Employment-Based Health Insurance, Uncertain Medical Expenses, and Aggregate Labor Supply*

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Abstract

Using a general equilibrium life cycle model with endogenous labor supply and idiosyncratic risks in both income and medical expenses, we argue that employment-based health insurance is an important reason why Americans work much 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. Since medical expenses are large and volatile, and there is no good alternative available in the private market, health insurance from employers can be highly valuable to risk-averse individuals (much more than its actuarially fair cost), thus providing them with extra incentive to work. Our quantitative results suggest that different health insurance systems and uncertain medical expenses can account for more than half of the difference in aggregate hours that Americans and Europeans work. Furthermore, our model is also consistent with several other relevant empirical observations: (1) the differences in employment rate and in the shares of full-time/part-time workers, and (2) the labor supply difference by age. When our model is extended to include the main existing explanation, the taxation hypothesis, the extended model can account for a major portion of the difference in aggregate labor supply between the U.S. and Europe.

Keywords: Labor Supply, Employment-Based Health Insurance, General Equilibrium.
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1. Introduction

It is well known that Americans work many more hours than Europeans (see Prescott, 2004; Rogerson, 2006). For instance, the aggregate hours worked per person (aged 15-64) in the United States are approximately a third higher than in the major European economies (see Table 1).[1] 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.[2] In this paper, we contribute to the literature by proposing a new explanation for the difference between the aggregate hours worked in the U.S. and Europe.

We argue that the unique employment-based health insurance (hereafter EHI) system in the U.S. is an important reason why Americans work much 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.[3] 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 possible to be offered EHI, working-age Americans have a stronger incentive than Europeans both to work and to work full-time.

Extensive empirical evidence suggests that health insurance plays an important role in working-age households' labor supply decisions. For instance, a recent study by Garthwaite, Gross and Notowidigdo (2014) finds that some workers (especially, low-income workers) are employed primarily in order to secure health insurance from their employers. Several other studies find that some workers postpone retirement simply to keep EHI, as they are not eligible for Medicare until age 65.[4] In addition, some studies find that the availabil-

[1] Here, the major economies include France, Germany, UK, and Italy, which are the four largest economies in Europe. As shown in Table 11, the fact remains true when the comparison is extended to include other developed European countries.

[2] For example, Prescott (2004), Rogerson (2006, 2007), Ohanian, Raffo, and Rogerson (2008), Rogerson and Wallenius (2009), and Erosa, Fuster, and Kambrourov (2012).

[3] In the U.S., over 90% of private health insurance coverage is employment-based.

[4] See Rust and Phelan (1997), Blau and Gilleskie (2006, 2008), and French and Jones (2011).

ity of spousal health insurance significantly reduces the labor supply of married women.[5]

Our paper is also motivated by the fact that there are many more full-time workers in the U.S. than in Europe. Using data from the OECD Labor Market Database, we document that a larger share of the American working-age population is working, and a larger share of American workers are working *full-time*. As Table 2 shows, the employment rate in the U.S. is 74.1%, while it is only 63.5%, on average, in four major European countries. In addition, among all American workers, 88.1% are working full-time, while this number is only 83.6% in these European countries. As a result, the full-time employment rate in the U.S. is much higher than in these European countries: 65% versus 53%.[6] A simple back-of-the-envelope decomposition calculation suggests that over two thirds of the difference is due to the differences in the employment rate and full-time worker share.[7]

To formalize the mechanisms described previously, we develop a general equilibrium life-cycle model with endogenous labor supply and idiosyncratic risks in both income and medical expenses.[8] We use a calibrated version of the model to assess the extent to which different health insurance systems and uncertain medical expenses can account for the difference in aggregate labor supply between the U.S. and Europe. First, 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: the EHI system for the working-age population and the universal government-provided public health insurance for the elderly. Then, we construct a counterfactual economy by replacing the EHI system in the model with a government-financed universal health insurance program that mimics the European system. We find that when the EHI system is replaced by a universal health insurance system, the aggregate hours worked in the model decrease by 14%. This suggests that different health insurance systems can account for over a half of the difference in aggregate labor supply between the U.S. and the four major European countries.

[5]Buchmueller and Valletta (1999), Olson (1998), Schone and Vistnes (2000), and Wellington and Cobb-Clark (2000)

[6]As shown in Table 12, the facts remain true when it is extended to include other developed European countries.

[7]The details of the decomposition calculation can be found in the appendix.

[8]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, such as Jeske and Kitao (2009), De Nardi, French, and Jones (2010), Kopecky and Koreshkova (2011), Hansen, Hsu, and Lee (2012), and Pashchenko and Porapakkarm (2013).

In addition, we show that the changes in the employment rate and in the share of full-time workers in the model are also consistent with the data.

Furthermore, we find that our model is also consistent with some relevant life-cycle observations. That is, the difference in hours worked is much larger for individuals at the beginning of their career and for those near retirement. As shown in Table 3, for individuals aged 20-24 and 55-64, the hours worked in Europe are only 57% and 66% of those in the U.S., respectively, while the ratio is 90% for individuals aged 25-54. Our quantitative results show that different health insurance systems and uncertain medical expenses can also generate these life-cycle patterns of hours worked. The intuition behind this result is the following. On the one hand, individuals at the beginning of their careers do not have time to accumulate enough precautionary saving, so they are particularly vulnerable to uncertain medical expenses. On the other hand, medical expenses increase rapidly as individuals approach retirement, but they do not get the government-financed public health insurance until the retirement age of 65. Consequently, EHI has a stronger effect on these two groups than on others in the population.

