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

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Abstract

The U.S. health insurance system for working-age households is characterized not only by its heavy dependence on the labor market but also by the segregation of risk pools across its three components: employer-sponsored health insurance (ESHI), individual health insurance exchange (HIX), and Medicaid. To assess the potential efficiency loss associated with this risk pool segregation, we develop and estimate an equilibrium model of labor and health insurance markets, with rich heterogeneity across local markets, households, and firms. We estimate the model exploiting variations across states and policy environments before and after the Affordable Care Act. We use the estimated model to implement counterfactual policies that cross-subsidize between ESHI and HIX, which include pure risk pooling between the two markets as a special case. We find that 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.

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1 Introduction

For the vast majority of working-age households in the U.S., health insurance is attainable via three different channels: employer-sponsored health insurance (ESHI), the individual insurance market (currently known as the health insurance exchange, or HIX), and public insurance mainly via Medicaid. Two features of this health insurance system stand out. The first feature is its tie to the labor market. Directly, ESHI is by far the most important insurance channel, covering over two thirds of the working-age population.[1] Indirectly, earnings on the labor market, being the most important source of income for this population, largely determine the costs a household faces for the other two insurance options: A household is ineligible for Medicaid if its income is above a certain threshold; it also faces an income-variant cost for HIX insurance due to the income-based HIX subsidy and credit it may receive from the government.

The second standout feature of the U.S. health insurance system is the segregation of risk pools across insurance channels. In particular, current regulations (e.g., medical loss ratio regulation) require that the premium on an ESHI or HIX market should closely reflect the risk among those insured on that market. As a result, 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. In the current equilibrium, ESHI-covered households are healthier, or less adversely-selected, than HIX enrollees.[2] As Akerlof (1970) suggests, adverse-selection pressure may limit the affordability and even availability of HIX insurance.[3] This leads to concerns not only about the lack of health insurance for many households, but also about the potential distortion of worker-firm sorting just because ESHI jobs provide access to affordable health insurance.

One natural question is whether or not the current segregated risk pool structure has caused non-trivial losses in household welfare and/or wastes in government expenditure. If there are non-trivial losses, then how to redesign the risk pool structure becomes a central issue. However, relative to the extensive discussion about government intervention in each insurance channel (e.g., ESHI tax deductibility, HIX subsidization and Medicaid eligibility), the issue about a proper risk pool structure has received much less attention, and our knowledge about the equity-efficiency implication of counterfactual risk pool structures is quite limited. This paper aims at moving a step forward toward a solid understanding of this issue.

To achieve this goal, one has to consider several key factors. First, changing the risk pool structure is likely to affect ESHI premiums (paid directly by ESHI-providing employers) and thereby

[1] For example, in 2015, of the U.S. population aged 22 to 64, 68% was insured via own or spousal ESHI, 10% was covered by Medicaid, and 7% by HIX; the remaining 15% was uninsured. Statistics are calculated from the American Community Survey (ACS).

[2] As we illustrate via a simple model in Section 3, risk segregation policies will make the risk pool on ESHI less adversely-selected than that on HIX. This prediction holds in the data (Section 5.1).

[3] For studies on this issue in pre-ACA individual health insurance markets, see for example, Hackmann et al. (2015).

affect equilibrium wages and allocation on the labor market. As pointed out by Summers (1989), given the role played by employers in providing many essential benefits, large-scale policy reforms should account for equilibrium responses in the labor market. Second, various insurance channels are inter-connected because households sort into different insurance options in the equilibrium: They can choose to work on a job with ESHI, adjust their labor supply and hence change their Medicaid eligibility and HIX costs, or stay uninsured. Third, any given adjustment of the current risk pool structure is likely to have different welfare impacts on different households. Under the status quo, households' choices differ across demographic groups and across seemingly similar households, and they may respond differently to any given policy. Similarly, the provision of ESHI appears to be related to firms' labor demand: Larger firms (i.e., firms demanding more labor) 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 may have differential impacts on different firms, and via 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), and hence the impact of adjusting the risk pool structure is likely to vary with these state-specific components.

In this paper, we provide a coherent framework incorporating all these factors. We develop 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 households and firms. 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 thereby pay ESHI premiums and ESHI fixed costs; it also chooses the number of workers in each (skill, full/part time) category, which are imperfect substitutes for one another. Wages are subject to payroll taxes and income taxes, while neither the firm nor the worker pays taxes on ESHI benefits. Equilibrium wages and premiums for HIX and ESHI clear the corresponding markets.

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 Affordable Care Act (ACA), which represents the U.S. health care system's most significant regulatory overhaul and expansion of coverage over the past five decades. We exploit the following variation associated with the ACA: 1) policy variation before and after the ACA came into effect in 2014; 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 of the ACA Medicaid expansion across states, which led to substantial differences in households' choice sets depending on their states of residence. 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 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 sample and the hold-out sample.

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, which tend to have higher TFP and more skill-biased technologies. 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 of the skill distribution. That is, households are ex post segregated into different risk pools largely by their skill levels. Unlike ESHI, HIX insurance is not bundled with one's job and hence may be more susceptible to adverse selection.[4] Indeed, in both the data and our model-predicted baseline equilibrium, ESHI-covered households are healthier than HIX participants and the uninsured. This implies that HIX premiums are higher than ESHI premiums (conditional on quality), and hence the distortion of labor force allocation mentioned before can be a real concern.

To explore potential improvement over the current risk pool structure, we design new schemes that can break down the segregation of risk pools *and* can be practically implemented with little change to the health insurance system. These counterfactual schemes regulate the ESHI-HIX premium differential by taxing ESHI insurers and transferring the tax revenue to subsidize HIX insurers (i.e., by implementing risk adjustment transfers *between* ESHI and HIX). Schemes differ in their tax rates (degrees of cross subsidization), where pure risk pooling between ESHI and HIX is a special case.

Our policy simulations suggest that the current risk pool segregation has led to a sizable welfare loss for households and wasteful government spending. Relative to the baseline (the ACA environment in 2015), cross subsidization policies would increase average household welfare by \$189 to \$340 (as measured by annual consumption equivalent variation) and decrease government expenditure by \$14 to \$41, depending on the degree of cross subsidization. Over 70% of households would gain in each case, which could potentially be higher if the saved government expenditure were to be used to compensate losing households. Furthermore, holding all initial conditions fixed, we find that

[4] An exception is the newly established Health Reimbursement Arrangement (HRA), which incentivizes small firms to insure their employees via HIX. HRA was introduced in 2019, much later than our sample periods (2012, 2015).

