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INTERACTION OF THE LABOR MARKET AND THE HEALTH INSURANCE SYSTEM:  
EMPLOYER-SPONSORED, INDIVIDUAL, AND PUBLIC INSURANCE

Naoki Aizawa  
Chao Fu

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Interaction of the Labor Market and the Health Insurance System: Employer-Sponsored, Individual, and Public Insurance

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**ABSTRACT**

We study regulations on the health insurance system for working-age U.S. households, consisting of employer-sponsored health insurance (ESHI), individual health insurance exchange (HIX), and Medicaid. We develop and estimate an equilibrium model with rich heterogeneity across local markets, households, and firms, which highlights the inter-relationship between various components of the health insurance system as well as their relationship with the labor market. We estimate the model exploiting variations across states and policy environments before and after the Affordable Care Act. In counterfactual experiments, we consider policies to cross subsidize between ESHI and HIX, which include pure risk pooling between the two markets as a special case. We find such policies would benefit most households, improve average household welfare, and decrease government expenditure. Furthermore, the welfare gains are larger if the cross subsidization is interacted with Medicaid expansion.

Naoki Aizawa

Department of Economics

University of Wisconsin-Madison

1180 Observatory Drive

Madison, WI 53706

and NBER

naizawa@wisc.edu

Chao Fu

Department of Economics

University of Wisconsin - Madison

1180 Observatory Drive

Madison, WI 53706

and NBER

cfu@ssc.wisc.edu

A data appendix is available at <http://www.nber.org/data-appendix/w26713>

# 1 Introduction

For the vast majority of working-age households in the U.S., health insurance is attainable via three channels: employer-sponsored health insurance (ESHI), the individual insurance market, currently known as the health insurance exchange (HIX), and public insurance mainly via Medicaid. Among the three, ESHI is by far the most popular channel. For example, in 2015, of the U.S. population aged 22 to 64, 68% was insured via own or spousal ESHI; around 10%, those at the lower end of the income distribution, was insured via Medicaid; and among the remaining 22%, about a third was covered via HIX.<sup>1</sup>

Under current health insurance regulations, once choosing a job with ESHI or earning an income low enough to qualify for Medicaid, a household is largely segregated from the risk pool on HIX.<sup>2</sup> Together with the low insured rate in the U.S. relative to other developed countries, such a segregated risk pool structure has triggered a series of heated policy debates. The most radical idea, known as “Medicare for all,” is to merge the entire U.S. population into one single risk pool. More moderately, various incentive schemes have been proposed to enlarge and improve the risk pool on HIX, typically by incentivizing uninsured households to participate in HIX. A new development is the Health Reimbursement Arrangement (HRA), which incentivizes small firms to insure their employees via HIX. Like ESHI, HRA is bundled with a job and offered by firms that include health insurance in their compensation schemes; but unlike ESHI, the insured are in the risk pool on HIX.

Although specifics differ, all of these existing policy debates share the common theme of how to structure health risk pooling in the population. Associated with these debates, a natural but yet-to-be-answered question arises: what would various risk pool structures imply for the welfare of the overall population and the welfare of various subpopulations?

To answer this question properly, one has to consider several key factors. First, the U.S. health insurance system is closely linked to the labor market. Directly, most of the working age population obtains insurance from their employers, which *choose* to offer health insurance benefits. Indirectly, household income is a key determinant of Medicaid eligibility and subsidies for HIX purchases. Second, various insurance channels are inter-connected because households sort into different insurance options (including staying uninsured) in the equilibrium. Third, the efficiency-equity policy trade-off depends on heterogeneity across households and firms. Household choices differ across demographic groups and across seemingly similar households. Similarly, ESHI offering appears to be related to firms’ labor demand: larger firms (i.e., firms with a larger labor demand) and firms with higher fractions of skilled employees (i.e., firms demanding more skilled labor) tend to offer ESHI. A policy change on the ESHI market, for example, may have differential impacts on different firms, and via

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<sup>1</sup>Statistics are calculated from the American Community Survey.

<sup>2</sup>For example, the existing medical loss ratio regulation imposes that the premium in each Market  $k \in \{\text{ESHI}, \text{HIX}\}$  should closely reflect the risk among those insured within Market  $k$ .

worker-firm sorting, on different types of households. Finally, the composition of households and policy environments differ across states, e.g., Medicaid eligibility rules are state-specific. The impact of any counterfactual risk pool structure is likely to vary with these state-specific components.<sup>3</sup>

In this paper, we provide a coherent framework incorporating all these factors. We develop and estimate an equilibrium model, where each state is a market consisting of a labor market and two insurance markets (HIX and ESHI). Markets are subject to various regulations, which may vary across states and policy eras. Each state consists of a distribution of firms and households. Households differ in their demographics (including health), skill levels and tastes. Skills and tastes are unobservable to the researcher and may be distributed differently across states. A household chooses, for each adult member, between full-time jobs with and without ESHI, part-time jobs with and without ESHI, and non-employment. It also makes decisions about Medicaid enrollment (if eligible) and individual health insurance purchases. Firms differ in their overall productivity and the degree to which their technologies are skill-biased. Each firm chooses whether or not to offer ESHI, and the number of workers in each (skill, full/part time) category, which are imperfect substitutes for one another. Wages and premiums for HIX and ESHI clear the corresponding markets in the equilibrium.

To estimate this model, which allows for unobserved heterogeneity across households, firms and states, one needs data with rich variation. We utilize the opportunity provided by the 2010 Affordable Care Act (ACA) and exploit 1) policy variation before and after the ACA; 2) the targeted nature of certain components of the ACA that created variation in policy doses received by different firms and/or households in the same market; and 3) the differential implementation across states of Medicaid expansion, which leads to policy variation across states under the ACA. We estimate the model via indirect inference, fully exploiting the aforementioned variation under the assumption that the *state-specific* distribution of unobservables is the same pre and post ACA (conditional on observables).

We use both pre- and post-ACA data from the American Community Survey, the Current Population Survey, Medical Expenditure Panel Survey, and the Kaiser Family Employer Health Insurance Benefit Survey. The first three data sets provide information on household characteristics, labor supply and health insurance choices, earnings, and medical expenditure; while the fourth provides information on firm size, ESHI provision, and employee composition in terms of wage levels and full/part time status. For the purpose of model validation, we deliberately leave the post-ACA data for a non-random sample of states out of the estimation. The estimated model matches patterns in both the estimation and the hold-out samples.

Our estimation results suggest a positive correlation between worker skill and their preferences for health insurance. In the equilibrium, high-skill workers are more likely to sort into firms offering ESHI, whose technologies are more likely to be skill-biased. Households who choose to be non-employed or earn wages low enough to be eligible for Medicaid are more likely to be at the lower end

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<sup>3</sup>See, for example, Kowalski (2014) and Garthwaite et al. (2019).

of the skill distribution. Thus, households at both ends of the skill distribution are largely segregated from the risk pool on HIX. Unlike ESHI, HIX insurance is not bundled with one's job and hence may be more susceptible to adverse selection.<sup>4</sup>

Given these findings, a natural thought experiment is to break the segregation of risk pools. However, a thought experiment would be of little practical value if it is hard to implement. We consider new policy schemes that largely desegregate risk pools but involve little change to the health insurance system. Specifically, these schemes regulate the ESHI-HIX premium differential by taxing ESHI insurers and transferring the tax revenue to subsidize HIX insurers (e.g., by implementing risk adjustment transfers *between* ESHI and HIX). These schemes differ in their tax rates (degrees of cross subsidization), of which pure risk pooling between ESHI and HIX is a special case. We find that average household welfare would increase by \$189 to \$340 (as measured by annual consumption equivalent variation), depending on the degree of cross subsidization, and that over 70% of households would gain in each case. Government expenditure would decrease. The uninsured rate would decrease by 0.1 to 0.3 percentage point (ppt) from the baseline (the ACA environment in 2015), and full-time employment would increase by 0.1 ppt. Furthermore, when we contrast the impact of ESHI-HIX cross subsidization for the same state if it did and did not expand Medicaid, we find that ESHI-HIX cross subsidization would lead to higher welfare gains with Medicaid expansion.

Our paper contributes to the literature on the link between the health insurance system and the labor market,<sup>5</sup> especially those aimed at exploring counterfactual policies.<sup>6</sup> Within this branch, one set of studies use individual decision models (e.g., Rust and Phelan (1997), French and Jones (2011), and De Nardi et al. (2016)). Pohl (2018) studies the effect of pre-ACA Medicaid policies; French et al. (2018) study the impact of the ACA on retirement, savings, and welfare. Another set of studies use labor market equilibrium models. Dey and Flinn (2005) estimate a search and bargaining model with endogenous ESHI. Aizawa and Fang (2020), Aizawa (2019), and Fang and Shephard (2019) estimate their models using pre-ACA data and simulate the impact of various components of the ACA (e.g., HIX subsidies for households and tax treatments of ESHI for employers).<sup>7</sup>

Our paper well complements these studies. First, we have the different goal of exploring policies that desegregate risk pools between ESHI and HIX, and how such policies interact with Medicaid. Second, we incorporate richer heterogeneity at multiple levels. We model how households with different skills, health conditions, and demographics sort into various insurance options. We account for the fact that a given change in risk pool regulations may affect different states differently, which

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<sup>4</sup>HRA policy was absent in our sample period. In both the data and the model, ESHI-covered households are more likely to be healthy than HIX participants and the uninsured, who are in turn healthier than Medicaid beneficiaries.

<sup>5</sup>See Currie and Madrian (1999) and Gruber (2000) for reviews of earlier work in this literature.

<sup>6</sup>Our paper also relates to the set of work on the impact of in-kind public benefits (e.g., Keane and Moffitt (1998), Chan (2013), Blundell et al. (2016), Low et al. (2018) and Gayle and Shephard (2019)).

<sup>7</sup>See Pashchenko and Porapakkarm (2013), Nakajima and Tuzemen (2017), and Ozkan (2017) for examples of macroeconomic analysis of the ACA.

would be ignored if one treats the entire nation as one homogeneous market. We also allow for two-dimensional firm productivity heterogeneity, which helps to explain not only why larger firms tend to offer ESHI, but also why firms with higher fractions of skilled employees (regardless of their sizes) tend to offer ESHI. Modeling this second layer of worker-firm sorting is important because the same policy may have differential impacts on different firms and different types of households. Moreover, many policies are targeted directly at firms, which calls for a better understanding of firm heterogeneity. Third, instead of evaluating the ACA’s impact via counterfactual simulations, we exploit policy variation associated with the ACA to estimate our model in order to study the effect of a new set of counterfactual policies with relatively less dependence on the model structure.

Our paper also complements the design-based literature on health insurance reforms, e.g., Finkelstein et al. (2012), Kolstad and Kowalski (2012), Garthwaite et al. (2014), Baicker et al. (2014), Hackmann et al. (2015), and Kolstad and Kowalski (2016). Examples studying the ACA include Kowalski (2014), Gooptu et al. (2016), Frean et al. (2017), Kaestner et al. (2017), Leung and Mas (2018) and Garthwaite et al. (2019).

A different but related literature focuses on policy designs on insurance markets in the presence of selection (see Einav et al. (2010) and Chetty and Finkelstein (2013) for reviews). A set of studies, e.g., Handel et al. (2015), Azevedo and Gottlieb (2017), Einav et al. (2019), Finkelstein et al. (2019b), have conducted in-depth analysis focusing on the individual health insurance market. We complement these studies and consider risk pooling across HIX and ESHI.

In the following, Section 2 briefly describes ACA policies; Section 3 illustrates the main idea with a simple model; Section 4 presents the full model; Sections 5, 6 and 7 describe the data, the estimation strategy and results; Section 8 conducts counterfactual experiments; Section 9 concludes.

## 2 Background Information

We use sample periods both pre and post ACA (2012 and 2015) to exploit variation associated with the ACA, which consists mainly of five components.

**Individual Mandate:** Since 2014, individuals are required to have a health insurance plan that meets minimum standards, or pay a tax penalty that varies with household income and household size.<sup>8</sup> In 2015, the penalty was the maximum of a) 2% of household income in excess of the 2015 income tax filing thresholds and b) \$325 per adult plus \$162.5 per child, up to \$975 per household.

**Employer Mandate:** Starting in 2015, every employer with more than  $N$  full-time-equivalent employees is required to provide a health insurance plan meeting minimum standards to full time employees (average weekly hours  $\geq 30$ ) and their dependent children, or pay a tax penalty. In 2015,  $N = 100$ , and starting from 2016,  $N = 50$ . The tax penalty is \$2,000 (indexed for future years) for

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<sup>8</sup>The individual mandate was abolished in 2019.

each full-time employee, excluding the first 30 employees.

**Health Insurance Exchanges (HIX)** are *state-based*, established in 2014. An individual can purchase a plan from insurers *only* in his/her state. The design of health insurance plans is government-regulated and categorized into four plans with different levels of generosity: bronze, silver, gold, and platinum. Insurers need to offer the same plans to every consumer. Insurance premiums are subject to modified community rating: premiums are based only on age and smoking status, with the variation specified by the government.<sup>9</sup>

**Income-Based Subsidies for Plans from HIX:** Participants on HIX may obtain both premium and coinsurance subsidies. Individuals are eligible for subsidies if 1) they are unable to get affordable coverage through an eligible employer plan that provides the minimum generosity; 2) they are ineligible for any other government health insurance program (e.g., Medicaid); and 3) their household income is between 100% and 400% of the Federal Poverty Line (FPL). The subsidy amount varies by income, family size, and states of residence: the maximum premium contribution by the household is 2% (9%) of its income if its household income is around 100% (400%) of FPL.<sup>10</sup> In addition, individuals purchasing the silver plan can obtain an income-based tax credit.