We also extend our analysis to include the taxation hypothesis, the main existing explanation for the different aggregate labor supply in the U.S. and Europe. As is well known in the literature, the average tax rate on labor income in Europe is approximately 20% higher than that in the U.S.. The higher labor income tax rate lowers the after-tax wage rate and, thus, discourages work. In a computational experiment, we introduce both the European health insurance system and its income tax rate into the benchmark economy, and we find that the aggregate hours worked in the model decreases by 21%. This result suggests that the health insurance hypothesis, together with the existing taxation explanation, can account for a major portion of the difference between the aggregate hours worked in the U.S. and Europe.

Recently, there has been a growing literature that uses quantitative macroeconomic models to account for the different aggregate hours worked in the U.S. and Europe.[9] The most well-known explanation says that different tax rates on labor income can explain the difference in aggregate hours worked in the U.S. and Europe (see Prescott (2004), and

[9]Prescott (2004), Rogerson (2006, 2007), Ohanian, Raffo, and Rogerson (2008), Guner, Kaygusuz, and Ventura (2012), Erosa, Fuster and Kambourov (2012), Wallenius (2013), and Chakraborty, Holter, and Stepanchuk (2014), etc.

Rogerson (2006, 2007) for a detailed description of this hypothesis). However, this explanation has often been criticized for making strict assumptions about labor supply elasticity and how tax revenues are spent. Another important explanation comes from Erosa, Fuster and Kambourov (2012), who study the effects of governmental programs on labor supply. They find that the difference in public pension and disability insurance programs is important for understanding the cross-country difference in aggregate hours worked. However, their model abstracts from health insurance and uncertain medical expenses. Our paper complements Erosa, Fuster and Kambourov (2012) by studying the role of health insurance in understanding the cross-country difference in aggregate labor supply. Our analysis suggests that health insurance may be quantitatively important because aggregate health expenditures have recently risen dramatically in developed countries, and the U.S. health insurance system is unique compared to its European counterparts.[10] In fact, Imrohoroglu (2012) points that "there is probably more significant differences between the U.S. and European countries regarding how health services are delivered" in his discussion of Erosa, Fuster, and Kambourov (2012). We take Imrohoroglu's point seriously by quantitatively evaluating the extent to which the different health insurance systems in the U.S. and Europe account for the difference in aggregate labor supply.[11]

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 conclude in Section 6.

2. The Model

[10]According to OECD health dataset (2014), aggregate health expenditures currently account for approximately 10-20% of GDP in these countries.

[11]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 employer-sponsored health insurance and its link to labor supply decisions.

2.1. The Individuals

Consider an economy inhabited by overlapping generations of agents whose age is $j = 1, 2, ..., T$. 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 ϵ, and medical expense shocks m in each period over the life cycle. An agent's state in each period can be characterized by a vector $s = \{j, a, m, e_h, h, \epsilon, e\}$, where j is age; a is assets; 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

$$\frac{a'}{1+r} + c + (1-\kappa_h)m = a + (\widetilde{w}e\epsilon l - ph')(1-\tau) + b + tr \tag{2}$$

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

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

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. β is the discounting factor, and P_j represents the conditional survival probability to the next period. Equation (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, after-tax earnings net of insurance premium (if any), and the bequest transfer b and welfare transfer tr (the transfers will be discussed in detail later). The left-hand side of the equation shows that the resources are allocated among consumption, out-of-pocket medical expenses, and saving for the next period.

We assume that there are three labor supply choices: full-time, part-time, and no work. Note that equation (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 κ_h 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).[12] Following Jeske and Kitao (2009), we assume that the wage rate is simply $\widetilde{w} = w - c_e$ if EHI is offered, and $\widetilde{w} = w$ 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.

Note that, in this economy, agents face mortality risks after retirement and, thus, may die with positive assets-i.e., accidental bequests. We assume that they are equally redistributed back to all working-age agents alive in the next period, which is captured by b.

After retirement ($j > R$), agents live on their own savings and Social Security payments $SS(e)$, which depend on their education level. Agents are also insured by public health insurance, which covers a κ_m fraction of their total medical expenses. In addition, agents face mortality risk. In each period, retirees make the consumption and saving decision to maximize their expected lifetime utility,

$(P2)$

$$V(s) = \max_{c} u(c, 0) + \beta P_j E[V(s')] \tag{4}$$

subject to

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

$$c \geq 0, \text{ and } a' \geq 0.$$

The medical expense shock m is assumed to be governed by a six-state Markov chain that will be calibrated using the Medical Expenditure Panel Survey (MEPS) dataset. The log of the idiosyncratic labor productivity shock ϵ is determined by the following equation:

$$\ln \epsilon = a_j + y,$$

[12] 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 (2010).

where a_j is the deterministic age-specific component, 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

$$y' = \rho y + u', u' \sim N(0, \sigma_u^2), \tag{6}$$

where ρ is the persistence coefficient.

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_Φ is a one-period operator on the distribution, which will be specified in the calibration section.