ESHI-HIX cross subsidization would lead to higher welfare gains if it were combined with Medicaid expansion.

Underlying these welfare gains are changes in health insurance premiums as well as changes in equilibrium wages. Cross subsidization would significantly decrease HIX premiums at the cost of small increases in ESHI premiums (e.g., a 34% decrease in the former and a 3% increase in the latter). These changes alleviate the distortion of allocation on the labor market by affecting the relative attractiveness of ESHI jobs for workers, and the relative cost of labor for firms and hence firms' labor demand and ESHI provision decisions. Consequently, we find sizable adjustment in equilibrium wage rates. Associated with changes in equilibrium prices, the uninsured rate would decrease by 0.3 percentage points (ppts), full-time employment would increase by 0.1 ppts (mainly due to switches from part-time to full-time employment), and average earnings would increase by 2%.

Our paper contributes to the literature on the link between the health insurance system and the labor market, especially studies aimed at evaluating counterfactual policies.[5] Of these studies, one subset focuses on individual decisions (e.g., Rust and Phelan, 1997, French and Jones, 2011, De Nardi et al., 2016 and Pohl, 2018). In particular, French et al. (2018) study the ACA's impact on retirement, savings, and welfare; they find that the ACA's effect on labor supply is small on average, but the effects are significantly heterogeneous. Another subset uses an equilibrium approach. 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 and ESHI tax treatments).[6]

Our paper well complements these studies. First, instead of evaluating ACA policies or their variants, we have a very different goal of assessing the potential welfare loss from risk pool segregation, which has been a long-standing feature of the U.S. health insurance system but has received little attention. Second, our framework incorporates richer heterogeneity, including policies and unobservables that differ at the state level, which is potentially important in assessing *distributional* effects of alternative risk pool structures. Indeed, we find that ESHI-HIX cross subsidization policies would lead to differential welfare impacts across households and different equilibrium responses across states. Third, we allow for more options for both workers and firms, including households' choices on work hours and firms' choices of labor inputs by skill and hour, in order to better understand how risk pool segregation may distort labor market allocation.[7] Finally, instead of evaluating the ACA's impact via counterfactual simulations, we exploit policy variation associated with the ACA

[5] See Currie and Madrian (1999) and Gruber (2000) for reviews of earlier work in this literature.

[6] Using a similar framework, Conti et al. (2018) study the effect of heath insurance in Mexico. See also Pashchenko and Porapakkarm (2013), Nakajima and Tuzemen (2017), and Ozkan (2017) for examples of macroeconomic analysis of the ACA.

[7] Previous studies have emphasized the importance of considering various ways workers and firms respond to price/policy changes. For example, Cutler and Madrian (1998) study the effect of health insurance costs on work hours and part-time employment; Dillender et al. (2020) study the effect of the ACA employer mandate on part-time employment.

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. In this regard, our paper draws insights from the design-based literature on the ACA, e.g., Kowalski (2014), Gooptu et al. (2016) , Frean et al. (2017), Kaestner et al. (2017), Leung and Mas (2018) and Garthwaite et al. (2019).[8]

Our paper also contributes to the broad literature that evaluates the impact of welfare programs and social insurance. A set of studies examine how labor supply may be affected by welfare programs (Keane and Moffitt, 1998, Chan, 2013, Blundell et al., 2016, and Low et al., 2018), by social security (French, 2005), and by disability insurance (Low and Pistaferri, 2015). Closely related to our paper, Gayle and Shephard (2019) emphasize the importance of modeling equilibrium market responses for understanding the optimal design of tax and welfare programs.

Because we aim to study large-scale counterfactual policies that change risk pool structures, we deliberately incorporate labor market equilibrium in our model, following the point made by Summers (1989). The cost of doing so is that we model individual health insurance markets in a relatively simple way, compared to the literature that conducts in-depth analysis of these markets, e.g., Handel et al. (2015), Einav et al. (2019), and Finkelstein et al. (2019b). Our paper well complements these studies by considering risk pooling across HIX and ESHI.

In the following, Section 2 briefly describes the background; 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

Unlike many other developed countries, the U.S. health insurance system for the working-age population is largely employer-based, with ESHI covering over two-thirds of this population. This is partly sustained by ESHI tax deductibility: Although wages are subject to payroll taxes and income taxes, ESHI benefits are not taxed. ESHI premiums are paid (mostly) by employers as a fringe benefit for their workers. For a single-coverage (family) plan, the ESHI premium paid by firms is about 9% (22%) of the average wage among ESHI-covered workers, based on data from the ACS and Kaiser. The second channel of health insurance, Medicaid, is provided as an in-kind transfer for the poor. Medicaid is administered by each state government, the cost of which is shared between federal and the state governments. The third channel is individual health insurance markets, which are often considered to suffer from significant adverse selection (e.g., Gruber, 2008).

All three insurance channels went through major reforms under the ACA, which represents the US health care system's most significant regulatory overhaul and expansion of coverage over the past

[8] For studies exploiting randomized experiments or health reforms other than the ACA, see, 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).

five decades. The ACA was signed into law in 2010 and its major provisions came into effect in 2014. We use sample periods both pre and post ACA (2012 and 2015) to exploit variation associated with the ACA, which consists mainly of the following five components:

Individual Mandate: Given the high uninsured rate (22% among working-age Americans in 2012), the ACA specified that starting from 2014, individuals shall have a health insurance plan meeting minimum standards, or pay a tax penalty that varied with household income and household size. 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. The individual mandate was abolished in 2019.

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

Health Insurance Exchanges (HIX): Before 2014, HIX did not exist and all insurers on private individual health insurance markets were allowed to price discriminate by consumers' demographics and health status. In 2014, HIX were established, which significantly restricted price discrimination: Insurance premiums are subject to modified community rating, and premiums are based *only* on age and smoking status, with the variation specified by the government. Regulations are set by the federal government, based on which, state governments can set further restrictions. Insurers on HIX also need to offer the same plans to every consumer, where the design of HIX insurance plans is government-regulated and categorized into four plans with different levels of generosity: bronze, silver, gold, and platinum. The most popular choice is the silver plan, which is more generous than typical health insurance plans purchased in pre-ACA individual markets (see Online Appendix D). One can purchase individual health insurance from HIX insurers *only* in one's state.