**Medicaid:** The ACA specifies (not mandates) that Medicaid expand to cover the uninsured whose household income is below 133% of FPL. By 2015, 32 states (including DC) had complied.<sup>11</sup>

### 3 A Simple Model for Illustration

To illustrate the implications of risk pool segregation, consider a simple economy with a competitive labor market and two competitive insurance markets (ESHI and HIX). There is a continuum of workers with the same skill and the same concave preference over consumption  $U(\cdot)$ , but different health risks  $x \in (0, \bar{x})$  and disutility of work  $d \in (0, \bar{d})$ , drawn from  $F(x, d)$ . If  $x > x'$ , the distribution of medical cost  $G(c^{med}|x)$  first-order-stochastically dominates  $G(c^{med}|x')$ . A worker chooses  $(h, z_1) \in \{(0, 0), (1, 0), (1, 1)\}$ , where  $h$  denotes whether or not one works, and  $z_1$  denotes whether or not the job has ESHI. If  $z_1 = 0$ , one can choose whether or not to enroll in HIX  $z_2 \in \{0, 1\}$ . A worker is uninsured if  $z_1 = z_2 = 0$ . There is a continuum of firms with homogeneous production technologies, which decide whether to offer ESHI  $z_1$  and how many workers to hire. Health insurance is available only via ESHI or HIX. Both markets offer an identical insurance product, which fully insures health risks, and neither market can price discriminate. The insurance premium on each market is equal to the average medical cost among enrollees in that market (*risk pool segregation*).

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<sup>9</sup>Regulations are set by the federal government, based on which, state governments can set further restrictions.

<sup>10</sup>If states offer Medicaid to individuals whose income is below 100%, then they are not eligible for these subsidies. For additional details, see <https://www.irs.gov/Affordable-Care-Act/Individuals-and-Families/Questions-and-Answers-on-the-Premium-Tax-Credit>

<sup>11</sup>Most states in the Northeast complied, while only half of the states in the South did.

Equilibrium prices include the premium on HIX ( $r$ ), the premium on ESHI ( $q$ ) and the wage rate for each type of jobs ( $w = [w_0, w_1]$ ).

**Worker's Problem** Given  $(r, w)$ , a worker's problem is

$$\begin{aligned} & \max_{h, z_1, z_2} E[U(C(h, z_1, z_2)) | x] - dh \\ \text{s.t. } & C(h, z_1, z_2) = (1 - h)b + hw_{z_1} - z_2r - (1 - z_1)(1 - z_2)c^{med}, \end{aligned} \quad (1)$$

where  $C(\cdot)$  is one's net consumption, and the expectation is taken over  $c^{med}|x$ . One's income is  $b$  ( $w_{z_1}$ ) when non-employed (employed with  $z_1$ ).<sup>12</sup> If  $z_2 = 1$ , one pays the HIX premium  $r$ . If uninsured ( $(1 - z_1)(1 - z_2) = 1$ ), one pays a random medical cost  $c^{med}$ .

A worker's problem can be solved via backward induction, and as shown in Online Appendix A, optimal decisions at both stages follow cutoff rules. At Stage 2 (HIX choice  $z_2$ ), given  $z_1 = 0$  and  $h$ , there is an  $x^*(y, r)$ , with  $y = (1 - h)b + hw_0$ , such that a worker would choose  $z_2 = 1$  if  $x > x^*(y, r)$ .<sup>13</sup> At Stage 1 (employment choice  $(h, z_1)$ ), for each  $x$ , there is a  $d^*(x; w, r)$ , such that one would work if  $d \leq d^*(x; w, r)$ ; in addition, there exists an  $x^{**}(w, r)$ , such that  $z_1 = 1$  if  $x > x^{**}(w, r)$ . For both HIX and ESHI, workers with higher health risks tend to enroll (adverse selection), and the severity of adverse selection may differ across the two markets in the equilibrium.

**Firm's Problem** Firm solve the following

$$\max_{z_1, n} f(n) - z_1(w_1 + q)n + (1 - z_1)w_0n.$$

Optimality requires that  $f'(n^*) = w_1 + q$  if  $z_1 = 1$  and  $f'(n^*) = w_0$  if  $z_1 = 0$ .

**Equilibrium with both ESHI and Non-ESHI Jobs** We focus on equilibriums when both types of jobs exist, as is the case in the U.S. In these equilibriums,  $w_0 - w_1 \leq r$ ; otherwise, ESHI jobs are inferior to non-ESHI jobs for all workers, and the supply for ESHI jobs would be zero. If  $w_0 - w_1 = r$ , it follows that  $q = r$ , i.e., ESHI and HIX markets feature the same degree of adverse selection. If  $w_0 - w_1 < r$ , then 1) all employed workers who are insured are enrolled in ESHI, and all HIX enrollees are non-employed; 2)  $q < r$ , i.e., the risk pool on ESHI is less adversely-selected than that on HIX. The existence of these equilibriums depends on primitives. As shown in Online Appendix A,  $w_0 - w_1 < r$  is more plausible if workers with poorer health incur higher disutility of work ( $corr(d, x) > 0$ ) and/or  $U(\cdot)$  does not feature a very strong income effect.

<sup>12</sup>Given that working involves disutility for workers and that workers value insurance, in equilibrium, the following must be true:  $w_0 > b$  and  $w_0 > w_1$ .

<sup>13</sup>The property of  $x^*(\cdot; r)$  depends on  $U(\cdot)$ , e.g.,  $x^*(y; r)$  increases with  $y$  (the income effect) if  $U(\cdot)$  is CRRA, and is independent of  $y$  if  $U(\cdot)$  is CARA. We consider  $x^*(w_0; r) \geq x^*(b; r)$ .



From this simple example, we have established that under risk pool segregation policies, if both ESHI and non-ESHI jobs exist, the risk pool on ESHI will be less adversely-selected than that on HIX and  $q \leq r$ . Moreover, when  $q < r$ , the segregation policy imposes a regressive welfare effect, where lower-income households (the non-employed in this example) face higher premiums than higher-income households. Given that marginal utility is higher for the lower-income households, it may be reasonable to consider policies that can reduce the premium differential (e.g., via risk pooling between ESHI and HIX). However, this simple model is insufficient for one to realistically evaluate alternative risk pool structures.<sup>14</sup> To do that, one needs to consider the presence of other policies (e.g., Medicaid, HIX subsidies, ESHI tax exemption) and, as discussed in the introduction, to incorporate heterogeneity at the firm, the household and the state level.

## 4 Model

### 4.1 Environment

There are  $M$  isolated markets defined by state and policy era (pre-ACA and ACA), each consisting of a labor market, an individual health insurance market, and an ESHI insurance market. In each market  $m$ , there is a distribution of heterogeneous households, choosing labor supply and health insurance status; and a distribution of firms that use labor inputs to produce a homogeneous goods with heterogeneous technologies. A firm chooses the combination of labor inputs and ESHI provision.

A household is characterized by  $(x, \mathbf{s}, \boldsymbol{\chi}, \epsilon)$ , where  $x$  is a vector of characteristics,  $(\mathbf{s}, \boldsymbol{\chi}, \epsilon)$  are unobservable to the researcher.<sup>15</sup> In particular,  $\mathbf{s}$  and  $\boldsymbol{\chi}$  are both two-dimensional vectors of discrete variables:  $\mathbf{s}$  consists of each spouse's human capital level and  $\boldsymbol{\chi}$  consists of their preference types;  $\mathbf{s}$  and  $\boldsymbol{\chi}$  may be correlated.<sup>16</sup> The distribution,  $\Pr((\mathbf{s}, \boldsymbol{\chi}) | x, \text{state})$ , varies with  $x$  and across states.  $\epsilon$  is a vector of choice-specific taste shocks that are i.i.d. across households.

Each labor market is competitive with a vector of wages  $\{w_{shz}^m\}$  for each category  $(s, h, z)$ , where  $s$  is skill level,  $h \in \{P, F\}$  denotes part/full time and  $z \in \{0, 1\}$  denotes ESHI or not. Exchanges on the labor market are based on  $(s, h, z)$  and blind to  $(x, \boldsymbol{\chi}, \epsilon)$ .

#### 4.1.1 Insurance and Out-of-Pocket Health Expense

A worker's health insurance status is described by a vector  $INS \in \{0, 1\}^4$ , where  $INS_1 = I(\text{ESHI})$ ,  $INS_2 = I(\text{spousal ESHI})$ ,  $INS_3 = I(\text{Medicaid})$ ,  $INS_4 = I(\text{individual insurance})$ . We assume that

<sup>14</sup>For example, in this simple model, ESHI provision is random across firms, and HIX enrollees are all non-employed, both of which are at odds with the data.

<sup>15</sup> $x$  includes marital status, number of young children, and each spouse's gender, age, education, and health status.

<sup>16</sup>In the case of singles, the second entry of the vector is irrelevant.

the four statuses are mutually exclusive, so that  $\sum_{s=1}^4 INS_s \in \{0, 1\}$  with  $\sum_{s=1}^4 INS_s = 0$  indicating no insurance. Let  $\mathbf{INS}$  be the  $4 \times 2$  matrix of health insurance status of a couple.

A household's out-of-pocket health expense  $OOP$  varies with its  $x$  (including health statuses of household members), its insurance status, the market it belongs to, and the individual insurance premium ( $r$ ). In addition,  $OOP$  is subject to medical expenditure shocks that are realized after the household makes its decisions.<sup>17</sup> The distribution of  $OOP$  is given by

$$OOP \sim F_{OOP}(x, \mathbf{INS}, m, r).$$

A major role of insurance is to make the  $OOP$  distribution less dispersed for a household.

#### 4.1.2 Household Preference

A household's utility depends on consumption  $C$ , leisure, and health insurance status, the trade-offs among which may be viewed differently by households with different  $(x, \chi)$ , such that

$$u(C, \mathbf{h}, \mathbf{INS}; x, \chi) = \frac{\left(\frac{C}{n_x}\right)^{1-\gamma_\chi}}{1-\gamma_\chi} + \varpi_{\mathbf{INS}} - D(\mathbf{h}, \chi, x),$$

where  $n_x$  is an adult-equivalence factor that varies with family size.<sup>18</sup>  $\gamma_\chi$  is a risk-aversion parameter that may differ by household type.  $\varpi_{\mathbf{INS}}$  captures non-pecuniary preferences for different types of insurance.  $\mathbf{h} = [h, h']$  is the vector of labor supply status of the household and  $D(\mathbf{h}, \chi, x)$  is disutility from work.

#### 4.1.3 Production Function

At each human capital *index/level*  $s$ , we denote  $k_s$  as the corresponding *amount* of human capital. Let  $n_{jsh}$  be the number of employees with human capital level  $s$  and working status  $h$  hired by Firm  $j$ . Let  $l_{jsh}$  be the Type- $(s, h)$  labor input in Firm  $j$ , which is the total amount of  $k_s$  possessed by the  $n_{jsh}$  employees. Firm  $j$ 's production is governed by the following modified CES function

$$Y_j = T_j \left[ A_j \sum_{s \geq s^*} B_{sF} l_{jsF}^\rho + (1 - A_j) \left( \sum_{s < s^*} B_{sF} l_{jsF}^\rho + \sum_{s=1}^S B_{sP} l_{jsP}^\rho \right) \right]^{\frac{\theta}{\rho}}, \quad (2)$$

$$\text{where } l_{jsh} = k_s n_{jsh}.$$

<sup>17</sup>Given the static nature of the model, we treat a health shock purely as an expenditure shock.

<sup>18</sup>We follow the literature and set  $n_x = 1$  for singles without children,  $n_x = 1.3$  for singles with children,  $n_x = 1.5$  for couples without children, and  $n_x = 1.8$  for couples with children.

The parameters  $\theta$ ,  $\rho$  and  $B$  are common across firms, with  $\sum_{s,h} B_{sh} = 1$ . Firms differ in  $(T_j, A_j)$  :  $T_j$  denotes Firm  $j$ 's TFP,  $A_j \in (0, 1)$  measures the degree to Firm  $j$ 's technology biases toward high skilled workers ( $s \geq s^*$ ) who works full time.<sup>19</sup> The two factors  $T_j$  and  $A_j$  may be correlated, which would help shape the equilibrium sorting between a firm's productivity and the skill composition of its employees.<sup>20</sup> Moreover, together with the correlation between a worker's skill and demand for health insurance,  $(T_j, A_j)$  correlation also underlies the correlation between firm productivity and ESHI provision.

## 4.2 Household's Problem

A household's problem can be solved in two steps. First, it chooses labor supply status  $(\mathbf{h}, \mathbf{z}) \in \{(0, 0), \{P, F\} \times \{0, 1\}\}^2$ , where each worker in the household can be non-employed or working in one job category. Second, it chooses its health insurance status INS given  $(\mathbf{h}, \mathbf{z})$ . A household solves the following problem<sup>21</sup>

$$\max_{(\mathbf{h}, \mathbf{z}) \in \{(0, 0), \{P, F\} \times \{0, 1\}\}^2} \{V(x, m, \chi, \mathbf{s}, \mathbf{h}, \mathbf{z}) + \epsilon_{\mathbf{h}, \mathbf{z}}\}, \quad (3)$$

where  $V(\cdot, \mathbf{h}, \mathbf{z})$  is the value function associated with the choice  $(\mathbf{h}, \mathbf{z})$ , as we specify below. The last term,  $\epsilon_{\mathbf{h}, \mathbf{z}}$ , is household's taste shocks associated with choice  $(\mathbf{h}, \mathbf{z})$ , assumed to be drawn from a Type-I extreme value distribution with a scale parameter  $\sigma_\epsilon$ . Let  $(\mathbf{h}^*, \mathbf{z}^*)_{(x, m, \chi, \mathbf{s}, \epsilon)}$  be the solution to (3).

$V(\cdot, \mathbf{h}, \mathbf{z})$  is the household's expected utility with its optimal INS choice given  $(\mathbf{h}, \mathbf{z})$  :

$$\begin{aligned} V(x, m, \chi, \mathbf{s}, \mathbf{h}, \mathbf{z}) &= \max_{\text{INS}} \left\{ \int u(C, \mathbf{h}, \text{INS}; x, \chi) dF_{OOP}(x, \text{INS}, m, r) \right\} \\ \text{s.t.} \quad C &= \max\{y - OOP, \underline{c}\} \\ y &= w_{shz}^m + w_{s'h'z'}^m + b(x, m, r, w_{shz}^m + w_{s'h'z'}^m, \text{INS}) \\ \text{INS} &\in \Omega(x, y, m, \mathbf{z}), \end{aligned} \quad (4)$$

where the expectation is taken over the distribution of OOP that reduces household consumption, but households are guaranteed a minimum consumption level  $\underline{c}$ .<sup>22</sup> Household total income  $y$  consists of the couple's labor earnings ( $w_{shz}^m = 0$  if  $h = 0$ ), and a net government transfer  $b(\cdot)$ . The function

<sup>19</sup>Empirically, we allow for 5 skill levels and define the top 40% in the skill distribution as  $s \geq s^*$ , i.e.,  $s^* = 4$  in our application.