2.2. The Government

There are three government programs: Social Security, public health insurance, and the social welfare program. The Social Security program provides agents with annuities after retirement, which are financed by a payroll tax rate τ_s. The public health insurance program provides health insurance to agents after retirement by covering a κ_m portion of their medical expenses, and it is financed by a payroll tax rate τ_m. The welfare program imposes a proportional tax τ_w on labor income and guarantees a minimum consumption floor $\underline{c}$ for everyone by conditioning the welfare transfer tr on each agent's total available resources. That is,

$$\begin{cases} tr(s) = \max\{\underline{c} - (\widetilde{w}e\epsilon l(s)(1-\tau) + a + b), 0\} & \text{if } \ j \leq R \\ tr(s) = \max\{\underline{c} - (SS(e) + a), 0\} & \text{if } \ j > R \end{cases}$$

By construction, $\tau \geq \tau_w + \tau_s + \tau_m$.

The budget constraints for each of these three government programs can be written, respectively, as follows,

$$\int tr(s) d\Phi(s) = \int \tau_w [\widetilde{w}e\epsilon l(s) - ph'(s)] d\Phi(s) \tag{7}$$

$$\int SS d\Phi(s) = \int \tau_s [\widetilde{w}e\epsilon l(s) - ph'(s)] d\Phi(s) \tag{8}$$

$$\int \kappa_m m I_{j \geq R} d\Phi(s) = \int \tau_m [\widetilde{w}e\epsilon l(s) - ph'(s)] d\Phi(s) \tag{9}$$

2.3. The Production Technology

On the production side, the economy consists of two sectors: the consumption goods sector and the health care sector. Production in the two sectors is governed by the same (Cobb-Douglas) production function but with sector-specific total productivity factor (TFP). Assuming that production is taken in competitive firms and that factors can move freely between the two sectors, it is easy to obtain 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.[13] 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, α is the capital share, A is the TFP, K is capital, and L is labor. Assuming that capital depreciates at a rate of δ, the firm chooses K and L by maximizing profits $Y - wL - (r+\delta)K$. The profit-maximizing behaviors of the firm imply that,

$$w = (1-\alpha)A(\frac{K}{L})^{\alpha}$$

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

2.4. The EHI Market

EHI is community-rated. That is, 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 π 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:

$$p = \pi\kappa_h \frac{\int E(m'(s))h'(s)d\Phi(s)}{1+r}. \tag{10}$$

[13]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.

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

$$\int c_e e\epsilon l(s) I_e d\Phi(s) = (1-\pi)\lambda\kappa_h \frac{E\int P_j m'(s) I_{h'(s)=1} d\Phi(s)}{1+r}. \tag{11}$$

Here I_e is the indicator function for whether EHI is offered.

2.5. Market-Clearing Conditions

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

$$K' = \int a'(s) d\Phi(s) \tag{12}$$

$$L = \int e\epsilon l(s) d\Phi(s) \tag{13}$$

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 $\{r, w\}$; Social Security, public health insurance, the social safety net; 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 and labor markets clear-that is, conditions (12)-(13) are satisfied.*

4. *The government programs, Social Security, public health insurance, and the transfer program are self-financing-that is, conditions (7-9) are satisfied.*

5. *The health insurance companies are competitive, and, thus, the insurance contracts satisfy conditions (10)-(11).*

6. *The distribution* $\Phi(s)$*, evolves over time according to the equation* $\Phi' = R_{\Phi}(\Phi)$*, and satisfies the stationary equilibrium condition:* $\Phi' = \Phi$*.*

7. *The amount of initial assets of the newborn cohort is equal to the amount of accidental bequests from the last 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 are born 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:

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

The value of γ is set to two in the benchmark so that the implied labor elasticity is 0.5, which is the consensus value for labor elasticity in the literature (see Chetty, 2012). The disutility parameter for labor supply ζ is calibrated to match the employment rate in the data: 74.1%. The discount factor β is set to match an annual interest rate of 4%, and the resulting value is $\beta = 0.975$.

3.2. Production

The capital share α in the production function is set to 0.36, and the depreciation rate δ 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 U.S. GDP per capita.

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 4 reports the medical expense grids.

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. The transition matrices are calibrated using the MEPS dataset.

The values of κ_h represent 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.

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 hours, 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. Note that full-time and part-time workers face the same wage rate, but full-time workers may have access to EHI.

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 a_j in the labor productivity process is calibrated using the average wage income by age in the MEPS dataset. The random labor productivity component, y, follows a three-state Markov chain that is approximated from the AR(1) process specified by equation (6). The AR(1) process is governed by two parameters $\{\rho, \sigma_\mu^2\}$. Following Alonso-Ortiz and Rogerson (2010), we set the persistence coefficient, ρ, to 0.94, which is also the intermediate value in the range of empirical estimates in the literature. We set the variance, σ_μ^2, to 0.205.

3.5. Government

The tax rate on labor income, τ, is set to 40%, based on the estimation in Prescott (2004). Tax revenues are used to finance the three government programs: Social Security, public health insurance, and the welfare program.

Social Security in the model is designed to capture the main features of the U.S. Social Security program. The Social Security payroll tax rate is set to 12.4%, according to SSA (Social Security Administration) data. Following Fuster, Imrohoroglu, and Imrohoroglu (2007), the Social Security payment is a non-linear function of the agent's lifetime earnings history. 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 self-financing.

The public health insurance program provides health insurance to every individual after age 65 by covering a κ_m fraction of their medical expenses. Here, we assume that public health insurance and EHI provide the same coinsurance rate-i.e., $\kappa_m = \kappa_h$. The payroll tax rate τ_m for public health insurance is endogenously determined by the program's self-financing budget constraint.

