.0068	0.0068
2	0.2963	0.4057	0.1869	0.0825	0.0135	0.0152
3	0.1029	0.2513	0.3862	0.1737	0.0455	0.0405
4	0.0646	0.0899	0.2809	0.3287	0.1348	0.1011
5	0.0588	0.0924	0.1933	0.2605	0.1597	0.2353
6	0.1017	0.1017	0.0763	0.1695	0.1102	0.4407
Age 56–65	$m = 1$	2	3	4	5	6
$m = 1$	0.7175	0.1675	0.0675	0.0225	0.0125	0.0125
2	0.2344	0.4065	0.2120	0.1047	0.0249	0.0175
3	0.1197	0.2718	0.3466	0.1671	0.0499	0.0449
4	0.0664	0.1577	0.2697	0.3071	0.1120	0.0871
5	0.0375	0.0625	0.1875	0.2875	0.2375	0.1875
6	0.1375	0.0250	0.1500	0.2500	0.1125	0.3250
Age 66–75	$m = 1$	2	3	4	5	6
$m = 1$	0.6561	0.1629	0.0769	0.0588	0.0271	0.0181
2	0.2036	0.3529	0.2805	0.1131	0.0136	0.0362
3	0.1267	0.2624	0.3032	0.2217	0.0407	0.0452
4	0.0376	0.1805	0.2406	0.3008	0.0827	0.1579
5	0.0682	0.0455	0.1591	0.3182	0.1591	0.2500
6	0.0682	0.0455	0.1818	0.1818	0.0682	0.4545
Age 75+	$m = 1$	2	3	4	5	6
$m = 1$	0.5390	0.1948	0.1623	0.0649	0.0195	0.0195
2	0.2000	0.3613	0.2645	0.1097	0.0258	0.0387
3	0.0645	0.2258	0.4000	0.2194	0.0387	0.0516
4	0.0645	0.1075	0.2473	0.3978	0.0323	0.1505
5	0.0645	0.0968	0.0645	0.4839	0.1290	0.1613
6	0.0968	0.0323	0.16	0.2581	0.1613	0.2903

reported in Table 11. We find that both the employment rate and the full-time share of workers decline, but the size of the decline is small. The implied aggregate hours worked in this experiment is approximately 1% lower than that in the benchmark economy. These results suggest that our main quantitative results remain after incorporating these alternative extreme options in the model.

Another related issue is the spousal insurance. In this paper, we abstract from the family structure, and do not model spousal coverage due to its complexity. It would be interesting to incorporate a realistic family structure into the model, and study the joint labor supply decisions of husbands and wives and how they are affected by the availability of spousal coverage. We leave this issue for future research.

### 6.3. Medicaid eligibility

Before the Affordable Care Act reform, the eligibility requirements for Medicaid differed substantially across the states. According to Pashchenko and Porapakkarm (2013), the income thresholds vary from below 50% to over 100% of the Federal Poverty Level (FPL). In the benchmark calibration, we set the income threshold,  $\Theta_{income}$ , to 100% of the FPL, a value probably on the up side. Here we explore alternative values for  $\Theta_{income}$ , and assess the sensitivity of our results to this value. These sensitivity results are reported in Table 12. As can be seen, the main results remain similar to the benchmark case as the Medicaid income eligibility varies.

### 6.4. Utility function parameters

In this section, we investigate the sensitivity of our main results to some key parameter values in the utility function.

In the benchmark calibration, we set the risk aversion parameter,  $\sigma$ , to two, which is in the middle of the range of values used in the existing literature. We also explore two alternative values for  $\sigma$ , one (log utility) and three, as robustness check. In each case, we recalibrate the model to match the same moments as in the benchmark calibration. The results from these robustness check exercises are reported in Table 13 in the appendix. As can be seen, our main results remain fairly similar to the benchmark case as the value  $\sigma$  varies.

We also explore the sensitivity of our main quantitative results to the value of another key parameter,  $\gamma$ . According to Chetty (2012), we set its value to two in the benchmark calibration. Here we consider two alternative values, one and three, for this parameter. The sensitivity analysis results are also reported in Table 13 in the appendix. We find that our main quantitative results are not sensitive to this parameter value.

## 7. Conclusion

In this paper, we study the impact of the employment-based health insurance system on the employment rate, the shares of full-time/part-time workers, and aggregate hours worked. We find that the unique EHI system in the U.S. and uncertain medical expenses are important reasons why Americans work more than Europeans. In contrast to Europeans, who get universal health insurance from the government, most working-age Americans get health insurance through their employers. In a quantitative dynamic general equilibrium model with endogenous labor supply and uncertain medical expenses, we quantitatively assess the extent to which different health insurance systems account for the labor supply difference between the U.S. and Europe. Our quantitative results suggest that the different health insurance systems can account for a significant fraction of the differences in employment rate and full-time/part-time shares of workers between the two areas. In addition, we find that the employment-based health insurance system is one of the reasons why many Americans work more than Europeans.

## Appendix A

### A1. A simple decomposition calculation

To further understand the causes of the difference between average annual hours worked in the U.S. and Europe, we conduct the following simple decomposition calculation. By definition, the average hours worked per person can be calculated as follows:

$$h = e[s_f h_f + (1 - s_f)h_p],$$

where  $h_f$  and  $h_p$  are the average hours worked per full-time worker and part-time worker, respectively.  $e$  is the employment rate and  $s_f$  is the share of the workers that are working full-time. This equation shows that the difference in average hours worked comes from two sources: (1) the difference in employment rate and full-time worker share, and (2) the difference in average hours worked per full-time and part-time worker. To assess the contribution from the first source, we construct a counterfactual measure  $\hat{h}$  for each country by plugging in the country-specific employment rates and full-time worker shares but the same  $h_f$  and  $h_p$ .<sup>40</sup> The results are reported in Table 13. As can be seen, using this counterfactual measure, the difference between annual hours worked in the U.S. and Europe are very similar to that in the data. More specifically, the annual hours worked in the four major European countries is, on average, 0.81 of that in the U.S. This suggests that over two thirds of the aggregate labor supply difference between the U.S. and these European countries is due to the differences in employment rate and full-time worker share.

### A2. Data and calibration details

Here we provide additional information regarding the MEPS panel dataset used in the calibration. we make use of the 2006–2007 wave of the MEPS dataset, which provides a good measure of the total health expenditure, i.e., “totexpy1” and “totexpy2”. We calibrate the six states for  $m$  by breaking down the total health expenditure distribution into four bins of sizes (0–25%; 25–50%; 50–75%; 75–90%; 90–95%; 95%–100%). We do so for each of the following age groups, 21–35, 36–45, 46–55, 56–65, 66–75, and 76–80. The results are reported in Table 3. Then, we compute the corresponding transition matrix for the health expense shock directly from the panel data.<sup>41</sup> In addition, since the MEPS dataset also contains information on whether the EHI is offered and information on education level, we can simply compute the transition matrix for the EHI offer for each education level directly from the data as well. These transition matrices are reported in Table 17.

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<sup>40</sup> Here, we assume that average hours worked per full-time worker is 2000 h, and the number is 1000 h for part-time workers. These numbers are approximately consistent with the averages of all countries in the data.

<sup>41</sup> These transition matrices are available upon request from the authors.

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