<sup>20</sup>See Eeckhout and Kircher (2018) for a theoretical study of a competitive labor market equilibrium with endogenous firm sizes and firm-worker sorting.

<sup>21</sup>We present the problem for a coupled household. The problem is simpler for singles, with  $h' = z' = 0$ .

<sup>22</sup>As specified later, welfare programs such as SNAP are included in  $b(\cdot)$ ;  $\underline{c}$  is explicitly introduced as a buffer against extreme health expenditure shocks.

$b(\cdot)$  accounts for taxes, welfare programs and health-insurance-related transfers, such as insurance premium subsidies and penalties on the uninsured (see Section 2). As such,  $b(\cdot)$  depends on market  $m$ , household characteristics  $x$ , earnings  $(w_{shz}^m + w_{s'h'z'}^m)$ , premium  $r$  and insurance status  $\text{INS}$ . The last constraint in (4) specifies that  $\text{INS}$  can only be chosen from  $\Omega(x, y, m, \mathbf{z})$ , which reflects the link between a household's choices of  $\text{INS}$  and job status.

#### 4.2.1 Health Insurance Choice Set $\Omega(\cdot)$

A household's health insurance choice set  $\Omega(\cdot)$  depends on its job status  $\mathbf{z}$ , which leads to the intrinsic connection between the insurance system and labor market. For example, ESHI ( $\text{INS}_1$ ) and spousal ESHI ( $\text{INS}'_2$ ) are both directly governed by  $z$ .<sup>23</sup> If neither of the spouses are covered by ESHI,  $(z, z') = 0$ , the household may be eligible for Medicaid governed by function  $MC(x, y, m)$ . Therefore, via income  $y$ , a household's labor supply decision indirectly affects  $\text{INS}_3$  and  $\text{INS}'_3$  (Medicaid). In addition to these natural links and the assumption that the four  $\text{INS}$  statuses are mutually exclusive, we impose the following simplifying assumptions on  $\Omega(\cdot)$ , which are in line with the observed choices among most households.

- 1) If only one spouse works on a job with ESHI, the other spouse and children will be covered, e.g.,  $\mathbf{z} = [1, 0]$  implies  $\text{INS}_1 = \text{INS}'_2 = 1$ .
- 2) If both spouses are covered by ESHI  $(z, z') = 1$ , they are indifferent between whose employer covers their children. As such, in expectation, the burden of child health insurance will be split evenly between the two employers.
- 3) *Conditional on choosing*  $(z, z') = 0$ , if a household is eligible for Medicaid ( $MC(x, y, m) = 1$ ), it chooses between using Medicaid ( $\text{INS}_3 = \text{INS}'_3 = 1$ ) or staying uninsured ( $\text{INS} = 0$ ).<sup>24</sup> If  $MC(x, y, m) = 0$ , it chooses between individual health insurance and staying uninsured, and  $\text{INS}_4 = \text{INS}'_4$ , so that individual health insurance purchase are made for the entire household.<sup>25</sup>

<sup>23</sup>  $\text{INS}_1 = z \in \{0, 1\}$ ; and  $\text{INS}'_2 = 0$  if  $z = 0$ .

<sup>24</sup> In the data, only 5.7% of households eligible for Medicaid chose individual insurance.

<sup>25</sup> In our empirical application, when  $z = z' = 0$  and hence the household faces a non-degenerate choice set of health insurance status, we introduce additional preference shocks  $\varepsilon$  for Medicaid versus no insurance (if Medicaid eligible) and for individual insurance versus no insurance (if Medicaid ineligible). These shocks help explain some variation in observed choices and are assumed to be realized after the labor supply choice has been made. When  $\mathbf{z} = (0, 0)$ , the value function (4) is modified to

$$\begin{aligned}
 V(x, m, \chi, \mathbf{s}, \mathbf{h}, \mathbf{z} = (0, 0)) &= E \max_{\text{INS}} \left\{ \int u(C, \mathbf{h}, \text{INS}; x, \chi) dF_{\text{OOP}}(x, \text{INS}, m, r) + \varepsilon_{\text{INS}} \right\} \\
 \text{s.t.} \quad C &= \max \{y - \text{OOP}, \underline{c}\} \\
 y &= w_{shz}^m + w_{s'h'z'}^m + b(x, m, r, w_{shz}^m + w_{s'h'z'}^m, \mathbf{h}, \text{INS}) \\
 \text{INS} &\in \Omega(x, y, m, \mathbf{z} = [0, 0]).
 \end{aligned} \tag{5}$$

Therefore, the choice set  $\Omega(\cdot)$  is given by

$$\begin{aligned}\Omega(x, y, m, \mathbf{z}=[1, 0]) &= \{([1, 0, 0, 0], [0, 1, 0, 0])\}, \\ \Omega(x, y, m, \mathbf{z}=[0, 1]) &= \{([0, 1, 0, 0], [1, 0, 0, 0])\}, \\ \Omega(x, y, m, \mathbf{z}=[1, 1]) &= \{[1, 0, 0, 0]^2\}, \\ \Omega(x, y, m, \mathbf{z}=[0, 0]) &= \left\{ \begin{array}{l} MC(x, y, m) \{[0, 0, 1, 0]^2, [0, 0, 0, 0]^2\} \\ (1 - MC(x, y, m)) \{[0, 0, 0, 1]^2, [0, 0, 0, 0]^2\} \end{array} \right\}.\end{aligned}\tag{6}$$

### 4.3 Firm's Problem

Firm  $j$  chooses the quantity  $n_{jsh}$  of labor inputs in each  $(s, h)$  category, and whether or not to provide ESHI. For tractability and due to data limitation, we assume that a firm's health insurance provision is the same for all of its employees with the same working status  $h$ .<sup>26</sup> Consistent with the data, we also assume that ESHI is offered to part-time workers only if it is also offered to full-time workers. That is,  $z_j = \{z_{jh}\}_{h \in \{P, F\}} \in \{(1, 1), (0, 1), (0, 0)\}$ . In the following, we describe a firm's problem without ESHI mandates. The case with ESHI mandates is described in Online Appendix B.

Firm  $j$  solves the following problem,

$$\pi_j^* = \max_{\{z_{jh}, \{n_{jsh}\}_s\}_h} \left\{ Y_j - \sum_{s, h} n_{jsh} [w_{sh}^m (1 + \tau_w^m) + q^m z_{jh} \kappa_{sh}^m] - \delta I(z_j \neq (0, 0)) + \eta_{z_j} \right\}, \tag{7}$$

where  $Y_j$  follows the technology (2),  $\tau_w^m$  is a payroll tax,  $q^m$  is the price of ESHI on Market  $m$ ,  $\kappa_{sh}^m$  is the expected demand for health insurance by a worker  $s$ . The cost of hiring a worker involves wage payments (plus payroll tax), and, if  $z_{jh} = 1$ , the expected cost of ESHI. The latter involves expectation because households differ in demands for health insurance, which in turn leads to different labor supply decisions. A firm needs to infer the expected demand for health insurance from a worker with skill  $s$  for his/her family ( $\kappa_{sh}^m$ ), conditional on the household's decision to let him/her work  $h$  hours with ESHI.<sup>27</sup>  $\delta$  is a fixed cost of providing ESHI,  $\eta_{z_j}$  is the an i.i.d. Type-I extreme-value distributed shock (with a scale parameter  $\sigma_\eta$ ) for choosing each  $z_j$  option. Notice that following the tax exemption treatment for ESHI, the firm does not pay payroll tax on ESHI, nor does the worker pay taxes on ESHI. Given the progressive income tax structure, this tax exemption provides a higher benefit for higher-skill workers.

<sup>26</sup>In Kaiser data we use for our estimation, we observe a firm's ESHI provision status only by worker's work status  $h$ , but not by wage levels.

<sup>27</sup>

$$\kappa_{sh}^m = \int \kappa(x, m, \chi, s, s', \epsilon) dF\left(x, \chi, s', \epsilon | s, m, (h^*, z^*)_{(x, m, \chi, s, \epsilon)} = (h, 1)\right), \tag{8}$$

where  $\kappa(x, m, \chi, s, s', \epsilon)$  is the adult-equivalent measure of the unit of health insurance demanded by a household from one employer with characteristics  $(x, m, \chi, s, s', \epsilon)$ . It depends on household size, and whether or not the spouse also works on an ESHI job.

Firm  $j$ 's optimal decision  $\left\{z_{jh}^*, \{n_{jsh}^*\}_s\right\}_h$  can be derived in two steps. First, given a particular vector  $z$ , Firm  $j$  chooses its optimal demand for each type of worker  $\{n_{sh}^*(z)\}_{sh}$ , which gives the maximum profit  $\pi_j^*(z)$  conditional on  $z$ . Second, it chooses the  $z$  associated with the highest profit. For a researcher, who has no information about  $\eta_{z_j}$ , the probability that a particular  $z^*$  is chosen follows

$$\Pr(z_j = z^*) = \frac{\exp\left(\frac{\pi_j^*(z^*)}{\sigma_\eta}\right)}{\sum_{z \in \{(0,0), (1,0), (1,1)\}} \exp\left(\frac{\pi_j^*(z)}{\sigma_\eta}\right)}.$$

## 4.4 Insurance Premiums

We assume a single product on HIX as in Hackmann et al. (2015) and a single product on ESHI. Our counterfactual experiments are likely to change the risk pools on HIX and ESHI markets, and hence the health insurance premiums. Although it is beyond the scope of this paper to incorporate a full-blown model of health insurance markets into our setting, we endogenize equilibrium insurance premiums in our counterfactuals such that on both ESHI and HIX, insurers are break-even.<sup>28</sup> Break-even on market  $m$  and insurance type  $k \in \{ESHI, HIX\}$  refers to the equalization of the total premium and the total reimbursement multiplied by the loading factor  $l_k^m$  on the  $(m, k)$  market.

For HIX, we incorporate its key feature that premiums are set according to a standard age-rating curve and are otherwise non-discriminatory. Let  $r_b^m$  be the base premium on Market  $m$ , and  $\Gamma(\cdot)$  be the exogenous age-rating curve, the premium faced by someone with characteristics  $x$  (including *age* as one component) is given by

$$r^m(x) = \Gamma(r_b^m, age). \quad (9)$$

On each HIX market  $m$ , the premium  $r_b^m$  adjusts to satisfy the break-even condition (as in Handel et al. (2015)).

## 4.5 Equilibrium

**Definition 1** *An equilibrium on Market  $m$  is a tuple*

- $\left\{(\mathbf{h}^*, \mathbf{z}^*)_{(x,m,\chi,s,\epsilon)}, (\{z_h^*, \{n_{sh}^*\}_s\}_h)_{(T,A)}, \{w_{shz}^m\}_{shz}, r_b^m, q^m\right\}$  that satisfies
- (1) *Given  $\{w_{shz}^m\}_{shz}$  and  $r^m(x)$ ,  $(\mathbf{h}^*, \mathbf{z}^*)_{(x,m,\chi,s,\epsilon)}$  solves household problem for each  $(x, m, \chi, s, \epsilon)$ .*
  - (2) *Given  $\{w_{shz}^m\}_{shz}$  and  $r^m(x)$ ,  $(\{z_h^*, \{n_{sh}^*\}_s\}_h)_{(T,A)}$  solves firm problem for each  $(T, A)$ .*
  - (3) *Equilibrium consistency:*
    - 1) *wages  $\{w_{shz}^m\}_{shz}$  equate the aggregate demand and supply for each  $(s, h, z)$  category;*
    - 2) *the base premium  $r_b^m$  and  $r^m(x)$  implied by (9) satisfy the break-even condition on the HIX market;*

<sup>28</sup>The pre-ACA individual health insurance premium structure was much more complex. We use the pre-ACA data only for estimating the model. The estimated model is used to conduct counterfactual experiments with premium regulations similar to HIX. For estimation, it suffices to take the observed equilibrium insurance premiums as given.

$q^m$  satisfies the break-even condition on the ESHI market.

**Discussion** Several aspects of the model deserve further discussion. First, we have assumed away market imperfections such as search friction. However, because of adverse selection on HIX and ESHI, the severity of which may differ between the two markets (as discussed in Section 3), the competitive labor market equilibrium need not be efficient.

Second, we take the distribution of  $x$  directly from the data, which may differ for the same state across policy eras for reasons our model is silent about, e.g., migration.<sup>29</sup> Via the correlation between  $x$  and unobservables, our model allows the distribution of  $(s, \chi)$  in a state to differ across policy eras. However, we assume that the conditional distribution  $\Pr((s, \chi) | x, state)$  is constant across policy eras, which is key to identifying state-level heterogeneity.

Third, we allow firms' technologies to differ in both TFP ( $T$ ) and skill-biasedness ( $A$ ), which allows us to capture how ESHI provisions relates to both firm sizes and within-firm worker compositions. All else equal, higher- $T$  firms would demand more labor and would have a cost advantage for offering ESHI, which involves a fixed cost; higher- $A$  firms would have higher demand for skilled labor relative to unskilled labor, and if skilled workers have higher demand for health insurance, higher- $A$  firms would tend to offer ESHI.

## 4.6 Further Empirical Specifications

### 4.6.1 Household Unobservables

A worker's human capital level  $s$  is observed by both the worker and the firm. The researcher observes neither human capital nor household types, the distribution of which varies with  $x$  and states, given by

$$\Pr((s, \chi) | x, state) = \Pr(\chi | x, state) \Pr(s | x, \chi),$$

where  $s \in \{1, \dots, S\}^2$ ,  $\chi \in \{1, 2\}^2$ .<sup>30</sup> We set the total number of skill levels  $S = 5$ , which leads to 20 categories of jobs defined by  $(s, h, z)$ , 10 unobserved types of singles defined by  $(s, \chi)$  and 100 unobserved types of coupled households defined by  $(s, \chi)$ .

**Preference Type** Denote the components in  $x$  such that the sub-vectors  $x_1$  and  $x_2$  refer to the individual characteristics of Spouse 1 and Spouse 2 and that  $x_0$  refers to household level characteristics. We assume that types of a couple follow a bivariate Probit distribution, with the latent variables drawn

<sup>29</sup>Some studies have examined migration responses to ACA, e.g., Goodman (2017) finds no effect of the ACA Medicaid expansion on migration.