The welfare program is supposed to capture the means-tested programs that are available for the U.S. population, such as food stamps, SNAP, and SSI. It insures the poor elderly against large negative shocks by guaranteeing a consumption floor. We set the value of the consumption floor $\underline{c}$ to \$2663 in the benchmark model, based on the estimation by De

Nardi, French, and Jones (2010). The corresponding payroll tax rate τ_w for the welfare program is endogenously chosen such that the welfare program is self-financing.

Note that the value of τ is higher than the sum of τ_s, τ_w, and τ_m. That is, the tax revenues are more than enough to finance the three public programs. We assume that the extra tax revenues are thrown away in each period.

3.6. Baseline Economy

The key results of the benchmark calibration are summarized in Table 5. 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 6 summarizes the key statistics of the benchmark model. Aggregate hours worked are 0.29 (approximately 1445 hours per year), and the employment rate is 76.1%-both consistent with the data. In addition, the share of full-time workers in the model is also consistent with the data (90.0% vs. 88%), even though we did not use it as a target in our calibration exercise. On the health insurance side, 58.9% of the working-age population are covered by EHI, and the take-up rate is 97.0%. Both are consistent with what we observe in the data.

Figures 1 and 2 present consumption and saving profiles in the baseline economy. Both profiles reproduce the empirically observed hump shape and track each other (see Gourinchas and Parker, 2002). The model also generates life-cycle profiles for employment rate and hours worked that are consistent with empirical observations. Based on Figures 3 and 4, both labor force participation and hours worked increase as agents move into their 20s. They peak in their early 30s and remain there until their 50s. Both decline as the mandatory retirement age approaches.

4. Quantitative Results

In this section, we use the calibrated model to assess the quantitative importance of the effect of different health insurance systems on aggregate labor supply. We answer the following quantitative question: To what extent can different health insurance systems account for the difference between the aggregate hours worked in the U.S. and the four major European countries?

4.1. EHI v.s. Universal Health Insurance

Specifically, we run the following thought experiment. We construct a counterfactual economy (experiment I) by replacing the EHI system in the benchmark model with a universal government-financed health insurance that mimics the European system. 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.[14] Table 7 displays the comparison of the key statistics in the two model economies. Figures 5-8 plot the key life-cycle profiles in the benchmark economy and the counterfactual economy.

As can be seen, the aggregate labor supply decreases substantially after the EHI system is replaced with universal government-financed health insurance. The average annual hours worked (aggregate labor supply) in the economy with the European system is only 86% of that in the benchmark economy with the U.S. system. Since the data show that the average annual hours worked in four major European countries is, on average, 76% of that in the U.S., the quantitative result obtained here suggests that more than half 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 effect of EHI is as follows. Since medical care expenses are large and extremely 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). As a result, the EHI system provides working-age Americans extra incentive to work. Because the European system offers universal health insurance coverage to the entire working age population, and thus it does not provide such work incentives.

We will conduct further analysis of some intermediate cases in Section 5 to provide more insights into the way the EHI system affects labor supply.

[14]Note that universal government-financed health insurance is assumed to be financed by lump-sum taxes, so the labor supply effect does not include the labor supply distortions from income taxation.

4.2. Hours Worked By Age

It is noteworthy that there are interesting life-cycle patterns with regard to the hours worked in the U.S. and Europe. That is, the difference in hours worked is much larger for individuals at the beginning of their career and those near retirement. As shown in Table 3, for individuals aged 15-24 and those aged 55-64, the hours worked in the four major European countries are only 73% and 57%, respectively, of those in the U.S., while the ratio is 87% for individuals aged 25-54.[15] We argue that it is important that the potential explanations of the difference in aggregate labor supply between the U.S. and Europe are also consistent with these life-cycle patterns.

Table 8 presents the hours worked by different age groups in both the benchmark economy and the counterfactual economy. As can be seen, our model is also consistent with the life-cycle patterns of hours worked documented in the data. That is, the difference in hours worked between the two model economies is significantly larger for agents aged below 25 and aged 55-64 than for agents aged 25-54. We argue that the mechanisms behind these life-cycle results are as follows. On the one hand, agents in the early stage of life do not have time to accumulate enough precautionary saving, so they are particularly vulnerable to uncertain medical expenses. On the other hand, medical expenses increase rapidly as agents approach retirement; therefore, the labor supply of agents near retirement is also affected more by medical expense risks.

4.3. 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 Europeans 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. According to our quantitative results, that is not the case.

We find that the decrease in aggregate hours worked is due mainly to low-productivity

[15]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.

agents who choose to work primarily to secure health insurance. This result suggests that the extra hours that Americans work may not add much to the aggregate effective labor in the US. As shown in Table 7, when the EHI system is replaced by a universal health insurance system, the aggregate raw labor (aggregate hours worked) decreases by 14%, but the aggregate effective labor drops by only 3%, and, thus, the output per person also drops by 3%. 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 be also due to other factors, such as technology.

5. Further Discussion

5.1. 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 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 $e_h = 1$. Table 7 presents the key statistics of the intermediate economy. As can be seen, the aggregate labor supply decreases substantially after the linkage between EHI and labor supply choices is removed. The average annual hours worked (aggregate labor supply) in this intermediate case is only 92% of that in the benchmark economy. This result highlights the key mechanism of the paper, which is that 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.[16]

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 ques-

[16]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.

tion, 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 aggregate labor supply decreases substantially after the tax exemption policy is removed. The average annual hours worked (aggregate labor supply) in this intermediate case is only 91% 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.[17] 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 72% when the tax exemption policy is removed. As a result, the health insurance premium increases from \$3181 to \$4410, and the share of the working-age population with holding EHI drops from 59% to 37%.