Income-Based Subsides 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 HIX premiums, 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.[9] In addition, individuals purchasing the silver plan can obtain an income-based tax credit.

Medicaid: Before the ACA, each state government chose Medicaid eligibility rules in the state. Very

[9] 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

few adults were eligible for Medicaid other than low-income parents with young children. The ACA specified (not mandated) that Medicaid expand to cover the uninsured whose household income is below 133% of FPL. By 2015, 32 states (including Washington DC) had complied.

Associated with the ACA reform, the uninsured rate among working-age Americans declined from 22% in 2012 to 15% in 2015. It should be noted that the uninsured are partially insured by implicit public insurance through uncompensated care. When uncompensated care occurs, a large part of the health cost for the uninsured is eventually paid by the government or charities.

3 A Simple Model: The Intuition

Before introducing the full model, we use a simple model to illustrate the implication of risk pool segregation. Consider an 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 concave preference over consumption $U(\cdot)$, but different health risks $x \in (0, \overline{x})$ and disutility of work $d \in \left(0, \overline{d}\right)$, drawn from $F(x, d)$. If $x > x'$, the distribution of medical cost $G\left(c^{med}|x\right)$ first-order-stochastically dominates $G\left(c^{med}|x'\right)$. A worker's labor supply choice is $(h, z_1) \in \{(0,0), (1,0), (1,1)\}$, 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 product that fully insures health risks; neither market can price discriminate.
Equilibrium prices include the premium on HIX (r), the premium on ESHI (q) and the wage rate for each type of jobs $(w = [w_0, w_1])$. The premiums r and q are equal to the average medical cost among enrollees on HIX and that on ESHI, respectively (*risk pool segregation*).

Worker's Problem Given (r, w), a worker chooses (h, z_1, z_2) to maximize her expected utility, accounting for the uncertain medical cost:

$$\begin{aligned} & \max_{h,z_1,z_2} \int U\left(C(h, z_1, z_2)\right) dG\left(c^{med}|x\right) - dh \qquad (1) \\ s.t.\ C(h, z_1, z_2) &= (1-h)\,b + hw_{z_1} - z_2 r - (1-z_1)(1-z_2)\,c^{med}, \end{aligned}$$

where $C(\cdot)$ is one's net consumption. In the constraint, one's income is b if not employed, and w_{z_1} if employed with z_1. If insured via HIX ($z_2 = 1$), one pays the HIX premium r. If uninsured $((1-z_1)(1-z_2) = 1)$, one pays a random medical cost c^{med}. Given that working involves disutility and that workers value insurance, in equilibrium, the following must be true: $w_0 > b$ and $w_0 > w_1$.

A worker's problem can be viewed as first choosing (h, z_1) and then choosing z_2. Online Appendix A shows that optimal decisions at both stages follow cutoff rules. 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 $x > x^{**}(w, r)$. If $z_1 = 0$, for $h = 0, 1$, there is an $x^*(y, r)$, with $y = (1 - h)b + hw_0$, such that a worker would choose $z_2 = 1$ if $x > x^*(y, r)$.[10] That is, 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 A firm solves the following

$$\max_{z_1, n} f(n) - z_1(w_1 + q)n + (1 - z_1)w_0 n.$$

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 the following holds: 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.

This simple example has the following implications:

Implication 1: If both ESHI and non-ESHI jobs exist, the risk pool on ESHI will be (weakly) less adversely-selected than that on HIX; and the premium on ESHI will be lower than that on HIX ($q \leq r$).

***Implication 2*:** When $q < r$, the segregation policy creates a regressive welfare effect: 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).

Although it delivers the basic idea, this simple model is insufficient for a realistic evaluation of alternative risk pool structures.[11] To do that, one needs to consider the presence of Medicaid and other policies. For example, HIX subsidies could alleviate/outweigh, while ESHI tax exemption could exacerbate the regressive welfare effect from risk segregation. Moreover, as discussed in the

[10] The properties of $x^*(\cdot; r)$ depend 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 $x^*(w_0; r) \geq x^*(b; r)$.

[11] 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.

introduction, one also needs to consider heterogeneity at the firm, household and state level. To incorporate these factors, we resort to our full model.

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 good with heterogeneous technologies. A firm chooses a combination of labor inputs and ESHI provision.

A household is characterized by $(x, \mathrm{s}, \boldsymbol{\chi}, \epsilon)$, where x is a vector of characteristics (marital status, number of young children, each spouse's gender, age, education, and health status); $(\mathrm{s}, \boldsymbol{\chi}, \epsilon)$ are unobservable to the researcher. In particular, s and $\boldsymbol{\chi}$ are both two-dimensional vectors of discrete variables: s consists of each spouse's human capital level and $\boldsymbol{\chi}$ consists of their preference types; s and $\boldsymbol{\chi}$ may be correlated. The distribution, $\Pr((\mathrm{s}, \boldsymbol{\chi}) | x, state)$, varies with x and across states. ϵ 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 $\{w^m_{shz}\}$ 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 $INS_1 = I$(ESHI), $INS_2 = I$(spousal ESHI), $INS_3 = I$(Medicaid), $INS_4 = I$(individual insurance). We assume that 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 **INS** be the 4×2 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.[12] 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.

[12]Given the static nature of the model, we treat a health shock purely as an expenditure shock.

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 $(x, \boldsymbol{\chi})$, such that

$$u(C, \mathbf{h}, \mathbf{INS}; x, \boldsymbol{\chi}) = \frac{\left(\frac{C}{n_x}\right)^{1-\gamma_{\boldsymbol{\chi}}}}{1-\gamma_{\boldsymbol{\chi}}} - D\left(\mathbf{h}, \boldsymbol{\chi}, x\right) + \varpi_{\mathbf{INS}}, \tag{2}$$

where n_x is an adult-equivalence factor that varies with family size.[13] $\gamma_{\boldsymbol{\chi}}$ is a risk-aversion parameter that may differ by household type. $\mathbf{h} = [h, h']$ is the vector of labor supply status of the household and $D\left(\mathbf{h}, \boldsymbol{\chi}, x\right)$ is disutility from work. $\varpi_{\mathbf{INS}}$ is households' non-pecuniary preference for a given insurance status. The vector $\{\varpi_{\mathbf{INS}}\}$ serve to capture various factors that may affect how households value different insurance choices beyond their pecuniary values (e.g., application costs and inertia).