<sup>30</sup>For singles, only the first entry of  $s$  and that of  $\chi$  are relevant.

from

$$N \left( \begin{bmatrix} x_0\beta_0 + x_1\beta + \xi_{state} \\ x_0\beta_0 + x_2\beta + \xi_{state} \end{bmatrix}, \begin{bmatrix} 1, \varrho \\ \varrho, 1 \end{bmatrix} \right). \quad (10)$$

where  $\xi_{state}$  is a state-specific parameter that introduces state-level unobservables into the model, and  $\varrho$  allows for matching on unobservables between a couple.<sup>31</sup>

**Skill** The probability that a worker's skill is of level  $s$  follows a discretized log-normal distribution:

$$\Pr(s|x, \chi) = \begin{cases} \Phi(\ln(k_s) - x'\lambda - \alpha_\chi) - \Phi(\ln(k_{s-1}) - x'\lambda - \alpha_\chi) & \text{for } 1 < s < S, \\ \Phi(\ln(k_s) - x'\lambda - \alpha_\chi) & \text{for } s = 1, \\ 1 - \Phi(\ln(k_{s-1}) - x'\lambda - \alpha_\chi) & \text{for } s = S, \end{cases} \quad (11)$$

where  $\alpha_\chi$  is a type-specific parameter that allows for correlation between  $s$  and  $\chi$ , with  $\alpha_2$  normalized to zero. The mass points of the amounts human capital ( $k_s$ ) are assumed to be quantiles from  $\ln N(\bar{x}'\lambda, 1)$ , where  $\bar{x}$  is the national average of  $x$ . That is, one's rank in the skill distribution is correlated with the distance of one's  $x$  from the national average.<sup>32</sup>

The distribution of a couple's skills is given by

$$\Pr(s|x, \chi) = \Pr(s|x, \chi) \Pr(s'|x, \chi').$$

Notice that a couple's skill levels are correlated because 1) household characteristics  $x$  enter the skill distributions for both, and 2) types  $\chi$  and  $\chi'$  are correlated between spouses and type enters the skill distribution via  $\alpha_\chi$ .

**Remark 1** *Our modeling of household unobservables is motivated by the following. First, in the data, the distribution of household outcomes conditional on  $x$  differ across states, which may arise partly from differences in state policies but presumably also from state-level unobservables. To account for the latter without imposing too much structure, we introduce a state-specific  $\xi_{state}$  into the conditional distribution of  $\chi|x$ . Second, due to the income effect, the CRRA utility function implies a negative relationship between the probability of being insured and income, ceteris paribus. As shown in Online Appendix C.3, this relationship is violated in the data. Without excluding other possible explanations, we rationalize this pattern by allowing for a correlation, via  $\alpha_\chi$ , between preferences and skills conditional on  $x$ .<sup>33</sup>*

<sup>31</sup>For singles,  $\Pr(\chi = 2) = \Phi(x_0\beta_0 + x_1\beta + \xi_{state})$ .

<sup>32</sup>Worker's skill and firm's TFP (two unobservable levels) jointly map into one observable object, i.e., wage. Therefore, one of the two unobservables (skill, TFP) needs to be normalized. We use the quantiles of  $\ln N(\bar{x}'\lambda, 1)$  as the mass points of  $k_s$  levels, which serves as a normalization.

<sup>33</sup>For example, this data fact can also be rationalized via heterogeneous non-pecuniary preferences for insurance ( $\varpi_{\text{INS}}$ ), but both types of heterogeneity cannot be separately identified. Since heterogeneous risk aversion is commonly allowed for in the literature (e.g., Handel et al. (2015)), we assume a common  $\varpi_{\text{INS}}$ .



#### 4.6.2 Firm Technology

We allow  $T_j$  and  $A_j$  to be correlated within a firm, but  $\{(T_j, A_j)\}_j$  are assumed to be independent across firms. Firm's TFP  $T_j$  follows a Pareto distribution,

$$T_j \sim \text{Pareto}(\underline{T}, \alpha_T),$$

where  $\underline{T}$  is the scale parameter (the minimum value of  $T_j$ ) and  $\alpha_T$  is the shape parameter. As a convenient way to guarantee that  $A_j \in (0, 1)$ , the weight  $A_j$  is assumed to follow a logit normal distribution, such that

$$\left[ \ln \left( \frac{A_j}{1 - A_j} \right) | T_j \right] \sim N \left( \ln \left( \frac{\mu_A}{1 - \mu_A} \right) + \nu (\ln(T_j) - \ln(\mu_T)), \sigma_A^2 \right),$$

where  $\mu_A$  is the median of  $A$  for firms with  $T = \mu_T \equiv E[T]$ , and  $\nu$  governs the correlation between  $T_j$  and  $A_j$ .

## 5 Data

For household information, we use three data sources: the American Community Survey (ACS), the Current Population Survey Annual Social and Economic Supplement (CPS), and the Medical Expenditure Panel Survey (MEPS). We focus on the population aged 22 to 64. For firm information, we use the Kaiser Family Employer Health Benefit Survey (Kaiser), supplemented with information from Statistics of U.S. Businesses (SUSB). To exploit policy variation, we use data from 2012 (pre-ACA era) and 2015 (ACA era).<sup>34</sup>

ACS and CPS both provide information on households' health insurance, labor market status, demographics and residential states. Given the inconsistency in the health insurance information in CPS arising from the re-design of relevant questions (Pascale (2016)), we rely mainly on ACS (a 5% random sample) and supplement it with information on household members' health status from CPS. We estimate a logistic probability function  $\Psi(\text{healthy}|x, \text{state})$  from CPS, which we use to simulate the health status for those in the ACS sample.<sup>35</sup> This CPS-supplemented ACS sample contains most of the information we need to estimate the model except for medical-expenditure-related information, for which we resort to MEPS.

<sup>34</sup>To reduce the computation burden, we use only two years of data, which nevertheless contain rich variation for identification. Moreover, we use data in 2012 as opposed to 2013 to mitigate concerns about anticipatory responses by households and firms.

<sup>35</sup>Health status is self-reported as one of the 5 categories: excellent, very good, good, fair or poor. We define the first 3 categories as being healthy. As shown in Online Appendix D.1, this variable is highly correlated with gross medical costs. In addition, self-reported measures are also highly correlated with labor market outcomes as shown in Blundell et al. (2017).

MEPS is a set of large-scale surveys of families and individuals, their medical providers, and employers across the U.S. We use its Household Component, a panel survey with several rounds of interviews covering two full calendar years. Key to our analyses, MEPS collects detailed information on each household member’s demographic characteristics, health conditions, health status, the use of medical services, charges and source of payments, health insurance coverage, income, and employment. We use the restricted MEPS data with geocode, which identifies 30 states with the remaining states encrypted. The 30 identified states account for 89% of households in the U.S., from which we exclude Massachusetts and Hawaii, i.e., the two states that already implemented state-wide (nearly) universal coverage before the ACA. Of the remaining 28 states, 15 expanded Medicaid by 2015. We use MEPS to estimate the medical expenditure distribution for each of the 28 states and restrict our ACS and CPS sample to households in these 28 states as well.

Kaiser is a cross-sectional survey of firms representative of U.S. firms with at least 3 workers. Crucial to our analyses, it contains information on firm size and health insurance provision, as well as employee composition in terms of wage levels and full/part time status. We focus on private-sector employers. Our sample consists of all private employers for which the information on ESHI offering is not missing.<sup>36</sup> Firm locations are known up to the Census Region (Northeast, Midwest, South, and West), which allows us to estimate firm-side parameters separately for each region.<sup>37</sup> To supplement statistics from Kaiser, which only covers firms with at least 3 workers, we resort to SUSB for information on the overall distribution of firms of all sizes.

## 5.1 Summary Statistics

Table 1 summarizes individual-level statistics from ACS (Panels A and C) and health information from CPS (Panel D), before and after the ACA and separately for ACA Medicaid expansion and non-expansion states.<sup>38</sup> Panel A shows that the demographic distribution in each group of states is largely stable before and after ACA, and that residents in expansion states tend to have more education than those in non-expansion states. Panel B shows that the uninsured rate declined significantly from 19.2% to 10.8% in expansion states, and from 26.3% to 19.4% in non-expansion states. In 2012, ESHI and Medicaid coverage rates were higher in expansion states (even before the expansion). After ACA, although shares in all three insured status increased, the biggest share increase occurred in Medicaid for expansion states, but in individual insurance for non-expansion states. Panel C shows

<sup>36</sup>The distribution of other firm-level variables in this sample is similar to that in the entire private-firm sample (e.g., MEPS IC components). Therefore, we assume that the ESHI offering information is missing at random and this sample is representative.

<sup>37</sup>Ideally, we should focus on the same 28 states for both firm and household sides of the data, which is not feasible given that a firm’s state ID is not available in Kaiser. We have compared, for each region, the distribution of firm characteristics (e.g., size) available in Statistics of U.S. Businesses (SUSB), using all states and using only the states included in the household sample. The distributions are extremely similar. See Figure A1 in Online Appendix F.

<sup>38</sup>Table A1 in Online Appendix F shows the joint distribution of characteristics and outcomes between spouses.

Table 1: Individual Level Summary Statistics

Residents in (%)	Medicaid Expansion States		Non-Expansion States	
	2012	2015	2012	2015
A. Demographics: ACS				
Edu Low (below high school)	12.13	11.49	13.10	12.13
Edu High (at least some college)	33.35	34.89	28.63	29.77
Single	42.09	42.82	42.80	44.24
Childless	61.62	62.31	61.34	62.21
B. Insurance Status: ACS				
Uninsured	19.20	10.76	26.28	19.42
ESHI	68.08	69.29	63.73	66.81
Medicaid	7.71	12.97	4.56	5.54
Ind. Insurance	5.01	6.98	5.43	8.23
C. Work Status: ACS				
Non-employment	22.16	20.00	22.59	21.18
Full-time	70.81	73.12	71.47	72.67
Number of Individuals (ACS)	27,140	27,465	18,927	19,734
D. % Unhealthy: CPS				
All	7.48	7.28	8.06	7.68
ESHI	5.42	5.22	5.92	5.88
Medicaid	18.43	17.45	22.99	20.56
Ind. Insurance	5.99	7.29	7.12	8.79
Number of Individuals (CPS)	31,866	25,325	19,977	19,933

that the distribution of employment status was very similar across the two groups of states in 2012. From 2012 to 2015, there was a 2.2 percentage points (ppt) growth in employment in expansion states and a 1.4 ppt growth in non-expansion states. Panel D shows that Medicaid enrollees are disproportionately unhealthy. Moreover, as predicted by the simple model in Section 3, individual insurance enrollees are more likely to be unhealthy than ESHI enrollees, especially after the ACA. As shown in Online Appendix D, for any given health insurance status, the average medical expenditure among the unhealthy is over 3 times as large as that among the healthy.

For a closer look at the data, we run regressions of the following form:

$$y_{ist} = x_{ist}\alpha_1 + d_s + I(t = 2015)x_{ist} [MEP_s\alpha_2 + (1 - MEP_s)\alpha_3] + \epsilon_{ist}. \quad (12)$$

where  $y_{ist}$  is an outcome variable for individual  $i$ , with characteristics  $x_{ist}$  in state  $s$  and year  $t$ ,  $d_s$  is a state fixed effect.  $MEP_s \in \{0, 1\}$  indicates whether or not State  $s$  expanded Medicaid under the ACA. The vector of parameters  $\alpha_2$  reflects (2015 versus 2012) changes in outcomes among different demographic groups ( $x$ ) in Medicaid expansion states; and  $\alpha_3$  reflects these changes in non-expansion states.  $\epsilon_{ist}$  is an error term.

Table 2: Insurance and Work Status Regressions

	Uninsured	Medicaid	ESHI	Nonemployed	Full time
ACA*Medicaid Expansion States ( $\alpha_2$ )					
$\alpha_{20}$	-0.059 (0.011)	0.049 (0.013)	0.007 (0.012)	-0.014 (0.007)	0.015 (0.008)
Edu Low ( $\alpha_{21}$ )	-0.055 (0.015)	0.064 (0.014)	-0.006 (0.012)	-0.005 (0.013)	0.015 (0.015)
Edu High ( $\alpha_{22}$ )	0.071 (0.011)	-0.059 (0.010)	-0.013 (0.012)	0.022 (0.005)	-0.010 (0.009)
Childless ( $\alpha_{23}$ )	0.003 (0.012)	-0.012 (0.010)	-0.004 (0.011)	-0.003 (0.008)	0.001 (0.009)
Single ( $\alpha_{24}$ )	-0.104 (0.013)	0.060 (0.012)	0.025 (0.017)	-0.026 (0.010)	0.020 (0.011)
ACA*Non-Expansion States ( $\alpha_3$ )					
$\alpha_{30}$	-0.058 (0.011)	-0.001 (0.008)	0.045 (0.017)	-0.027 (0.012)	0.022 (0.011)
Edu Low ( $\alpha_{31}$ )	0.019 (0.015)	-0.025 (0.014)	-0.003 (0.013)	0.033 (0.020)	-0.020 (0.020)
Edu High ( $\alpha_{32}$ )	0.012 (0.017)	0.012 (0.006)	-0.015 (0.013)	0.010 (0.008)	-0.001 (0.007)
Childless ( $\alpha_{33}$ )	-0.013 (0.015)	0.023 (0.007)	-0.017 (0.013)	0.027 (0.009)	-0.023 (0.009)
Single ( $\alpha_{34}$ )	-0.019 (0.015)	-0.008 (0.007)	0.005 (0.013)	-0.026 (0.009)	0.017 (0.009)

Other control variables: state dummies, education, gender, I(childless), marital status, age and age<sup>2</sup>.  
Standard errors are clustered at the state level.

Each column of Table 2 shows the estimates from one outcome regression. The two panels report coefficient vectors on the post-ACA dummy in Medicaid expansion states ( $\alpha_2$ ) and non-expansion states ( $\alpha_3$ ) separately, which exhibits some noticeable differences across demographic groups and across the two groups of states. For example, after ACA, the uninsured rate decreased significantly among the low-educated and/or singles living in Medicaid expansion states, mostly via the increased Medicaid coverage. Relative to changes in insurance status, changes in work status are not as significant.<sup>39</sup>

The upper panel of Table 3 summarizes firm level statistics from Kaiser data (cross-firm standard deviations are in parentheses), which consists of about 1,900 firms in each of the two years. In the 2012 sample, 56% of firms provided ESHI. In the 2015 sample, 51% did so. For firm size and worker

<sup>39</sup>Our findings are consistent with Leung and Mas (2018), who also find that Medicaid expansion significantly increased Medicaid coverage but did not reduce “employment lock” among childless adults. Note that empirical findings of effects of the ACA components have been mixed (e.g., Frean et al. (2017) and Lurie et al. (2019)). Our estimated regression coefficients serve to summarize the data, which should not be interpreted as causal effects.