5.2. The Taxation Hypothesis

In this section, we extend our analysis to include the taxation hypothesis-the main existing explanation for the difference between aggregate labor supply in the U.S. and Europe. This hypothesis argues that different tax rates on labor income can account for the difference in hours worked in the U.S. and Europe (see Prescott, 2004; Rogerson, 2006). The tax rate on labor income discourages work because it reduces the after-tax wage rate. In the rest of this section, we consider the following quantitative question: Can the model account for the entire difference between aggregate hours worked in the U.S. and the four major European countries when different tax rates are also included?

As Prescott (2004) estimates, the U.S. tax rate is approximately 40%, while the average tax rate in Europe is 60%. To include the taxation mechanism, we construct another counterfactual economy (experiment II) by changing both the health insurance system and the labor income tax rate. That is, we replace the EHI system with a universal government-

[17] Note that EHI is group-rated, and, thus, it may suffer from adverse selection.

financed health insurance, and raise the tax rate on labor income, τ, from 40% to 60%.[18] We compare this counterfactual economy to the benchmark economy to identify the joint effect of different health insurance systems and different tax rates on labor supply, as well as other variables of interest. The key statistics in this counterfactual economy are reported in Table 9.

As the table shows, the aggregate labor supply decreases further after the taxation mechanism is incorporated. The average annual hours worked in this counterfactual is only 79% of that in the benchmark economy. Since the average annual hours worked in the four major European countries is, on average, 76% of that in the U.S., the quantitative result obtained here suggests that different health insurance systems together with the taxation hypothesis can account for a major portion of the difference in aggregate labor supply between the U.S. and these European countries.

5.3. Alternative Health Insurance

Thus far, we have assumed that EHI is available only through the agent's own employer. However, working-age Americans may also receive health insurance through their spouse's employer. In the benchmark economy, we do not model spousal coverage due to its complexity and the lack of information on its dynamics in the data. To shed some light on the importance of spousal coverage in understanding the labor supply effect of EHI, we conduct the following robustness check. Specifically, we introduce one more individual state variable, e_s, to indicate whether spousal insurance is available to the agent. We assume that the spousal coverage is as generous as the insurance through the agent's own employer. Note that spousal coverage is not conditional on job status; therefore, agents with spousal coverage do not have the incentive to work for health insurance.

To assess quantitatively how spousal coverage affects labor supply, we simply recompute the stationary equilibrium in this extended model with spousal coverage, and compare it to the benchmark economy.[19] We use the MEPS dataset to estimate the probability of getting spousal coverage in each period. In the data, approximately 34% of working-age

[18] Following the tradition in the literature (e.g., Prescott,2004), we equally redistribute the tax revenues resulting from the increase in the tax rate back to the working-age population.

[19] We do not describe the individual's problem again for the extended model with spousal coverage because it is the same as the problem in the benchmark model except for the extra state variable e_s.

males who receive EHI are both married and working full-time. In one experiment, we set the probability of getting spousal coverage to match this fraction, and we find that the aggregate hours worked in this extended model is 2% lower than that in the benchmark economy. Note that this result provides the upper bound for the impact of spousal coverage on labor supply. The actual impact of spousal coverage may be even smaller because (1) not all employers offer spousal coverage, and (2) the spousal coverage is usually not as generous as the coverage through the agents' own employers. Overall, this robustness check exercise suggests that our main results are not sensitive to this modeling choice.

We also assume that there is no individual health insurance available in the private market because the individual health insurance market features price discrimination and, thus, offers very limited risk-sharing. As a result, most working-age Americans without EHI do not buy individual health insurance as a substitute. 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.

6. Conclusion

In this paper, we provide a new explanation for the substantial difference in aggregate labor supply between the U.S. and Europe. We argue 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. Since only full-time workers are possible to be offered with EHI, working-age Americans have a stronger incentive than Europeans to both work and work *full-time*.

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 different health insurance systems can account for more than half the difference in average hours worked in the U.S. and Europe. When the different tax rates on labor income are also included, the model accounts for a major portion of the difference in aggregate labor. Furthermore, our model can also match some interesting life-cycle patterns of hours worked. That is, the difference in hours worked is much larger for individuals at the beginning of their careers and for those near retirement.

Lastly, we find that the extra hours that Americans work are mainly by low-productivity workers who work primarily to secure health insurance. Therefore, the difference in aggregate effective labor between the U.S. and Europe may be much smaller. This result suggests that the higher output per capita in the U.S. may not be mainly due to the fact that Americans work more hours. Instead, the different per capita outputs may still be driven by other factors, such as different technology levels.

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7. Appendix: 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_f 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 $\widehat{h}$ for each country by plugging in the country-specific employment rates and full-time worker shares but the same h_f and h_p.[20] The results are reported in Table 10. 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, 0.83 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.

[20]Here, we assume that average hours worked per full-time worker is 2000 hours, and the number is 1000 hours for part-time workers. These numbers are approximately consistent with the averages of all countries in the data.

Table 1: Aggregate Labor Supply: U.S. vs. Four Major European Countries

	Annual Hours Worked per person (age 15-64)	Compared to the US (U.S.=1)
U.S.	1360	1
France	940	0.69
Germany	965	0.71
Italy	980	0.72
UK	1227	0.90
Average (Major 4)	1028	0.76

Data source: OECD Labor Market Data (2000).