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

$$\begin{aligned} Y_j &= T_j \left[A_j \sum_{s \geq s^*} B_{sF} l_{jsF}^{\rho} + (1 - A_j) \left(\sum_{s < s^*} B_{sF} l_{jsF}^{\rho} + \sum_{s=1}^{S} B_{sP} l_{jsP}^{\rho} \right) \right]^{\frac{\theta}{\rho}}, \\ \text{where } l_{jsh} &= k_s n_{jsh}. \end{aligned} \tag{3}$$

The parameters θ, ρ 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.[14] 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. 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.

[13] 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.

[14] 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.

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 $\mathbf{INS}$ given $(\mathbf{h}, \mathbf{z})$. A household solves the following problem[15]

$$\max_{(\mathbf{h},\mathbf{z})\in\{(0,0),\{P,F\}\times\{0,1\}\}^2} \{V(x, m, \boldsymbol{\chi}, \mathbf{s}, \mathbf{h}, \mathbf{z}) + \epsilon_{\mathbf{h},\mathbf{z}}\}, \tag{4}$$

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 σ_ϵ. Let $(\mathbf{h}^*, \mathbf{z}^*)_{(x,m,\boldsymbol{\chi},\mathbf{s},\epsilon)}$ be the solution to (4).

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

$$\begin{aligned} V(x, m, \boldsymbol{\chi}, \mathbf{s}, \mathbf{h}, \mathbf{z}) &= \max_{\mathbf{INS}} \left\{ \int u(C, \mathbf{h}, \mathbf{INS}; x, \boldsymbol{\chi}) dF_{OOP}(x, \mathbf{INS}, m, r) \right\} \\ s.t. \qquad C &= \max\{y - OOP,\ \underline{c}\} \\ y &= w^m_{shz} + w^m_{s'h'z'} + b(x, m, r, w^m_{shz} + w^m_{s'h'z'}, \mathbf{INS}) \\ \mathbf{INS} &\in \Omega(x, y, m, \mathbf{z}), \end{aligned} \tag{5}$$

where the expectation is taken over the distribution of OOP that reduces household consumption, but households are guaranteed a minimum consumption level $\underline{c}$.[16] Household total income y consists of the couple's labor earnings ($w^m_{shz} = 0$ if $h = 0$), and a net government transfer $b(\cdot)$. The function $b(\cdot)$ 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 $(w^m_{shz} + w^m_{s'h'z'})$, premium r and insurance status $\mathbf{INS}$. The last constraint in (5) specifies that $\mathbf{INS}$ can only be chosen from $\Omega(x, y, m, \mathbf{z})$, which reflects the link between a household's choices of $\mathbf{INS}$ 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 (INS_1) and spousal ESHI (INS_2') are both directly governed by z: $INS_1 = z \in \{0,1\}$; and $INS_2' = 0$ if $z = 0$. If neither of the spouses are covered by ESHI, $(z, z') = 0$, the household may be eligible for Medicaid

[15] We present the problem for a coupled household; the problem is simpler for singles, with $h' = z' = 0$.

[16] 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.

governed by function $MC(x, y, m)$. Therefore, via income y, a household's labor supply decision indirectly affects INS_3 and INS_3' (Medicaid). In addition to these natural links and the assumption that the four 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 $INS_1 = INS_2' = 1$.

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 $(INS_3 = INS_3' = 1)$ or staying uninsured $(\mathbf{INS} = \mathbf{0})$.[17] If $MC(x, y, m) = 0$, it chooses between individual health insurance and staying uninsured, and $INS_4 = INS_4'$, so that individual health insurance purchase are made for the entire household.[18]

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

$$
\begin{aligned}
\Omega(x, y, m, \mathbf{z} = [1, 0]) &= \{([1, 0, 0, 0], [0, 1, 0, 0])\}, \\
\Omega(x, y, m, \mathbf{z} = [0, 1]) &= \{([0, 1, 0, 0], [1, 0, 0, 0])\}, \\
\Omega(x, y, m, \mathbf{z} = [1, 1]) &= \{[1, 0, 0, 0]^2\}, \\
\Omega(x, y, m, \mathbf{z} = [0, 0]) &= \left\{ \begin{array}{c} MC(x, y, m) \left\{[0, 0, 1, 0]^2, [0, 0, 0, 0]^2\right\} \\ (1 - MC(x, y, m)) \left\{[0, 0, 0, 1]^2, [0, 0, 0, 0]^2\right\} \end{array} \right\}.
\end{aligned}
\tag{7}
$$

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.[19] Consistent with the data, we

[17] In the data, only 5.7% of households eligible for Medicaid chose individual insurance.

[18] 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 ε 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 (5) is modified to

$$
\begin{aligned}
V(x, m, \boldsymbol{\chi}, \mathbf{s}, \mathbf{h}, \mathbf{z} = (0, 0)) &= E \max_{\mathbf{INS}} \left\{ \int u(C, \mathbf{h}, \mathbf{INS}; x, \boldsymbol{\chi}) dF_{OOP}(x, \mathbf{INS}, m, r) + \varepsilon_{\mathbf{INS}} \right\} \\
s.t. \qquad C &= \max\{y - OOP, \underline{c}\} \\
y &= w^m_{shz} + w^m_{s'h'z'} + b(x, m, r, w^m_{shz} + w^m_{s'h'z'}, \mathbf{h}, \mathbf{INS}) \\
\mathbf{INS} &\in \Omega(x, y, m, \mathbf{z} = [0, 0]).
\end{aligned}
\tag{6}
$$

[19] 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.

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,

$$\pi_j^* = \max_{\left\{z_{jh}, \{n_{jsh}\}_s\right\}_h} \left\{ Y_j - \sum_{s,h} n_{jsh} \left[w_{shz}^m \left(1 + \tau_w^m\right) + q^m z_{jh} \kappa_{sh}^m \right] - \delta I\left(z_j \neq (0,0)\right) + \eta_{z_j} \right\}, \tag{8}$$

where Y_j follows the technology (3), τ_w^m is a payroll tax, q^m is the price of ESHI on Market m, κ_{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 (κ_{sh}^m), conditional on the household's decision to let him/her work h hours with ESHI.[20] δ is a fixed cost of providing ESHI, and η_{z_j} is the an i.i.d. Type-I extreme-value distributed shock (with a scale parameter σ_η) 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.