Table 3: Summary Statistics: Firms

Kaiser										
Year	Obs.	ESHI	Size <sup>a</sup>		Size $\geq$ 500 (%)		% Full-time workers		% High-wage workers	
		%	All	ESHI	All	ESHI	All	ESHI	All	ESHI
2012	1,981	56.1	22.0	32.8	0.71	1.25	74.5	84.6	23.6	32.3
		-	(55.0)	(70.6)	-	-	(29.6)	(19.6)	(26.6)	(26.2)
2015	1,852	51.4	22.1	34.5	0.74	1.42	72.8	79.3	26.9	33.7
		-	(56.3)	(75.5)	-	-	(30.5)	(26.5)	(28.7)	(29.0)

<sup>a</sup>Firm sizes in Kaiser are top coded at 500, and treated so in this calculation. .

SUSB						
Year		All Firms	Size $\leq$ 4	4<Size< 100	100 $\leq$ Size< 500	Size $\geq$ 500
2012	%Firms	100	61.43	36.71	1.26	0.60
	Size	19.5	1.7	15.9	151.4	1063.6
2015	%Firms	100	61.23	36.75	1.41	0.64
	Size	20.3	1.6	16.2	151.2	1082.4

compositions, we present the statistics among all firms and among firms with ESHI. The average and standard deviation of sizes are subject to the caveat that firm sizes in Kaiser are top coded at 500, so we also present the fraction of firms of size $\geq 500$ .<sup>40</sup> With this caveat, we can see that compared to average firms, firms with ESHI are larger, have more full-time workers and more high-wage workers.<sup>41</sup> The lower panel of Table 4 shows the size distribution of all firms in SUSB.<sup>42</sup> Between the two years, we see a slight shift of the distribution to the right.

## 6 Estimation

### 6.1 Parameters Estimated outside of the Model

To reduce computational burden, we estimate the following objects outside of the model: the out-of-pocket health expenditure distribution  $F_{OOP}(\cdot)$ , government health-care-related policies, and the net transfer function. We briefly describe each, with further details in Online Appendix D.

**Out-of-pocket health expenditure** consists of the health insurance premium  $r^m(x)$  and out-of-pocket medical costs, which are estimated using data from MEPS. For  $r^m(x)$  used in the estimation sample, we use the observed average premium among households with  $r^m(x)$ .<sup>43</sup> A household's out-

<sup>40</sup>The top-coding of firm sizes in Kaiser data is taken into account in our estimation, as we explain in Footnote 56.

<sup>41</sup>Kaiser only specifies three crude division of wage levels: \$24,000 (\$23,000) is the upper bound for low earnings and \$55,000 (\$58,000) is the lower bound for high earnings in 2012 (2015) in real dollar terms.

<sup>42</sup>SUSB firm size is categorical, and size $\leq 4$  is the first category, while Kaiser data only contains firms with size $\geq 3$ .

<sup>43</sup>Similarly,  $q^m$  is set at the average ESHI premiums reported by firms in Kaiser on each market  $m$ . Notice that the premium entering  $OOP$  and the ESHI premium  $q^m$  are both estimated directly from the data only for estimating the model. For counterfactual policy simulation, premiums on both HIX and ESHI will be equilibrium objects to be

of-pocket medical cost is the sum of its members' gross medical costs minus the total reimbursement based on the most common health insurance plan. We estimate each household member's gross medical cost as a stochastic function of one's own characteristics, household characteristics, and insurance status, where the distribution of the random component is market-specific.

**Health-care-related government policies** are parameterized as precisely as we can, including those implemented under the ACA. In particular, we specify the Medicaid eligibility and coverage rule  $MC(x, y, m)$  as a market-specific function of household characteristics and income, which varies before and after the ACA and across states. We parameterize  $MC(x, y, m)$  using information from Kaiser Family Foundation.<sup>44</sup>

**Government net transfer function** is broken down into its components including household income tax, welfare benefits (TANF), food stamps (SNAP), HIX premium subsidies, and tax penalties for the uninsured with ACA individual mandates. We parameterize each component. In particular, we follow Chan (2013) in specifying the eligibility and benefits of TANF and SNAP.

## 6.2 Structural Estimation: Overview

### 6.2.1 Estimation Sample and Validation Sample

We divide the household data into two samples: one for estimation and the other for model validation. The estimation sample, from which our auxiliary models are calculated, includes the pre-ACA data of all 28 states in our sample, and the post-ACA data of all but the 7 states with the lowest poverty rates. The post-ACA data for these 7 states are held out for model validation.<sup>45</sup>

We use the data in this fashion for the following reasons. First, information of a state in at least one policy era is necessary to identify state-specific parameters; and information of multiple states in both policy eras gives us the variation to identify policy-invariant household preference parameters without having to rely entirely on the model structure. Second, several major ACA components were targeted at low-income households, leading to potentially different impacts in states with different poverty rates. It will increase credibility of our model and its counterfactual policy implications if the model is able to fit the post-ACA patterns in this non-random hold-out sample. As shown in Table 4, the hold-out sample (lowest-poverty) states are indeed quite different from the other states: they are disproportionally more likely to have expanded Medicaid ( $\frac{5}{7}$  versus  $\frac{10}{21}$ ); and the population in these states are more educated.

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determined internally.

<sup>44</sup>See <https://www.kff.org/state-category/medicaid-chip>. We abstract from asset testing for Medicaid, which would require detailed asset data and non-trivial complication in our setting. See French et al. (2019) for a study of how asset testing for Medicaid affects individuals' retirement decisions.

<sup>45</sup>The hold-out model validation is limited to the household-side estimation. We use all of the firm data in the firm-side estimation, given the relatively small sample size and that firm locations are known only at the Census Region level.

Table 4: State Characteristics (Sample Split)

States Groups	#States	#Medicaid Exp States	Edu=high	Edu=low	Singles	Childless
Lowest Poverty States	7	5	38.5%	8.0%	40.7%	62.0%
Other States	21	10	30.9%	13.3 %	43.3%	61.8%

### 6.2.2 Equilibrium Prices in the Estimation

Taking the observed equilibrium as given, our estimation procedure does not require solving for the equilibrium. Households and firms take equilibrium prices as given in making their optimal decisions. Among equilibrium prices, health insurance premiums are directly observable in the data; while wages  $\{w_{shz}^m\}$  are not, because skill  $s$  is unobservable (although we observe both the types of jobs  $(h, z)$  chosen and the wages earned by individuals with different characteristics  $x$ ). However, since the realized equilibrium wages  $\{w_{shz}^m\}$  are taken as given by households and firms, they can be treated as parameters to be estimated together with structural parameters.

To keep the estimation tractable, we assume that wages without ESHI  $\{w_{sh0}^m\}$  can be approximated by a discretized log-normal distribution.<sup>46</sup> In particular, within each hour ( $h$ ) category on Market  $m$ , the skill-specific log wages  $\{\ln(w_{sh0}^m)\}_{s=1}^S$  without ESHI are quantiles from

$$N(\omega_h^0 + \omega_{state}^0 + \omega_{year}^0, \sigma_{wh}^2),$$

where  $\omega^0$  is a vector of dummies for part/full time ( $h$ ), state and year. To capture the idea of compensating wage differentials, we assume that wages with ESHI are proportional to their non-ESHI counterparts. The wage ratio, and hence the magnitude of compensating differentials, is allowed to vary with wage levels, as given by<sup>47</sup>

$$\frac{w_{sh1}^m}{w_{sh0}^m} = \frac{1}{1 + \exp(\omega_0^1 + \omega_1^1 w_{sh0}^m)}.$$

We treat  $\{\omega^0, \omega^1, \sigma_w\}$  as parameters to be estimated, which jointly imply  $\{w_{shz}^m\}$ . Notice that  $\{\omega^0, \omega^1, \sigma_w\}$  are not structural parameters, which are used in the estimation *only*; in counterfactual policy simulations, wages and insurance premiums are all determined internally as equilibrium outcomes following Definition 1.<sup>48</sup>

<sup>46</sup>Similar approaches have been used in the literature to approximate equilibrium objects that are too complex to compute exactly, e.g., Lee and Wolpin (2006) and Meghir et al. (2015).

<sup>47</sup>In particular, if  $\omega_1^1 \leq 0$ , compensating differentials will increase with skill levels; however, if  $\omega_1^1 > 0$  the wage ratio will decrease with skill and hence compensating differentials need not be higher for higher-skilled workers.

<sup>48</sup>Functional form assumptions on wages are used during the estimation to keep the exercise feasible. In simulating the equilibrium, all prices will be treated non-parametrically, and obtained by solving a fixed point problem.

### 6.2.3 Two-Stage Estimation via Indirect Inference

Stage 1: Estimate household-side parameters  $(\Theta^H)$  and  $\{\omega^0, \omega^1, \sigma_w\}$  by matching model-predicted household decisions with the observed household choices, where  $\Theta^H$  consists of the parameters governing household preferences and the conditional distribution of unobserved household skill and preference types  $\Pr((s, \chi) | x, state)$ .

Stage 2: Given parameter estimates in Stage 1 (hence household decision rules and equilibrium wages), estimate firm-side parameters  $(\Theta^F)$  by matching firms' optimal decisions with the observed firm choices.

In both stages, the estimation is via indirect inference, an approach that involves two steps: 1) compute from the data a set of “auxiliary models” that summarize the patterns in the data; and 2) repeatedly simulate data with the structural model, compute corresponding auxiliary models using the simulated data, and search for model parameters that match model-generated auxiliary models with those from the true data. In particular, let  $\bar{\beta}$  denote our chosen set of auxiliary model parameters computed from data; let  $\hat{\beta}(\Theta)$  denote the corresponding auxiliary model parameters obtained from simulating a large dataset from the model (parameterized by a particular vector  $\Theta$ ) and computing the same estimators. The structural parameter estimator is then the solution

$$\hat{\Theta} = \operatorname{argmin}_{\Theta} [\hat{\beta}(\Theta) - \bar{\beta}]' W [\hat{\beta}(\Theta) - \bar{\beta}],$$

where  $W$  is a diagonal weighting matrix. We obtain standard errors for  $\hat{\beta}(\Theta)$  by numerically computing  $\frac{\partial \hat{\Theta}}{\partial \bar{\beta}}$  and applying the delta method to the variance-covariance matrix of  $\bar{\beta}$ .

## 6.3 Structural Estimation: Auxiliary Models

Our auxiliary models exploit the rich variation across states and policy eras, as well as the varying policy doses across different households and firms. We summarize how this directly *observable* variation (prices and known policy rules) is embedded in our model.<sup>49</sup>

**Household Side:** 1) Variation in the equilibrium premiums  $r^m(x)$  for individual health insurance affect household out-of-pocket expenditure  $OOP$  if they choose to get individual insurance. 2) Medicaid eligibility rules  $MC(\cdot)$ , and hence the choice set of household insurance status  $\Omega(\cdot)$ , differ across states and across time in states that expanded Medicaid. 3) HIX premium subsidies and the individual mandate both affect household budget via the net government transfer function  $b(\cdot)$  that depends on their insurance status.

**Firm Side:** The cost/incentive of ESHI provision is changed via 1) changes in the equilibrium premi-

<sup>49</sup>Prices are endogenous. However, during the estimation, we only need to solve individual household/firm problems, who takes the observed equilibrium prices as given.



ums  $q^m$  and 2) the employer mandate.<sup>50</sup>

We now describe our auxiliary models, followed by brief identification arguments that guide our choice of these auxiliary models.

### 6.3.1 Stage 1

We target the following auxiliary models, all of which are based on the estimation sample only.

#### 1. Individual level targets from ACS

- a. Regressions as reported in the data section for insurance status and work status, i.e.,

$$y_{ist} = x_{ist}\alpha_1 + d_s + I(t = 2015)x_{ist} [MEP_s\alpha_2 + (1 - MEP_s)\alpha_3] + \epsilon_{ist}.$$

- b. Earnings regression of the following form:

$$\ln(w_{ist}) = x_{ist}\alpha_1^w + d_s^w + I(t = 2015)\alpha_2^w + I(h_{ist} = F)\alpha_3^w + ESHI_{ist}\alpha_4^w + IND_{ist}\alpha_5^w + \epsilon_{ist}^w,$$

where  $d_s^w$  is a state dummy, coefficients  $\alpha_3^w$  to  $\alpha_5^w$  capture the correlation between earnings and full/part time status ( $h$ ), ESHI status, and individual insurance purchase.<sup>51</sup>

- c.  $E[(\ln(w_{ist}))^2]$

- d. Moments overall and by one-way demographics (marital status, presence of children, education, age groups):

- i. Fractions of uninsured, insured via ESHI, and insured via Medicaid.
- ii. Fractions of non-employed and employed full time.
- iii. Fractions of uninsured  $\times$  part time, uninsured  $\times$  non-employed, Medicaid  $\times$  part time, Medicaid  $\times$  non-employed, and ESHI  $\times$  full time

#### 2. Individual level moments (by pre/post-ACA $\times$ Medicaid expansion/non-expansion states) from CPS that are informative of health-related utility parameters:

- a. Fractions of uninsured  $\times$  healthy, ESHI  $\times$  healthy, and Medicaid  $\times$  healthy
- b. Fractions of non-employed  $\times$  healthy and full time  $\times$  healthy

#### 3. Moments of joint outcomes between couples from ACS that are informative the correlation of types between spouses:

- a. Covariance of log earnings between two spouses.
- b. Fractions of couples who both work, who both work full time.

The household-side model to be estimated in Stage 1 is essentially a generalized Roy model (Heckman and Vytlacil (2007)), with parameters governing (i) the wage offer distribution, (ii) house-

<sup>50</sup>On average ESHI premiums increased by about 4% between 2012 and 2015.