Table 2: Full-time Workers: U.S. vs. Four Major European Countries

	Employment Rate	FT Share (% of All Workers)	FT Employment Rate(relative to the U.S.)	Annual Hours Worked (relative to the U.S.)
U.S.	74.1%	88.1%	65.31%(1)	1
France	61.7%	85.9%	53.0%(0.81)	0.69
Germany	65.6%	82.8%	54.3%(0.83)	0.71
Italy	53.9%	87.9	47.4%(0.73)	0.72
UK	72.2%	77.8%	56.2%(0.86)	0.90
Average(Major 4)	63.4%	83.6%	53.0%(0.81)	0.76

Data source: OECD Labor Market Data (2000).

Table 3: Annual Hours Worked By Age: U.S. vs. Four Major European Countries

	Ages 15-24 (relative to the U.S.)	Ages 25-54 ..	Ages 55-64 ..
U.S.	1	1	1
France	0.51	0.89	0.46
Germany	0.88	0.89	0.59
Italy	0.54	0.80	0.47
UK	0.98	0.89	0.76
Average(Major 4)	0.73	0.87	0.57

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

Table 4: 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.

Table 5: The Benchmark Calibration

Parameter	Value	Source
α	0.36	Macro literature
δ	0.06	Macro literature
γ	2	Chetty (2012)
A	680	U.S. GDP per capita: $36467
τ	40%	Prescott(2004)
τ_s	12.4%	U.S. Social Security tax rate
κ_h, κ_m	0.8	U.S. data
β	0.975	Annual interest rate: 4.0%
π	0.2	Sommers(2002)
ζ	0.85	Employment rate: 74.1%
ρ	0.94	Alonso-Ortiz and Rogerson (2010)
σ_μ^2	0.205	Alonso-Ortiz and Rogerson (2010)

Table 6: Key Statistics of the Benchmark Economy

Statistics	Model	Data
Output per person	$37482	$36467
Interest rate	3.9%	4.0%
Aggregate hours worked	0.29 (appr. 1445 hours)	1360 hours
Employment rate	76.1%	74.1%
Full-time worker share	90.0%	88.1%
% of working-age popu. with ESHI	58.9%	59.4%
ESHI take-up rate	97.0%	96%

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	$37482	$36455	$ 36541	$36005
Interest rate	3.9%	3.9%	3.9%	4.0%
Aggregate hours worked	0.290	0.250	0.266	0.263
(relative to the benchmark)	(1)	(86%)	(92%)	(91%)
Employment rate	76.1%	67.2%	72.9%	74.6%
Full-time worker share	90.0%	85.6%	82.8%	79.1%
Aggregate effective labor	0.680	0.660	0.662	0.659
% of working-age popu. (with ESHI)	58.9%	..	70.5%	36.9%
ESHI take-up rate	97%	..	83%	72%
ESHI premium	$3181	..	$3048	$4410

Table 8: Aggregate Hours Worked By Age: Model vs. Data

	Age 15-24	Age 25-54	Age 55-64
Data			
Four major European countries (relative to the U.S.)	0.73	0.87	0.57
Model			
Counterfactual (with Eur HI) (relative to the benchmark)	0.84	0.88	0.82

Table 9: The Taxation Hypothesis

Statistics	Benchmark	Experiment I (Eur HI)	Experiment II (Eur HI+ Eur tax)
Output per person	$37482	$36455	$33310
Interest rate	3.9%	3.9%	4.5%
Aggregate hours worked	0.29	0.25	0.23
(relative to the benchmark)	(1)	(86%)	(79%)
Employment rate	76.1%	67.2%	68.9%
Full-time worker share	90.0%	85.6%	66.5%
Aggregate effective labor	0.680	0.660	0.626

Table 10: Aggregate Labor Supply: Decomposition

	Actual Annual Hours Worked: h (relative to the U.S.)	Constructed annual hours worked: $\widehat{h}$ (relative to the U.S.)
U.S.	1	1
France	0.69	0.82
Germany	0.71	0.86
Italy	0.72	0.73
UK	0.90	0.92
Average (Major four)	0.76	0.83

Data source: OECD Labor Market Data (2000).

Table 11: Aggregate Labor Supply: U.S. vs. Europe

	Annual Hours Worked per person (ages 15-64)	Compared to the US (U.S.=1)
U.S.	1360	1
France	940	0.69
Germany	965	0.71
Italy	980	0.72
UK	1227	0.90
Average (Major 4)	1028	0.76
Austria	1258	0.92
Belgium	941	0.69
Ireland	1119	0.82
Netherlands	1035	0.76
Spain	994	0.73
Switzerland	1323	0.97
Portugal	1223	0.90
Greece	1191	0.88
Norway	1133	0.83
Sweden	1220	0.90
Finland	1182	0.87
Denmark	1208	0.89
Average (exclude Scan.)	1100	0.81
Average (all)	1121	0.82

Data source: OECD Labor Market Data (2000).