Firm j's optimal decision $\left\{z_{jh}^*, \left\{n_{jsh}^*\right\}_s\right\}_h$ 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 η_{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

[20]
$$\kappa_{sh}^m = \int \kappa\left(x, m, \boldsymbol{\chi}, s, s', \epsilon\right) dF\left(x, \boldsymbol{\chi}, s', \epsilon | s, m, (h^*, z^*)_{(x,m,\boldsymbol{\chi},\mathbf{s},\epsilon)} = (h,1)\right), \tag{9}$$

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

premiums in our counterfactuals such that on both ESHI and HIX, insurers are break-even.[21] 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

$$r^m(x) = \Gamma(r_b^m, age). \tag{10}$$

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*
$\left\{(\mathbf{h}^*, \mathbf{z}^*)_{(x,m,\boldsymbol{\chi},\mathbf{s},\epsilon)}, \left(\{z_h^*, \{n_{sh}^*\}_s\}_h\right)_{(T,A)}, \{w_{shz}^m\}_{shz}, r_b^m, q^m\right\}$ *that satisfies*
(1) Given $\{w_{shz}^m\}_{shz}$ *and* $r^m(x)$, $(\mathbf{h}^*, \mathbf{z}^*)_{(x,m,\boldsymbol{\chi},\mathbf{s},\epsilon)}$ *solves household problem for each* $(x, m, \boldsymbol{\chi}, \mathbf{s}, \epsilon)$.
(2) Given $\{w_{shz}^m\}_{shz}$ *and* $r^m(x)$, $\left(\{z_h^*, \{n_{sh}^*\}_s\}_h\right)_{(T,A)}$ *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* (10) *satisfy the break-even condition on the HIX market;* 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, the competitive labor market equilibrium in our model can be inefficient because of adverse selection on HIX and ESHI, the severity of which may differ between the two markets (Implication 1 in Section 3).
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.[22] Via the correlation between x and unobservables, our model allows the distribution of $(\mathbf{s}, \boldsymbol{\chi})$ in a state to differ across policy eras. However, we assume that the conditional distribution $\Pr((\mathbf{s}, \boldsymbol{\chi})|x, state)$ 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

[21] 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.

[22] Some studies have examined migration responses to ACA, e.g., Goodman (2017) finds no effect of the ACA Medicaid expansion on migration.

us to capture how ESHI provision relates to both firm sizes and within-firm worker compositions.[23] All else equal, higher-T firms would demand more labor and have a cost advantage for offering ESHI because of the fixed cost of ESHI; higher-A firms would have higher demand for skilled labor relative to unskilled labor, and would tend to offer ESHI if skilled workers have higher demand for health insurance.

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

$$\Pr\left((\mathbf{s},\boldsymbol{\chi})\,|x,state\right)=\Pr\left(\boldsymbol{\chi}|x,state\right)\Pr\left(\mathbf{s}|x,\boldsymbol{\chi}\right),$$

where s $\in\{1,...S\}^2$, $\boldsymbol{\chi}\in\{1,2\}^2$.[24] 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,χ) and 100 unobserved types of coupled households defined by $(\mathbf{s},\boldsymbol{\chi})$.

Preference Type Denote elements 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 from

$$N\left(\left[\begin{array}{c} x_0\beta_0+x_1\beta+\xi_{state} \\ x_0\beta_0+x_2\beta+\xi_{state}\end{array}\right],\left[\begin{array}{c}1,\varrho\\ \varrho,1\end{array}\right]\right), \tag{11}$$

where ξ_{state} is a state-specific parameter that introduces state-level unobservables into the model; ϱ allows for matching on unobservables between a couple.[25]

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

$$\Pr\left(s|x,\chi\right)=\begin{cases}\Phi(\ln(k_s)-x'\lambda-\alpha_\chi)-\Phi(\ln(k_{s-1})-x'\lambda-\alpha_\chi) & \text{for } 1<s<S,\\ \Phi(\ln(k_s)-x'\lambda-\alpha_\chi) & \text{for } s=1,\\ 1-\Phi(\ln(k_{s-1})-x'\lambda-\alpha_\chi) & \text{for } s=S,\end{cases} \tag{12}$$

[23] See Eeckhout and Kircher (2018) for a theoretical study of a competitive labor market equilibrium with endogenous firm sizes and firm-worker sorting.

[24] For singles, only the first entry of s and that of $\boldsymbol{\chi}$ are relevant.

[25] We do not impose any restriction on the vector $\{\xi_{state,}\}$. As such ξ_{state} can be freely correlated with a state's policies, including Medicaid expansion. For singles, $\Pr(\chi=2)=\Phi\left(x_0\beta_0+x_1\beta+\xi_{state}\right)$.

where α_χ is a type-specific parameter that allows for correlation between s and χ, with α_2 normalized to zero. The mass points of the amounts human capital (k_s) are assumed to be quantiles from $\ln N(\overline{x}'\lambda, 1)$, where $\overline{x}$ 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.[26]

The distribution of a couple's skills is given by

$$\Pr(\mathbf{s}|x, \boldsymbol{\chi}) = \Pr(s|x, \chi)\Pr(s'|x, \chi').$$

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

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 ξ_{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 between preferences and skills conditional on x*, as captured by α_χ.[27]

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,

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

where $\underline{T}$ is the scale parameter (the minimum value of T_j) and α_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

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

[26] 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 $\ln N(\overline{x}'\lambda, 1)$ as the mass points of k_s levels, which serves as a normalization.

[27] For example, this data fact can also be rationalized via heterogeneous non-pecuniary preferences for insurance ($\varpi_{\mathbf{INS}}$), 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 $\varpi_{\mathbf{INS}}$.

where μ_A is the median of A for firms with $T = \mu_T \equiv E[T]$, and ν 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).[28]

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 $\Psi\left(healthy|x, state\right)$ from CPS, which we use to simulate the health status for those in the ACS sample.[29] 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.

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 geocodes, 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 that are representative of U.S. firms with at least 3

[28]To reduce the computational 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.

[29]Health status is self-reported as one of 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 health measures are also highly correlated with labor market outcomes as shown in Blundell et al. (2017).