<sup>51</sup>Coefficients in regression Targets 1a and 1b should not be viewed as causal, rather, they are a succinct way to summarize data patterns that are informative of our structural model parameters, as we discuss below.

hold preferences and (iii) the conditional distribution of unobserved household skill and preference types  $\Pr((s, \chi) | x, state)$ . As summarized in French and Taber (2011), identifying this class of models in a cross section requires exclusion restrictions that affect the payoff in the relevant sector, but not payoffs in other sectors. Although we also impose exclusion restrictions and functional form assumptions, identification of our model is greatly facilitated by the fact that our data, although not a panel, contain much more information than what is available in a cross section. We observe the distribution of household outcomes in each state *both before and after* the ACA. This data structure allows us to exploit ACA policies and their interactions with household characteristics, such as those reflected in Targets 1a, to inform us of (policy-invariant) parameters in (ii) and (iii). For example, state dummies in 1a are informative of the state-specific shifter parameters in  $\Pr((s, \chi) | x, state)$ , while cross-era comparison of household choices as captured by  $\alpha_2$  and  $\alpha_3$  are informative of household preferences.

Specifically, this policy variation is first exploited in the work status regressions in 1a, which are targeted jointly with the earnings regression and variance (1b and 1c). To correct the self selection problem that may affect correct inference for (i), we supplement policy variation with an exclusion restriction, where we exclude the presence of children from the skill distribution and thus from wage offers.<sup>52</sup> By itself, this variable increases the disutility of work and, via medical expenses, increases the value of ESHI jobs relative to non-ESHI jobs. Moreover, it interacts with policy changes. For example, although the ACA-induced change in equilibrium wages equally affected households of the same skill type within a state (which will be partly captured by  $\alpha_2^w$  in Target 1b), the ACA-induced change in individual insurance premiums affected these households differently depending on the presence of children. Moreover, some policy changes under ACA, such as insurance premium subsidies, for which ESHI-covered workers are not eligible, interact with the size of the households. As such, ACA premium subsidies directly increase the value of non-ESHI jobs and differentially so for households with and without children, which creates policy variation within the same unobservable type of households, given our exclusion restriction.

This policy variation is also exploited in the insurance status regressions in Target 1a. Because insurance premium subsidies and the individual mandate directly affected the monetary incentive to obtain insurance, and because Medicaid expansion directly changes households' choice set of insurance status, these regressions are informative of the non-pecuniary benefits/costs associated with insurance status ( $\varpi_{INS}$ ) and risk aversion coefficients ( $\gamma_\chi$ ).

Moreover, it also helps that for the *same* household, we observe not only their labor market outcomes but also their choice of whether or not to get individual insurance/Medicaid if not covered by ESHI. Conditional on  $(x, state, year)$ , the correlation between the latter choice and income is informative of how skill and preferences are correlated, as discussed in Remark 1. In particular, coefficients  $\alpha_4^w$  and  $\alpha_5^w$  in Target 1b capture how earnings correlate with ESHI and individual insurance status

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<sup>52</sup>The  $x$  entering  $\Pr((s, \chi) | x, state)$  includes education, age, gender and marital status.

(relative to Medicaid and uninsured), which, together with the set of regressions 1a, are informative of how skill and preference may be correlated.

### 6.3.2 Stage 2

Borrowing from the literature (e.g., Garicano et al. (2016)), we set parameter  $\theta = 0.75$  in the production function (2), because it is neither the focus of our paper nor clearly identified. For each Census Region, we estimate  $\{B_{sh}\}$ ,  $\rho$ ,  $\delta$  and parameters governing the distribution of  $(A_j, T_j)$  by targeting sets of moments that map closely to firm's optimal decisions and an additional set of moments that impose labor market equilibrium conditions. Specifically, for each region, we target the following region-specific auxiliary models:

1. Moments from Kaiser: (by policy era)
  - a. Mean and variance of firm size, fraction(full time employees), fraction(employees earning low/high wages)
  - b. Fraction of firms with  $ESHI = 1$
  - c.  $\text{Cov}(ESHI, \text{firm size})$ ,  $\text{Cov}(ESHI, \text{fraction of employees earning high wages})$ ,  $\text{Cov}(ESHI, \text{fraction of full time})$
  - d.  $\text{Cov}(\text{firm size}, \text{fraction of full time employees})$ ,  $\text{Cov}(\text{firm size}, \text{fraction of employees earning low/high wages})$ .
2. (by policy era): The aggregate supply of labor for each  $(s, h, z)$  category derived from Stage 1 estimates.
3. Moments from SUSB (by policy era): Fraction of small firms.<sup>53</sup>

Given ESHI choices  $z_{jh}$ , firms' first order conditions with respect to labor inputs are given by<sup>54</sup>

$$w_{shz}^m + q^m z_{jh} \kappa_{sh}^m = \begin{cases} T_j L_j^{\frac{\theta}{\rho}-1} A_j B_{sh} k_s^\rho (n_{jsh})^{\rho-1} & \text{if } s \geq s^* \text{ and } h = F, \\ T_j L_j^{\frac{\theta}{\rho}-1} (1 - A_j) B_{sh} k_s^\rho (n_{jsh})^{\rho-1} & \text{otherwise.} \end{cases} \quad (13)$$

The marginal cost of labor (the LHS of (13)) consists of wage and the expected cost of ESHI, both of which are known given estimates from Stage 1 and vary across markets  $m$ , i.e., state  $\times$  policy era.<sup>55</sup> Given  $\{k_s\}$  implied by the skill distribution parameters estimated in Stage 1, the marginal productivity

<sup>53</sup>Firm size is known up to size groups in SUSB, with the first category being size  $\in [1, 4]$ . We target the fraction of firms belonging to this group.

<sup>54</sup>

$$L_j = A_j \sum_{s \geq s^*} B_{sF} l_{jsF}^\rho + (1 - A_j) \left( \sum_{s < s^*} B_{sF} l_{jsF}^\rho + \sum_s B_{sP} l_{jsP}^\rho \right).$$

<sup>55</sup>Wages are Stage-1 parameter estimates, ESHI price  $q^m$  is data and  $\kappa_{sh}^m$  is derived from household preference parameters.

of labor (the RHS of (13)) is known up to parameters  $(A_j, T_j, \{B_{sh}\}, \rho)$ . Via (13), these parameters govern firms' size and labor composition, as captured in Moments 1a.

Moments 1b and 1c focus on firm's choice of ESHI offering and its correlation with labor inputs. The relative profitability of different choices of ESHI offering depends on (1) wage differentials between ESHI and non-ESHI jobs, equilibrium ESHI premium ( $q^m$ ) and household expected demand for ESHI ( $\kappa_{sh}^m$ ), (2) the employer mandate, (3) the fixed cost of ESHI provision and (4) a firm's productivity  $(A_j, T_j)$ . Among these, (1) is known from Stage 1 and varies across states and policy eras, (2) follows a known formula that is relevant only under ACA and only for bigger (more productive) firms. Given variation in (1) and (2), Moments 1b and 1c inform us of the policy-invariant parameters governing (3). Moreover, joint with 1a, 1b and 1c also inform us of the distribution of  $(A_j, T_j)$ , where the identification benefits from the assumption that the fixed cost and the random shocks associated with ESHI offering are independent of  $(A_j, T_j)$ .

Moments 1d are informative about the correlation between  $A_j$  and  $T_j$  for the following reason. As implied by Condition (13), given ESHI choice, the ratio of different types of labor is independent of  $T_j$  but dependent on  $A_j$ ; TFP  $T_j$ , however, directly affects the size of a firm. As such, given ESHI choice, the correlation between labor ratio and firm size arises from the correlation between  $(A_j, T_j)$ . Conditional on the correlation between firm size and worker composition that is associated with ESHI offering (i.e., Moments 1b and 1c), Moments 1d provides direct information on the correlation between  $(A_j, T_j)$ .

Moments 2 serve two purposes. First, they discipline the estimation algorithm to favor parameters that guarantee equilibrium consistency, which we deem as important for equilibrium counterfactual analyses. Second, Kaiser only includes crude measures of wages; skill-specific labor supply from Stage 1 supplements Moments 1 in pinning down the production technology parameters. Similarly, to overcome the limitation that only firms with more than 3 workers are represented in Kaiser, we target the fraction of small firms (Moments 3) from SUSB, which, together with Moments 1, provide a more complete picture of the distribution of firms.<sup>56</sup>

## 7 Estimation Results

### 7.1 Parameter Estimates

We report a selected set of parameter estimates in this section and the others in Online Appendix F. The standard errors are reported in parentheses, which tend to be larger for firm-side parameters than household-side parameters. Panel A of Table 5 shows selected parameters governing household

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<sup>56</sup>Our model-simulated firms can be of any size. In calculating Moments 1 from our simulated data, we only use simulated firms with at least 3 workers and top code their sizes at 500, as is the case in the data. For Moments 2 and 3, all simulated firms are included in the calculation and their sizes are not top coded. Details are in Online Appendix D.3.

Table 5: Selected Parameter Estimates: Household

<b>A. Preferences</b>					
$\gamma_\chi$ : Type 1 singles or (Types 1, 1) couples	4.12	(0.003)	Disutility of Working		
$\gamma_\chi$ : Type 2 singles or (Types 2, 2) couples	2.11	(0.003)	Full-time job (unhealthy)	-3.29	(0.03)
$\gamma_\chi$ : (Types 1, 2) couples	3.29	(0.01)	Part-time job (unhealthy)	-3.16	(0.03)
Consumption floor (\$10,000)	0.26	(0.001)	Full-time job (Type1)	-2.10	(0.004)
Nonpecuniary value: Medicaid	-0.40	(0.002)	Part-time job (Type 1)	-2.32	(0.01)
Nonpecuniary value: Individual insurance	-0.13	(0.001)	Full-time job (Type 2)	-3.36	(0.01)
Nonpecuniary value: ESHI	1.43	(0.003)	Part-time job (Type 2)	-4.23	(0.01)
<b>B. Type and Skill Distribution*</b>					
$\Pr(\chi = 2 x, state)$			$\Pr(s x, \chi)$		
Age	-0.42	(0.002)	Age	0.82	(0.001)
Education = middle	0.94	(0.01)	Education = middle	-2.64	(0.01)
Education = low	1.10	(0.01)	Education = low	-3.88	(0.01)
Married	0.40	(0.001)	Female	-0.92	(0.002)
Female	0.58	(0.002)	$\chi = 1$	1.51	(0.003)
$\varrho$ : type correlation between a couple	0.77	(0.01)			
<b>C. Simulated Type Distribution in the Sample: <math>\Pr(\chi = 1 \cdot)</math> (%)</b>					
By Demographics			By State of Residence		
All	85.4		Expansion States	92.0	
Singles	79.1		Non-Expansion States	75.1	
Edu=low	75.6		State Poverty Rate (Lowest)	94.6	
Edu=high	95.3		State Poverty Rate (Q2)	93.8	
Age>40	93.1		State Poverty Rate (Q3)	85.2	
Childless	85.8		State Poverty Rate (Highest)	70.6	

preferences. The left columns show that Type 1 singles and (Type 1, Type 1) couples have higher relative risk aversion ( $\gamma_\chi$ ) compared with their Type 2 counterparts; households with mixed types of spouses have  $\gamma_\chi$  closer to Type 1 households. These estimated  $\gamma$ 's are in the range of the estimates in other studies (e.g., French and Jones 2011 and Cohen and Einav 2016). The annual consumption floor (against health expenditure shocks) is estimated at \$2,600, which is very close to the estimate in De Nardi et al. (2010). The nonpecuniary values of both Medicaid and individual insurance are negative, while that of ESHI is positive. These parameters help to explain household choices beyond what is explained by the pecuniary values of insurance per se, which may capture factors such as the inertia against taking up Medicaid and the psychic cost associated with applying for individual insurance. Based on our parameter estimates, we have calculated the elasticity of the demand and the willingness to pay for health insurance, both of which are comparable to those found in the literature (e.g., Finkelstein et al. (2019b) and Finkelstein et al. (2019a)).<sup>57</sup>

<sup>57</sup>Following Finkelstein et al. (2019b), who focus on the population faced with the choice between participating in HIX and staying uninsured, we find that among them, the HIX enrollment rate would be 49% if 75% of the premium costs are subsidized and 61% if 90% of the costs are subsidized. The corresponding enrollment rates in Finkelstein et al. (2019b)

Table 6: Selected Firm-Side Parameter Estimates

Region	Northeast		Midwest		West		South	
A. TFP Distribution $T_j \sim Pareto(\underline{T}, \alpha_T)$								
Scale $\underline{T}$ (2012)	24.53	(3.52)	25.50	(4.71)	25.57	(1.58)	25.09	(4.09)
Scale $\underline{T}$ (2015)	25.11	(1.40)	25.95	(3.15)	26.41	(3.37)	25.50	(3.09)
Shape $\alpha_T$	3.49	(0.26)	3.76	(0.51)	3.90	(0.21)	4.14	(0.19)
B. Skill Bias $\ln\left(\frac{A_j}{1-A_j}\right)   T_j \sim N\left(\ln\left(\frac{\mu_A}{1-\mu_A}\right) + \nu(\ln(T_j) - \ln(\mu_T))\right), \sigma_A^2$								
$\mu_A$	0.67	(0.122)	0.73	(0.04)	0.74	(0.04)	0.68	(0.02)
$\sigma_A$	1.41	(0.198)	1.61	(0.35)	2.19	(0.23)	1.27	(0.22)
$\nu$	0.86	(0.661)	0.93	(0.19)	1.55	(0.85)	1.15	(0.04)
C. Other Selected Parameters								
$\rho$ (CES power parameter)	0.42	(0.03)	0.41	(0.02)	0.40	(0.01)	0.45	(0.01)
Fixed cost of ESHI (\$10,000)	3.57	(0.53)	3.07	(0.84)	2.99	(0.56)	5.09	(1.84)
$\sigma_\eta$ (ESHI decision shock)	1.92	(0.43)	1.87	(1.02)	1.91	(0.77)	1.92	(1.19)

The right columns of Panel A show that, compared to others, unhealthy individuals and those with children incur larger disutility from working. In general, Type 1 individuals incur lower disutility from working. In addition, we find that the disutility of working full time is lower than that of working part time, which may seem counter-intuitive. However, it should be noted that the “disutility of working” in this model is a composite of various factors that affect labor supply choices beyond contemporary pecuniary benefits. Without taking a stand on these factors, it is not clear that full-time jobs should be more costly than part-time jobs.

The left part of Panel B reports estimates relating  $x$  to type.<sup>58</sup> Individuals who are younger, lower-educated, married and/or females are more likely to be Type 2 (the less risk averse type). Moreover, we do find that couples are more likely to be the same type, conditional on observables. The right columns of Panel B reports the skill distribution. In particular, we find that Type 1 (the more risk averse type) are more likely to have higher skills. For an easier illustration of the parameters, Panel C of Table 5 reports the percentage of Type 1 individuals by demographic groups and by state of residence. Overall, 85% of individuals are Type 1’s, but this fraction is much higher in Medicaid expansion states and states with lower poverty rates, which arises both from the different distribution of observables across states and from the state-specific shifters in type distribution (Equation 10).