Table 12: Full-time Workers: U.S. vs. Europe

	Employment Rate	FT Worker (% of All Workers)	FT Employment Rate	FT Employment Rate (relative to the U.S.)	Annual Hours Worked (relative to the U.S.)
U.S.	74.1%	88.1%	65.31%	1	1
France	61.7%	85.9%	53.0%	0.81	0.69
Germany	65.6%	82.8%	54.3%	0.83	0.71
Italy	53.9%	87.9%	47.4%	0.73	0.72
UK	72.2%	77.8%	56.2%	0.86	0.90
Average(Major 4)	63.4%	83.6%	53.0%	0.81	0.76
Austria	68.3%	87.8%	60.0%	0.92	0.92
Belgium	60.9%	81.0%	49.3%	0.76	0.69
Ireland	65.1%	81.9%	53.3%	0.82	0.82
Netherlands	72.1%	67.9%	48.9%	0.75	0.76
Spain	57.4%	92.3%	53.0%	0.81	0.73
Switzerland	78.4%	75.6%	59.3%	0.91	0.97
Portugal	68.3%	90.6%	61.9%	0.95	0.90
Greece	55.9%	94.6%	52.9%	0.81	0.88
Norway	77.9%	79.8%	62.2%	0.95	0.83
Sweden	74.3%	86.0%	63.9%	0.98	0.90
Finland	67.5%	89.6%	60.5%	0.93	0.87
Denmark	76.4%	83.9%	64.1%	0.98	0.89
Average(exclude Scan.)	65%	84%	54%	0.83	0.81
Average(all)	67%	84%	56%	0.86	0.82

Data source: OECD Labor Market Data (2000).

Figure 1: Life-Cycle Profile in the Benchmark Economy: Consumption

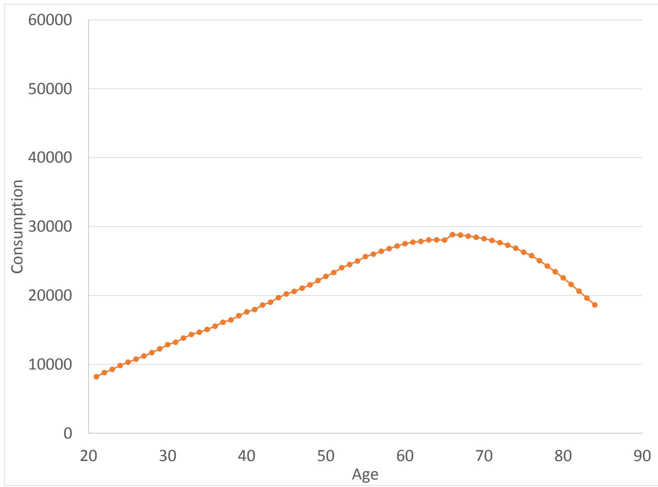


Figure 2: Life-Cycle Profile in the Benchmark Economy: Saving

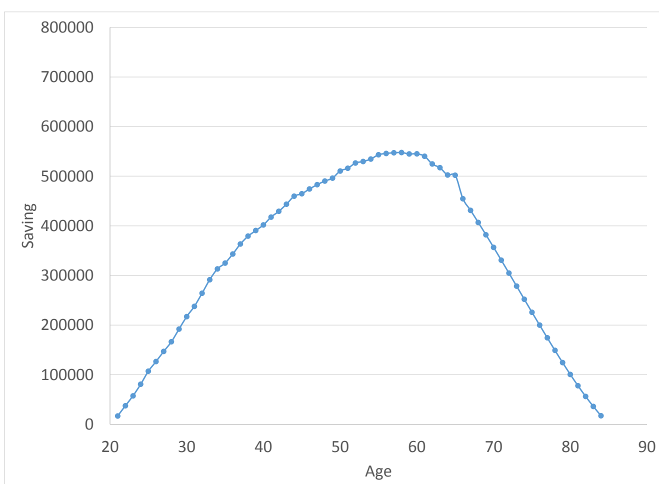


Figure 3: Life-Cycle Profile in the Benchmark Economy: Employment Rate

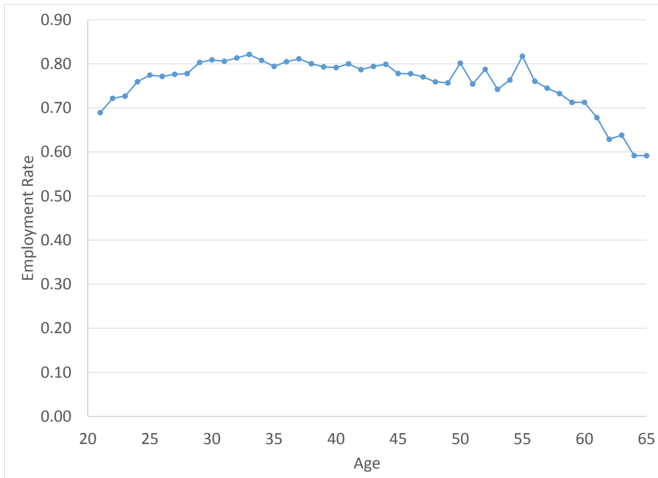


Figure 4: Life-Cycle Profile in the Benchmark Economy: Labor Supply (hours worked)