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.[30] 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.[31] Because Kaiser only covers firms with at least 3 workers and is topcoded at 500 workers, we supplement it with information from SUSB about the overall distribution of firms of all sizes.

5.1 Summary Statistics

The goal of this paper is not to study the impact of the ACA. However, the ACA provides rich policy variation that we can exploit to estimate our structural model. In this section, we summarize how outcomes vary across households, states and policy eras; in Section 6.3, we discuss how these covariations help identify the structural model. Table 1 summarizes individual-level statistics from the ACS (Panels A to C) and health information from CPS (Panel D), before and after the ACA and separately for ACA Medicaid expansion and non-expansion states.[32] 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 from 19.2% to 10.8% in expansion states (a 44% decrease), and from 26.3% to 19.4% in non-expansion states (a 26% decrease). In 2012, ESHI and Medicaid coverage rates were higher in expansion states (even before the expansion). After the ACA, although shares in all three insured statuses increased, the biggest share increase occurred in Medicaid for expansion states, but in individual insurance for non-expansion states. Panel C shows 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 (ppts) 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, in line with Implication 1 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 how outcomes vary with these policy variations, we run regressions of the

[30] 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.

[31] 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.

[32] 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

following form:

$$y_{ist} = x_{ist}\alpha_1 + d_s + I(t = 2015)x_{ist}\left[MEP_s\alpha_2 + (1 - MEP_s)\,\alpha_3\right] + \epsilon_{ist}. \tag{13}$$

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 α_2 reflects (2015 versus 2012) changes in outcomes among different demographic groups (x) in Medicaid expansion states; and α_3 reflects these changes in non-expansion states. ϵ_{ist} is an error term.

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 (α_2) and non-expansion states (α_3) separately, which exhibits some noticeable differences across demographic groups and across the two groups of states. For example, after the 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 statuses, changes in work statuses are not as significant. Our findings are consistent with Leung and Mas (2018), who also find that Medicaid

Table 2: Insurance and Work Status Regressions

	Uninsured	Medicaid	ESHI	Nonemployed	Full time
ACA*Medicaid Expansion States (α_2)					
α_{20}	-0.059	0.049	0.007	-0.014	0.015
	(0.011)	(0.013)	(0.012)	(0.007)	(0.008)
Edu Low (α_{21})	-0.055	0.064	-0.006	-0.005	0.015
	(0.015)	(0.014)	(0.012)	(0.013)	(0.015)
Edu High (α_{22})	0.071	-0.059	-0.013	0.022	-0.010
	(0.011)	(0.010)	(0.012)	(0.005)	(0.009)
Childless (α_{23})	0.003	-0.012	-0.004	-0.003	0.001
	(0.012)	(0.010)	(0.011)	(0.008)	(0.009)
Single (α_{24})	-0.104	0.060	0.025	-0.026	0.020
	(0.013)	(0.012)	(0.017)	(0.010)	(0.011)
ACA*Non-Expansion States (α_3)					
α_{30}	-0.058	-0.001	0.045	-0.027	0.022
	(0.011)	(0.008)	(0.017)	(0.012)	(0.011)
Edu Low (α_{31})	0.019	-0.025	-0.003	0.033	-0.020
	(0.015)	(0.014)	(0.013)	(0.020)	(0.020)
Edu High (α_{32})	0.012	0.012	-0.015	0.010	-0.001
	(0.017)	(0.006)	(0.013)	(0.008)	(0.007)
Childless (α_{33})	-0.013	0.023	-0.017	0.027	-0.023
	(0.015)	(0.007)	(0.013)	(0.009)	(0.009)
Single (α_{34})	-0.019	-0.008	0.005	-0.026	0.017
	(0.015)	(0.007)	(0.013)	(0.009)	(0.009)

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

expansion significantly increased Medicaid coverage but did not reduce "employment lock" among childless adults.

Remark 2 *A few points are worth emphasizing. First, the estimated coefficients in Table 2 should not be interpreted as causal effects; instead, they serve as a succinct way to summarize data variations that we use to identify our structural model. For example, we allow coefficients in the two vectors* α_2 *and* α_3 *in Equation* (13) *to differ by* x *and states' Medicaid expansion status because many ACA policy doses vary across households, who differ in their earnings potentials, and because Medicaid expansion induced significant changes in households' choice sets.*[33] *How outcomes covary with these policy doses provides information to identify our model. Second, it is important to use both types of data patterns, i.e., the significant change in insurance status and the lack of significant change in work status, to discipline our structural model. Finally, the insignificant change in work status associated the ACA does not justify ignoring labor market responses to other counterfactual policies. This is*

[33]Notice that the most important criterion for ACA policy doses is income, a fact that has been exploited in previous studies on the ACA, e.g., Frean et al. (2017) and Lurie et al. (2019).

especially true for our paper, which aims at evaluating counterfactual risk pool structures that would directly affect ESHI premiums and hence equilibrium wages.

Table 3: Summary Statistics: Firms

Kaiser										
Year	Obs.	ESHI	Size[a]		Size≥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)

[a]Firm sizes in Kaiser are top coded at 500, and treated so in this calculation.

SUSB						
Year		All Firms	Size≤4	4<Size< 100	100≤Size< 500	Size≥ 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

Next, we summarize firm-level data patterns. The upper panel of Table 3 summarizes data from Kaiser (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 compositions, we present the statistics among all firms and among firms with ESHI. The average and the standard deviation of firm sizes are subject to the caveat that firm sizes in Kaiser are top coded at 500, so we also present the fraction of firms sized over 500.[34] With the aforementioned caveat, we can see that compared to average firms, firms with ESHI are larger, have more full-time workers and more high-wage workers.[35] The lower panel of Table 3 shows the size distribution of all firms in SUSB.[36] 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

[34]The top-coding of firm sizes in Kaiser data is taken into account in our estimation, as we explain in Footnote 46.

[35]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.

[36]SUSB firm size is categorical, and size≤ 4 is the first category, while Kaiser data only contains firms with size≥ 3.

transfer function. We briefly describe each here and provide 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 paid by households with x on market m.[37] A household's out-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, following rules specific to each state before and after 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, where a market is a state-era combination.[38] We parameterize $MC(x, y, m)$ using information from Kaiser Family Foundation.[39]

Government net transfer function consists of household income tax, welfare benefits (TANF), food stamps (SNAP), consumer subsidies on HIX, and tax penalties for the uninsured (ACA individual mandates). We parameterize each of these components. In particular, we follow Chan (2013) in specifying TANF and SNAP functions.