Table 6 reports firm-side parameters. In general, these parameters are similar across regions, although the fixed cost of ESHI appears higher in the South. One thing to notice is that the estimated  $\nu$ ’s in Panel B, which govern the correlation between  $T_j$  and  $A_j$ , are positive. That is, higher TFP firms are also more likely to be more skill-biased, and hence have higher demand for high-skill workers

are 49% and 79%, respectively. Similarly, our estimates imply that among those covered by Medicaid, the willingness to pay for Medicaid is \$851 in terms of consumption equivalent variation, or 21% of the cost of Medicaid, which is close to but lower than the 22% to 46% range found in Finkelstein et al. (2019a).

<sup>58</sup>State-specific parameters in the type distribution are included but not reported in this table.

ceteris paribus. As shown in Table 2, individuals with higher risk aversion are also more likely to have higher skill levels. As a result, in the equilibrium, higher TFP firms are more likely to offer ESHI, and high-skill workers are more likely to sort into these firms.

Given our estimated model, for each market  $m$  and insurance type  $k \in \{ESHI, HIX\}$  we obtain the loading factor  $l_k^m$  from the baseline equilibrium in the post-ACA era, which is defined as the ratio between the total premium and the total reimbursement on each  $(m, k)$  market. We use these loading factors to compute new equilibrium premiums in our counterfactual policy experiments.

## 7.2 Model Fit

Table 7 and Table 8 report the household-side model fit within the estimation sample. Table 7 shows that the model fits well the distribution of insurance and work statuses by year, while the fit of earnings is not as good. Table 8 shows that the model fit of the insurance status regressions in Target 1a is reasonably good. Table 9 report the out-of-sample model validation. In particular, we show that the model can reasonably replicate the patterns in the lowest-poverty-rate states in the post ACA era, both overall and in Medicaid expansion (MEP) states. Given that the hold-out sample is systematically different from the estimation sample, this validation exercise lends us some confidence of the model in conducting counterfactual policy experiment. Finally, Table 10 shows the firm-side model fit at the national level by year. The region-year-specific fits are reported in Table A2 in Online Appendix F. The overall fit is good, but the model over-predicts the fraction of high-wage employees and that of full-time employees.

Table 7. Within-Sample Fit: Status and Earnings Moments

Year	Status (%)				ln(Earnings)			
	Data		Model		Data		Model	
	2012	2015	2012	2015	2012	2015	2012	2015
ESHI	66.30	67.06	67.91	67.49	8.14	8.13	8.44	8.44
Medicaid	6.41	10.03	5.46	9.39	6.94	6.88	6.80	6.70
Uninsured	22.11	15.20	21.94	15.37	7.25	7.26	7.56	7.79
Part time	6.58	6.53	6.81	6.70	6.66	6.58	6.30	6.29
Full time	71.08	72.18	73.20	73.42	8.05	8.04	8.41	8.41

Table 8. Within-Sample Fit: Status Regressions

Medi. Expand	Uninsured		Medicaid		ESHI		Nonemployed		Full time	
	Expand	No	Expand	No	Expand	No	Expand	No	Expand	No
Data										
ACA	-0.067	-0.058	0.051	0.002	0.011	0.038	-0.014	-0.025	0.015	0.022
ACA*lowEdu	-0.061	0.023	0.066	-0.024	-0.004	-0.007	-0.001	0.035	0.015	-0.022
ACA*highEdu	0.073	0.006	-0.064	0.013	-0.015	-0.012	0.018	0.010	-0.003	-0.003
ACA*single	-0.101	-0.013	0.063	-0.010	0.019	0.003	-0.025	-0.028	0.018	0.017
ACA*childless	0.005	-0.016	-0.013	0.021	-0.002	-0.013	-0.004	0.026	0.001	-0.023
Model										
ACA	-0.026	-0.087	0.026	0.008	-0.034	0.036	0.001	0.015	-0.002	-0.024
ACA*lowEdu	-0.131	-0.022	0.127	-0.047	-0.019	0.045	0.014	-0.014	-0.008	0.001
ACA*highEdu	0.097	0.015	-0.080	0.012	0.012	0.002	0.001	-0.008	-0.001	0.013
ACA*single	-0.145	0.024	0.105	0.010	0.016	-0.036	0.006	-0.002	-0.001	0.002
ACA*childless	-0.025	0.027	0.000	0.005	0.039	-0.024	-0.017	-0.014	0.013	0.025

Table 9. Holdout Sample Fit (Lowest Poverty States 2015)

%	Data		Model	
	All	MEP States	All	MEP. States
ESHI	74.44	72.72	72.58	72.21
Medicaid	8.92	10.19	8.32	10.09
Uninsured	10.18	10.51	10.57	10.19
Part time	6.80	6.69	7.29	7.38
Full time	76.81	76.55	74.33	73.25

Table 10: Model Fits: Firm-Side Moments

Year	Data		Model	
	2012	2015	2012	2015
Size	22.08	22.26	21.29	21.20
ESHI %	56.59	51.37	56.80	50.88
Fr(HighWage Workers) %	23.57	27.55	33.77	35.79
Fr(FullTime Workers) %	74.02	73.29	80.12	80.26
Size*ESHI	18.66	17.83	18.51	16.67
ESHI*Fr(HighWage Workers) %	17.61	17.81	22.56	22.19
ESHI*Fr(FullTime Workers) %	47.62	41.44	49.10	44.71



## 8 Counterfactual Experiments

Our estimation results suggest that high-skill workers are more likely to sort into firms offering ESHI, which are more likely to be endowed with skill-biased technologies; and that households who choose to be non-employed and/or earn wages low enough to be eligible for Medicaid are more likely to be at the lower end of the skill distribution. Under the current health insurance system, these two types of households are largely “segregated” from the risk pool on HIX.<sup>59</sup> Various policies have been proposed to enlarge/improve the risk pool on HIX (currently covering 7.5% of the working-age population), mostly aimed at encouraging the uninsured (14.4% of the population), especially the healthy ones, to participate in HIX.

A natural alternative, as hinted at by the simple model in Section 3, is to look beyond the 21.9% HIX+uninsured population and to desegregate the risk pools between ESHI and HIX. This type of thought experiment can be properly conducted in our framework, which explicitly accounts for the connection between various components of the health insurance system and their connection with the labor market. Moreover, under the status quo, the pool on ESHI is of lower risk than that on HIX (Table 1). Pooling the risk across the two markets may decrease the HIX premium, but at the cost of increasing the ESHI premium and hence disturbing the labor market. The welfare implication is therefore theoretically ambiguous, depending on how households and firms would respond in the equilibrium. This in turn depends on the distribution of household and firm heterogeneity, and our estimated model has provided us with this knowledge.

However, a thought experiment would have no practical value if it is infeasible to implement. In the following, we first show that ESHI-HIX risk pooling can be implemented by a simple cross-subsidization policy. The policy taxes ESHI insurers and transfers the tax revenue to subsidize HIX insurers, which involves no structural change to the current health insurance system. Then, we examine the interaction between such cross-subsidization policies with Medicaid expansion policies.<sup>60</sup>

### 8.1 Cross-Subsidization between ESHI and HIX

The desegregation between ESHI and HIX does not require literally pooling the two markets; instead, it can be achieved via cross subsidization between the two markets. To see this, we first explain the ESHI-HIX risk pooling equilibrium, and then introduce the exact cross-subsidization scheme that implements such an equilibrium.

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<sup>59</sup>See Footnote 2 for policy details.

<sup>60</sup>Relative to regular health insurance programs, Medicaid has an additional role of providing social benefits to the disadvantaged population. We therefore leave it out of the risk pooling. Instead, we examine the interaction between Medicaid eligibility rules with ESHI-HIX risk pooling.

### 8.1.1 Risk-Pooling Equilibrium

Let  $\tilde{r}_b^m$  be the new base premium on HIX, which implies age-adjusted premiums

$$\tilde{r}^m(x) = \Gamma(\tilde{r}_b^m, age) \quad (14)$$

as in the baseline; let the premium on ESHI be

$$\tilde{q}^m = \theta \tilde{r}_b^m, \quad (15)$$

where  $\theta$  is a modifiable policy parameter that governs the degree of premium adjustment.<sup>61</sup> For a given  $\theta$ , we solve for the new equilibrium wages and insurance premiums, such that under  $\tilde{r}_b^m(\theta)$ , which implies  $\tilde{r}^m(x; \theta)$  (as in (14)) and  $\tilde{q}^m(\theta)$  (as in (15)), the break-even condition holds *across* ESHI and HIX, i.e., the sum of total expected cost for insurers on ESHI and HIX is equal to the sum of total premiums on these two markets. Such an equilibrium effectively pools the risks on ESHI and HIX. Moreover, equilibrium prices and outcomes are governed by the policy parameter  $\theta$ .

### 8.1.2 Implementation: ESHI-HIX Cross Subsidization

To implement the ESHI-HIX risk pooling equilibrium associated with any given  $\tilde{r}_b^m(\theta)$ , an easy policy tool is to cross subsidize between ESHI and HIX. Specifically, for  $k \in \{HIX, ESHI\}$  and Market  $m$ , let  $\mu_k^m(x; \theta)$  be the measure of households with characteristics  $x$  who opt for  $k$  on  $m$  in the new *equilibrium* associated with  $\tilde{r}_b^m(\theta)$ , and  $C_k^m(x; \theta)$  be the average expected cost among these households for the insurer. The ESHI-HIX risk pooling equilibrium with  $\tilde{r}_b^m(\theta)$  can be implemented by imposing taxes  $\tau_k^m(\theta)$  defined by

$$\begin{aligned} (1 - \tau_{HIX}^m(\theta)) \int \mu_{HIX}^m(x; \theta) \tilde{r}^m(x; \theta) dF_m(x) &= \int \mu_{HIX}^m(x; \theta) C_{HIX}^m(x; \theta) dF_m(x), \\ (1 - \tau_{ESHI}^m(\theta)) \int \mu_{ESHI}^m(x; \theta) \tilde{q}^m(\theta) dF_m(x) &= \int \mu_{ESHI}^m(x; \theta) C_{ESHI}^m(x; \theta) dF_m(x). \end{aligned}$$

For  $k \in \{HIX, ESHI\}$ ,  $\tau_k^m(\theta)$  is a positive (negative) tax if the total cost for the insurer on  $k$  is smaller (larger) than the total premium collected on  $k$ .<sup>62</sup>

After imposing  $\tau_k^m(\theta)$  on insurers on  $k \in \{HIX, ESHI\}$ , there is no need for further intervention: HIX and ESHI markets would still operate separately (as they do in the status quo), yet, the

<sup>61</sup>At this point,  $\theta$  is simply a premium intervening parameter, however, we will give it a specific role when we introduce cross-ESHI-HIX subsidy.

<sup>62</sup>This policy can also be interpreted as a risk adjustment policy. Risk adjustment policies have been central policy components in many health insurance markets, including Medicare Advantage, Medicare Part D, as well as HIX, see, for example, Handel et al. (2015) for their analysis of risk adjustment within HIX. As far as we know, we are the first to consider risk adjustment transfers *between* ESHI and HIX.

equilibrium premiums on HIX and ESHI would be  $\tilde{r}^m(x; \theta)$  and  $\tilde{q}^m(\theta)$ , i.e., the desired risk-pooling equilibrium premiums. By construction, the total subsidy allocated to insurers on the riskier market is offset by the total tax collected from insurers on the healthier market.

**The Degree of Adjustment  $\theta$  :** The policy parameter  $\theta$  serves to adjust the degree of cross-subsidization between ESHI and HIX: a higher  $\theta$  implies a larger subsidization flowing from ESHI to HIX. As a starting point, we consider a  $\theta$  that is just enough to offset the difference between ESHI and HIX in their actuarially fair values and quality of care, which is denoted as  $\theta^0$  and calibrated at 1.4.<sup>63</sup> The equilibrium achieved under  $\theta^0$  is one that simply pools the risk across ESHI and HIX, without further adjustment. Then, we experiment with a series of  $\theta$ 's with increasing degrees of subsidization toward HIX, capped at  $2\theta^0$ . Among these experiments, we find qualitatively consistent results; quantitatively, the welfare impact increases at first but levels off around  $1.5\theta^0$ . To save space, we report policy impacts under  $\theta^0$  and under  $1.5\theta^0$ .

### 8.1.3 Policy Impacts

We examine the effect of ESHI-HIX cross subsidization imposed on the baseline economy, i.e., the equilibrium under the state-specific policies as implemented in 2015. Panel A of Table 11 shows percentage changes in equilibrium prices, averaged across states. Premiums adjust much more for HIX than for ESHI, e.g., with  $\theta = 1.5\theta^0$ , HIX premium decreases by 33.6% while ESHI premium increases only by 2.8%. A main reason is that ESHI is a much larger market than HIX: a one-dollar transfer from a large market to a small market would have a more noticeable impact on the latter. Wages decrease for non-ESHI jobs ( $w_0$ ) while increase for ESHI jobs ( $w_1$ ), and hence compensating wage differentials ( $w_0 - w_1$ ) decrease.<sup>64</sup> Notice that it may be expected that ( $w_0 - w_1$ ) would decrease: obtaining insurance from one's employer becomes less valuable when HIX premiums decrease. However, level changes in  $w_0$  and in  $w_1$  are less clear ex ante. First, for ESHI jobs, labor supply would go down as HIX premiums go down, and labor demand would also go down as ESHI premiums go up. For non-ESHI jobs, labor demand is expected to go up, but labor supply may go up or down at the presence of the non-employment option. Second, given that higher productivity firms are more likely to offer ESHI, with increased ESHI premiums, the lower-productivity ESHI firms are more likely to switch into non-ESHI firms, which would increase the average firm productivity on both types of jobs.

<sup>63</sup>Specifically,  $\theta^0 = \frac{q_{ESHI}}{q_{HIX}} \frac{ME_{ESHI}}{ME_{HIX}}$ , where  $\frac{q_{ESHI}}{q_{HIX}} = \frac{0.85}{0.7}$  is the ratio of generosity or actuarial values of ESHI relative to HIX, and  $\frac{ME_{ESHI}}{ME_{HIX}}$  accounts for differences in the quality of care as proxied by the population level medical spending on  $k \in \{ESHI, HIX\}$ :  $ME_k$  is the average medical expenditure if *everyone* (i.e., without selection) participates in  $k$ , where the expenditure is predicted by our estimated medical expenditure process on  $k$ .