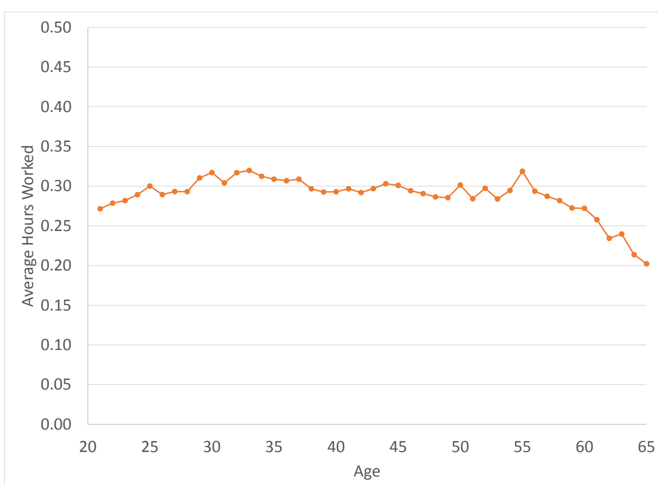
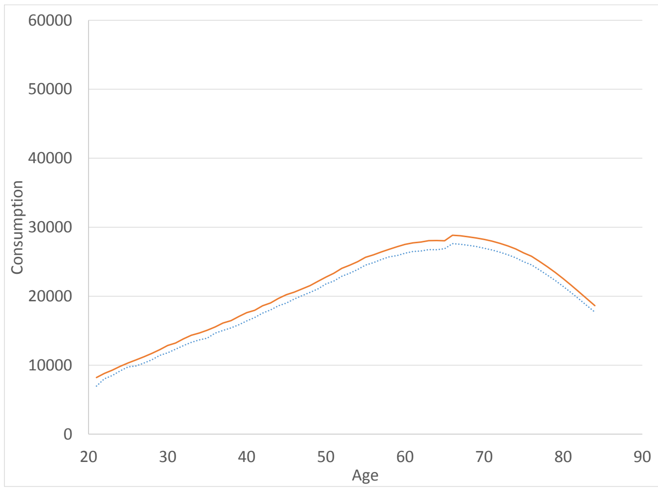
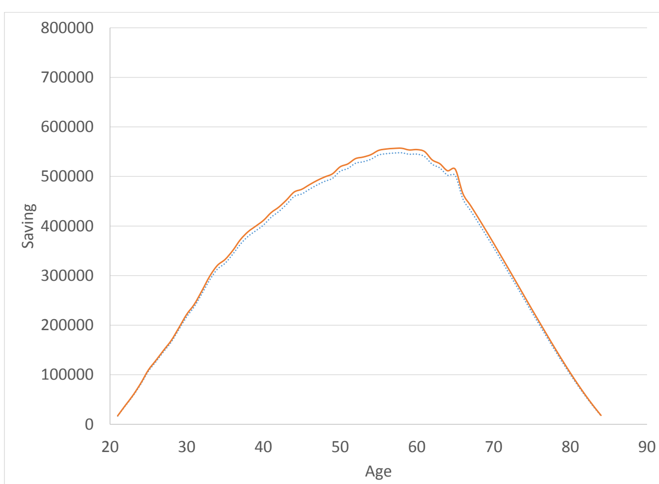


Figure 5: Benchmark vs. Counterfactual (U.S. vs. EUR): Consumption



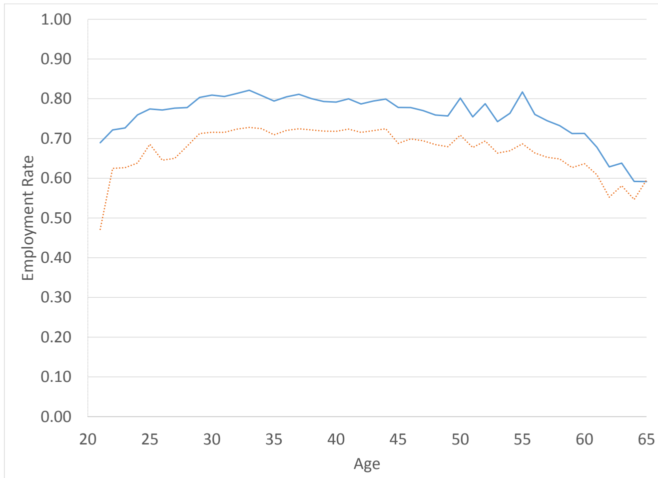
Note: the dashed line represents the counterfactual.

Figure 6: Benchmark vs. Counterfactual (U.S. vs. EUR): Saving



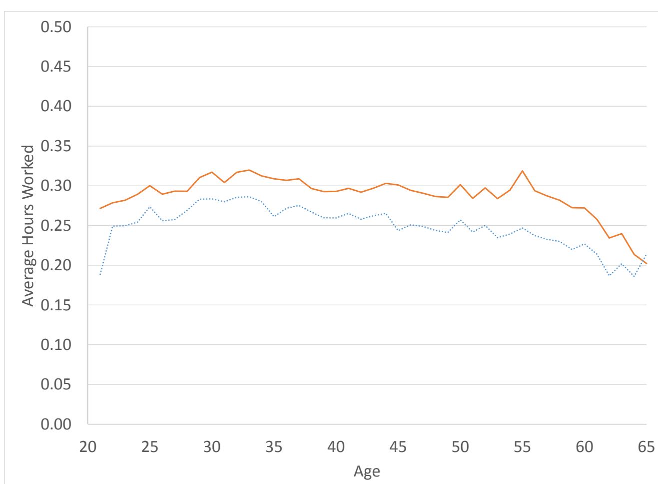
Note: the dashed line represents the counterfactual.

Figure 7: Benchmark vs. Counterfactual (U.S. vs. EUR): Employment Rate



Note: the dashed line represents the counterfactual.

Figure 8: Benchmark vs. Counterfactual (U.S. vs. EUR): Labor Supply (hours worked)



Note: the dashed line represents the counterfactual.