6.2 Structural Estimation: Overview

6.2.1 Estimation Sample and Validation Sample

We divide the household sample 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.[40]

We use the data this way 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

[37] Similarly, q^m is set at the average ESHI premium reported by firms in Kaiser on market m. Notice that $r^m(x)$ and q^m are estimated directly from the data only for estimating the model. For counterfactual policy simulation, premiums on both HIX and ESHI are equilibrium objects to be determined internally.

[38] In modeling $MC(\cdot)$, we account for the substantial variation in Medicaid eligibility rules across states before ACA. After ACA, we model Medicaid eligibility rules as defined by the federal government in Medicaid expansion states. In non-expansion states, we explicitly account for state-specific programs that provide Medicaid to the low-income population. However, 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.

[39] See https://www.kff.org/state-category/medicaid-chip.

[40] 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%

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 disproportionately more likely to have expanded Medicaid ($\frac{5}{7}$ versus $\frac{10}{21}$); and the population in these states are more educated.

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 decisions. Among these prices, health insurance premiums are directly observable in the data; while wages $\{w^m_{shz}\}$ are not observable because skill s is not observable (although we observe, for individuals with different x, their job types (h, z) and wages). However, since the realized equilibrium wages $\{w^m_{shz}\}$ 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 of non-ESHI jobs $\{w^m_{sh0}\}$ can be approximated by a discretized log-normal distribution.[41] In particular, on Market m, the skill-specific log wages $\{\ln(w^m_{sh0})\}_{s=1}^S$ are quantiles from

$$N\left(\omega^0_h + \omega^0_{state} + \omega^0_{year},\ \sigma^2_{wh}\right), \tag{14}$$

where the mean is governed by the vector ω^0, including the part/full time dummy (ω^0_h), state dummies (ω^0_{state}) and year dummies (ω^0_{year}). To capture the idea of compensating wage differentials, we assume that wages of ESHI jobs 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[42]

$$\frac{w^m_{sh1}}{w^m_{sh0}} = \frac{1}{1 + \exp\left(\omega^1_0 + \omega^1_1 w^m_{sh0}\right)}. \tag{15}$$

[41] 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).

[42] 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.

We treat the vector $\{\omega^0, \omega^1, \sigma_w\}$ in (14) and (15) as parameters to be estimated, which jointly imply $\{w^m_{shz}\}$. Notice that $\{\omega^0, \omega^1, \sigma_w\}$ are not structural parameters, and are used *only* in the estimation; in counterfactual policy simulations, wages and insurance premiums are all determined internally as equilibrium outcomes following Definition 1.[43]

6.2.3 Two-Stage Estimation via Indirect Inference

Stage 1: Estimate household-side parameters $\left(\Theta^H\right)$ and $\{\omega^0, \omega^1, \sigma_w\}$ by matching model-predicted household decisions with the observed household choices.
Stage 2: Given parameter estimates in Stage 1 (hence household decision rules and equilibrium wages), estimate firm-side parameters $\left(\Theta^F\right)$ 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 $\overline{\beta}$ denote our chosen set of auxiliary model parameters computed from data; let $\widehat{\beta}(\Theta)$ denote the corresponding auxiliary model parameters obtained from simulating a large dataset from the model (parameterized by a particular vector Θ) and computing the same estimators. The structural parameter estimator is then the solution

$$\widehat{\Theta} = \text{argmin}_{\Theta} \, [\widehat{\beta}(\Theta) - \overline{\beta}]' W [\widehat{\beta}(\Theta) - \overline{\beta}],$$

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

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. Notice that prices are endogenous, however, during the estimation, we only need to solve individual household/firm problems, who takes the observed equilibrium prices as given.
Household Side: 1) Variation in the equilibrium premiums $r^m(x)$ for individual health insurance affects 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 $\Omega(\cdot)$, dif-

[43] 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.

fer 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: ESHI premiums q^m vary across markets (state $\times$ policy era). For example, on average, ESHI premiums increased by about 4% between 2012 and 2015. The ACA employer mandate directly changed the cost of not providing ESHI.

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

6.3.1 Auxiliary Models for Stage 1 Estimation

We target the following auxiliary models (Aux^h, superscript h for households), all of which are based on the estimation sample only.

Aux^h 1. Targets from the ACS

a. Regressions as reported in Section 5.1 for individuals' insurance status and work status, i.e.,

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

b. Individuals' earnings regression of the following form:

$$\ln(w_{ist}) = x_{ist}\alpha_1^w + d_s^w + I(t = 2015)\alpha_2^w + I\left(h_{ist} = \text{full}\right)\alpha_3^w + \text{ESHI}_{ist}\alpha_4^w + \text{IND}_{ist}\alpha_5^w + \epsilon_{ist}^w,$$

where d_s^w is a state dummy, coefficients α_3^w to α_5^w capture the *correlation* between earnings and full/part time status (h), ESHI status, and individual insurance purchase.

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

d. Fractions of individuals in each of the following categories, both for all individuals and by one-way demographics (marital status, presence of children, education, age groups):

· Uninsured, insured via ESHI, insured via Medicaid.

· Non-employed, employed full time.

· Uninsured and employed part time, uninsured and non-employed, Medicaid-covered and employed part time, Medicaid-covered and non-employed, and ESHI-covered and employed full time.

Aux^h 2. Moments from CPS that are informative of health-related utility parameters: by pre/post-ACA$\times$Medicaid expansion/non-expansion states, the fraction of individuals who are

a. healthy and uninsured, healthy with ESHI, healthy with Medicaid.

b. healthy and non-employed, healthy and working full time.

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

a. Covariance of log earnings between two spouses.

b. Fractions of couples who both work and 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) household preferences and (iii) the conditional distribution of unobserved household skill and preference types $\Pr((\mathbf{s}, \boldsymbol{\chi})|x, state)$. 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 Aux^h 1a, to inform us of parameters in (ii) and (iii). Given our assumption that $\Pr((\mathbf{s}, \boldsymbol{\chi})|x, state)$ is policy-invariant, state dummies $\{d_s\}$ in Aux^h 1a are informative of the state-specific shifter parameters in $\Pr((\mathbf{s}, \boldsymbol{\chi})|x, state)$. Meanwhile, cross-era comparison of household choices as captured by α_2 and α_3 in Aux^h 1a are informative of (policy-invariant) household preference parameters.