<sup>64</sup>To save space, we report the % change in wages averaged across the  $5 \times 2$  skill-hour categories and across 28 states, i.e.,  $\frac{1}{5 \times 2 \times 28} \sum_{s,h,m} \left( \frac{w_{shz}^{m,new} - w_{shz}^{m,base}}{w_{shz}^{m,base}} \right)$  for  $z = 0$  (non-ESHI) and  $z = 1$  (ESHI).

Table 11. Cross-Subsidization between ESHI and HIX: Prices, Status and Earnings

$\theta = \theta^0$						$\theta = 1.5\theta^0$				
A. $\Delta$ Prices (%)										
Premium	HIX		ESHI			HIX		ESHI		
	-6.33		0.59			-33.61		2.81		
Wage	Non-ESHI Jobs		ESHI Jobs			Non-ESHI Jobs		ESHI Jobs		
	-0.28		1.98			-0.30		4.07		
B. $\Delta$ Status (ppt)										
	Uninsured	HIX	ESHI	Nonwork	Fulltime	Uninsured	HIX	ESHI	Nonwork	Fulltime
All	-0.10	0.19	-0.12	0.01	0.07	-0.29	0.74	-0.58	-0.01	0.11
Low Edu	-0.02	0.17	-0.16	0.05	-0.03	-0.10	0.51	-0.44	0.06	-0.03
High Edu	-0.17	0.16	-0.09	-0.05	0.18	-0.42	0.75	-0.81	-0.17	0.38
Single	-0.14	0.16	0.02	-0.02	0.16	-0.38	0.71	-0.37	-0.02	0.13
Childless	-0.18	0.26	-0.11	0.02	0.06	-0.41	0.86	-0.53	0.02	0.04
C. $\Delta$ Earnings (%)										
2.15						1.98				

Panel B shows the percentage point (ppt) changes in insurance and work status across all individuals and by demographics. Under both  $\theta$ 's, the cross-subsidization policy increases the fraction of individuals covered by HIX and lowers that covered by ESHI, leading to a very small reduction in the uninsured rate in all demographic groups. There is also a very small positive effect on employment, in that the fraction of full-time workers is slightly larger while labor force participation rate is barely affected. The only exception is the lowest education group, where there appears to be a small work disincentive effect. Panel C shows that average earnings among those who work increase by about 2% in both cases, which comes from both the increase in wages on average (Panel A) and worker-job resorting (Panel B), where more workers work full-time (especially the highly-educated) and on non-ESHI jobs ( $w_0 > w_1$  because ESHI is valuable).

**Result 1:** ESHI-HIX cross subsidization has small positive effects on the insured rate, work status, and average earnings.

Table 11 hints at two welfare-improving factors: 1) wages increase for ESHI jobs, 2) although wages decrease slightly for non-ESHI jobs, HIX premiums are reduced significantly. Table 12 shows the change in households' ex ante welfare, the fraction of winning households and the change in government budgets. For each household, we measure the change in its ex ante welfare by consumption equivalent variation (CEV), i.e., the expected dollar change in a household's baseline consumption that would make it equally well off as it would be in the new equilibrium.<sup>65</sup> Overall, average household welfare increases by \$189 under the pure risk pooling case ( $\theta = \theta^0$ ) and by \$340 under  $\theta = 1.5\theta^0$ . In both cases, over 70% of households would win. Welfare gains differ across households: house-

<sup>65</sup>Ex ante welfare is defined as  $\mathbf{V}(x, m, \chi, \mathbf{s}) \equiv E \max_{(\mathbf{h}, \mathbf{z})} \{V(x, m, \chi, \mathbf{s}, \mathbf{h}, \mathbf{z}) + \epsilon_{\mathbf{h}, \mathbf{z}}\}$ . See Online Appendix E for the derivation of CEV.

Table 12: Cross-Subsidization between ESHI and HIX: Household Welfare and Gov Spending

	$\theta = \theta^0$		$\theta = 1.5\theta^0$	
Welfare	CEV (\$)	Fr(Winners)	CEV (\$)	Fr(Winners)
Overall	189.4	0.71	340.3	0.73
Low Edu Singles or (Low, Low) Couples	81.4	0.63	125.1	0.61
High Edu Singles or (High, High) Couples	283.7	0.77	525.4	0.81
Single	194.5	0.69	372.9	0.72
Childless	211.6	0.71	398.0	0.75
Type 1 Singles or (Type 1, Type 1) Couples	221.3	0.74	395.0	0.77
Type 2 Singles or (Type 2, Type 2) Couples	43.5	0.52	52.6	0.55
Savings in Gov. expenditure per hh (\$)	14.5		40.9	
Savings in HIX subsidies per enrolled hh (\$)	229.0		759.1	

holds with high education are more likely to win and to win more, because they are less likely to qualify for HIX subsidies and hence more likely to benefit from the decrease in HIX premiums, and because they are more likely to work on ESHI jobs, wages of which are increased (Table 11). Type-1 households, who are more risk averse, are also more likely to win. Government net spending in the health insurance system decreases by \$14 per household (hh) under  $\theta = \theta^0$  and by \$41 per hh under  $\theta = 1.5\theta^0$ .<sup>66</sup> The savings come mostly from decreases in HIX premium subsidies since subsidies are directly linked to HIX premiums.

**Result 2:** ESHI-HIX cross subsidization benefits most households, increases average household welfare, and lowers government expenditure.

## 8.2 Interaction between ESHI-HIX Cross Subsidization and Medicaid

Given the connection between the three components of the health insurance system, the effect of policies on ESHI and HIX markets may vary with Medicaid policies. To see this point, we examine the impact of ESHI-HIX cross subsidization policies separately for the 15 ACA Medicaid expansion (MEP) complying states and 13 non-complying states under counterfactual scenarios with and without Medicaid expansion.<sup>67</sup> In doing so, we would like to highlight the impacts of ESHI-HIX cross subsidization on different groups of states given the same hypothetical Medicaid expansion status, and the impacts of ESHI-HIX cross subsidization on the same group of states under different hypothetical Medicaid expansion statuses.

Table 13 shows these effects under  $\theta = \theta^0$  (the left panel) and  $\theta = 1.5\theta^0$  (the right panel). Within each panel, the first two columns are for the 15 MEP complying states, with the first (second) column

<sup>66</sup>Government net spending includes expenditures on Medicaid and HIX subsidies net of revenues from insurance mandate tax penalties (the cross subsidization between ESHI and HIX per se is revenue neutral).

<sup>67</sup>For MEP complying states, we use their 2012 state-specific Medicaid eligibility rules in the counterfactual non-expansion scenario. Of all households in the sample, 57.8% live in MEP complying states.

Table 13: Effects of ESHI-HIX Cross Subsidization by Medicaid Expansion Status

Group of States Medicaid Expansion	$\theta = \theta^0$				$\theta = 1.5\theta^0$			
	MEP Compliers No	MEP Compliers <b>Yes</b>	Non-Compliers <b>No</b>	Non-Compliers Yes	MEP Compliers No	MEP Compliers <b>Yes</b>	Non-Compliers <b>No</b>	Non-Compliers Yes
Change in Uninsured (ppt)	-0.01	-0.03	-0.20	-0.11	-0.18	-0.23	-0.38	-0.30
CEV (\$)	73.7	169.9	216.1	234.2	170.5	338.0	343.4	451.7
Fr(winner)	0.58	0.75	0.64	0.69	0.77	0.72	0.75	0.76
Savings for Gov. per hh	12.4	11.3	18.8	14.1	44.0	27.9	58.8	51.8

showing the effect of ESHI-HIX cross subsidization without (with) Medicaid expansion.<sup>68</sup> The third and fourth columns show the same statistics for the 13 MEP non-complying states. For each group of states, the bold-faced **Yes/No** status is their observed Medicaid expansion status in 2015.

First, we find that overall, cross-subsidization between ESHI and HIX improves welfare, lowers the uninsured rate and government expenditures in both groups of states, regardless of whether or not Medicaid were expanded; and the effect is larger under  $\theta = 1.5\theta^0$ . Second, given the same Medicaid expansion status and the same degree of adjustment  $\theta$ , the effect of ESHI-HIX cross subsidization is larger in MEP non-complying states in terms of declines in uninsured rates, average welfare gains, fractions of winners and savings in government expenditure.<sup>69</sup> Finally, there is some limited interaction between Medicaid expansion and ESHI-HIX cross subsidization. Given  $\theta$  and the same group of states, welfare gains from the cross subsidization, in terms of both CEV alone and CEV plus government savings, tend to be larger when Medicaid is expanded.

**Result 3:** ESHI-HIX cross subsidization leads to higher welfare gains when it is interacted with Medicaid expansion.

It is theoretically ambiguous whether ESHI-HIX cross subsidization would be more effective with or without Medicaid expansion for the same state. On the one hand, with Medicaid expansion, fewer people would be uninsured, which leaves less scope for improvement from a decrease in HIX premiums. On the other hand, as Medicaid absorbs a disproportionately unhealthy population, the risk pool on HIX is relatively healthier with Medicaid expansion, which means cross subsidization would be less distorting for ESHI premiums.<sup>70</sup> Our finding suggests that the second force is stronger than the first.

<sup>68</sup>For example, to get the results shown in the first column, for each state, we compute the equilibrium if Medicaid were not expanded and there is no ESHI-HIX cross subsidization (E0), then, we compute the equilibrium if Medicaid were not expanded but ESHI-HIX cross subsidization were in place (E1), Column 1 shows the difference between E1 and E0.

<sup>69</sup>The two groups of states differ both in their population composition, state-specific unobservables and state-specific policies. For a given yes/no Medicaid expansion status, the uninsured rate is higher in MEP non-complying states before cross subsidization.

<sup>70</sup>Table 14 in the appendix shows that, with Medicaid expansion, cross-subsidization would lead to smaller changes in insurance premiums and larger increases in ESHI wages.

## 9 Conclusion

We have developed and estimated an equilibrium model of the labor market and health insurance markets, highlighting the interactions across various components of the health insurance system, and their relationship with the labor market. The model features rich heterogeneity across local markets, workers, and firms. We estimate the model exploiting policy variation associated with the Affordable Care Act. The estimated model well matches the data, including patterns in the hold-out sample.

Via counterfactual policy experiments, we find that ESHI-HIX cross subsidization could lower the uninsured rate, improve household welfare and lower government expenditure. Moreover, the policy leads to higher welfare gains when it is interacted with Medicaid expansion. These findings have illustrated the value of a framework like ours, which enables one to explore alternative risk-pool structures and to study policies that regulate different parts of the health insurance system in a complementary manner. As such, this paper has made a modest step toward the goal of answering globally optimal social insurance design questions as pointed out by Chetty and Finkelstein (2013).

This paper has several important limitations. For example, without considering the funding regime (e.g., the tax system) underlying the health insurance system and the general equilibrium effect on health care costs, it is beyond the scope of this paper to properly study the effect of more drastic health insurance reforms, such as “Medicare for All.” We have also left several challenging extensions for future work. One extension is to embed dynamics into our framework, including household savings and potential direct effects of health insurance on one’s health and hence future productivity. Another is to consider health insurance regulations in the presence of other sources of inefficiency besides the adverse selection in health insurance choices, such as search friction on the labor market (e.g., Dey and Flinn (2005)) and non-competitive insurance markets (e.g., Tebaldi (2017)).

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## Appendix

**Functional Forms:** We assume that household utility is separable in consumption, leisure and non-pecuniary preferences for health insurance. Let  $n_x$  be the adult equivalent measure of household  $x$ , utility function is given by

$$u(C, \mathbf{h}, \mathbf{INS}; x, \boldsymbol{\chi}) = \frac{(C/n_x)^{1-\gamma_{\boldsymbol{\chi}}}}{1-\gamma_{\boldsymbol{\chi}}} + \sum_{k=1,3,4} \varpi_k I(INS_k = 1) - D(\mathbf{h}, \boldsymbol{\chi}, x).$$

The utility from consumption is assumed to be governed by a CRRA function, with household-type-specific parameter  $\gamma_{\boldsymbol{\chi}}$ .  $\{\varpi_k\}$  captures household's non-pecuniary preferences for ESHI, Medicaid and individual insurance coverage.  $D(\cdot)$  is the disutility from working, taking the following form  $D(\mathbf{h}, \boldsymbol{\chi}, x) =$

$$\begin{cases} \sum_{l=P,F} I(h=l) (d_{\chi l} + \varphi_{1l} I(kid > 0) + \varphi_{2l} I(unhealthy)) & \text{if single} \\ v \sum_{n=1}^2 \sum_{l=P,F} I(h_n=l) (d_{\chi l} + \varphi_{1l} I(kid > 0) + \varphi_{2l} I(unhealthy)) & \text{otherwise} \end{cases},$$

where  $d_{\chi l}$  is a type-specific disutility of working with status  $l = P, F$ .  $\varphi_{1l}$  and  $\varphi_{2l}$  are the additional disutility from working in the presence of young children and in bad health, respectively. For a coupled household, the disutility is summed over each spouse's disutility, with a scale parameter  $v$  to be estimated.<sup>71</sup>

Table 14: Price Effects of Cross-ESHI-HIX Subsidization by Medicaid Expansion Status

% Group of States	$\theta = \theta^0$				$\theta = 1.5\theta^0$			
	MEP Compliers		Non-Compliers		MEP Compliers		Non-Compliers	
Medicaid Expansion	No	Yes	No	Yes	No	Yes	No	Yes
Non-ESHI Wages ( $w_0$ )	-0.58	-0.24	-0.32	-0.50	0.05	-0.21	-0.39	-0.59
ESHI Wages ( $w_1$ )	0.95	1.15	2.94	3.25	0.56	1.06	2.52	6.56
HIX Premium ( $r$ )	-4.33	-4.04	-8.97	-7.80	-32.21	-32.01	-35.46	-34.66
ESHI Premium ( $q$ )	0.42	0.43	0.78	0.69	2.61	2.60	3.05	2.92

<sup>71</sup>One could use vectors of disutility parameters separately for singles and for couples. We instead use a scale parameter to save on the total number of parameters.