Specifically, we first exploit state-era policy variation in the work status regressions in Aux^h 1a, which are targeted jointly with the earnings regression and earnings variance (Aux^h 1b and 1c). To correct the self selection problem that may affect 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.[44] By itself, the presence of children increases the disutility of work and, via medical expenses, increases the value of ESHI jobs relative to non-ESHI jobs. More importantly, this variable interacts with policy changes. For example, although the ACA-induced change in equilibrium wages equally affects households of the same skill type within a state (partly captured by α_2^w in Aux^h 1b), the ACA-induced change in individual insurance premiums affects these households differently depending on the presence of children. Similarly, 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.

State-era policy variation is also exploited in the insurance status regressions in Aux^h 1a. Because insurance premium subsidies and the individual mandate directly affect 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 (ϖ_{INS}) and risk aversion coefficients (γ_χ).

Identification is further facilitated by the fact that for the *same* household, we observe not only

[44]The x entering $\Pr((\mathbf{s}, \boldsymbol{\chi})|x, state)$ includes education, age, gender and marital status.

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 α_4^w and α_5^w in Aux^h 1b capture how earnings correlate with ESHI and individual insurance status (relative to Medicaid and uninsured), which, together with Aux^h 1a, are informative of how skill and preference may be correlated.

6.3.2 Auxiliary Models for Stage 2 Estimation

Borrowing from the literature (e.g., Garicano et al., 2016), we set parameter $\theta = 0.75$ in the production function (3), because it is neither the focus of our paper nor clearly identified. For each Census Region, we estimate $\{B_{sh}\}$, ρ, δ 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. For each region, we target the following region-specific auxiliary models (Aux^f, superscript f for firms):

Aux^f 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 offering ESHI.

c. Cov($ESHI$, firm size), Cov($ESHI$, fraction of employees earning high wages), Cov($ESHI$, fraction of full time).

d. Cov(firm size, fraction of full time employees), Cov(firm size, fraction of employees earning low/high wages).

Aux^f 2. The aggregate supply of labor for each (s, h, z) category derived from Stage 1 estimates (by policy era).

Aux^f 3. Moments from SUSB (by policy era): Fraction of small firms.[45]

Given ESHI choices z_{jh}, firms' first order conditions with respect to labor inputs are given by

$$\begin{aligned} w^m_{shz} + q^m z_{jh} \kappa^m_{sh} &= \begin{cases} T_j L_j^{\frac{\theta}{\rho}-1} A_j B_{sh} k_s^{\rho} \left(n_{jsh}\right)^{\rho-1} \text{ if } s \geq s^* \text{ and } h = F, \\ T_j L_j^{\frac{\theta}{\rho}-1} \left(1 - A_j\right) B_{sh} k_s^{\rho} \left(n_{jsh}\right)^{\rho-1} \text{ otherwise,} \end{cases} \\ \text{where } L_j &= A_j \sum_{s \geq s^*} B_{sF} l_{jsF}^{\rho} + \left(1 - A_j\right) \left(\sum_{s < s^*} B_{sF} l_{jsF}^{\rho} + \sum_s B_{sP} l_{jsP}^{\rho} \right). \end{aligned} \quad (16)$$

The marginal cost of labor (the LHS of (16)) consists of wage and the expected cost of ESHI, both of which are known given estimates from Stage 1: $\{w^m_{shz}\}$ are Stage-1 parameter estimates, q^m is data

[45] 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.

and κ_{sh}^m is derived from household preference parameters. Moreover, these costs vary across markets m, i.e., state$\times$policy era. Given $\{k_s\}$ implied by the skill distribution parameters estimated in Stage 1, the marginal productivity of labor (the RHS of (16)) is known up to parameters $(A_j, T_j, \{B_{sh}\}, \rho)$. Via (16), these parameters govern firms' size and labor composition, as captured in Aux^f 1a.

Aux^f 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 (κ_{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), Aux^f 1b and 1c inform us of the policy-invariant parameters governing 3). Moreover, joint with Aux^f 1a, Aux^f 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).

As implied by Condition (16), 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). Therefore, conditional on the correlation between firm size and worker composition that is associated with ESHI offering (i.e., Aux^f 1b and 1c), Aux^f 1d provides direct information on the correlation between (A_j, T_j).

Targets under Aux^f 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 Aux^f 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 (Aux^f 3) from SUSB, which, together with Aux^f 1, provide a more complete picture of the distribution of firms.[46]

Remark 3 *Our identification is based on the idea of exploiting rich state-era policy variation as much as we can. We do, however, impose functional form assumptions in estimating the model. A valid concern is whether or not our counterfactual policy results are driven mostly by functional form assumptions. The following three points may ease this concern. First, the fundamental economic intuition underlying our counterfactual policy implications is already reflected in the simple model in Section 3 without specifying functional forms. Second, as will be shown in Section 7.1, our model estimates, e.g., the willingness to pay for health insurance, are largely consistent with those in liter-*

[46]Our model-simulated firms can be of any size. In calculating Aux^f 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 Aux^f 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

A. Preferences					
γ_χ : Type 1 singles or (Types 1, 1) couples	4.12	(0.003)	Disutility of Working		
γ_χ : Type 2 singles or (Types 2, 2) couples	2.11	(0.003)	Full-time job (unhealthy)	-3.29	(0.03)
γ_χ : (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 ϖ_{INS}: Medicaid	-0.40	(0.002)	Part-time job (Type 1)	-2.32	(0.01)
Nonpecuniary value ϖ_{INS}: Individual insurance	-0.13	(0.001)	Full-time job (Type 2)	-3.36	(0.01)
Nonpecuniary value ϖ_{INS}: ESHI	1.43	(0.003)	Part-time job (Type 2)	-4.23	(0.01)
B. Type and Skill Distribution*					
$\Pr(\chi = 2 \vert x, state)$			$\Pr(s \vert x, \chi)$		
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)
ϱ : type correlation between a couple	0.77	(0.01)			
C. Simulated Type Distribution in the Sample: $\Pr(\chi = 1 \vert \cdot)$ (%)					
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	

State-specific parameters in the type distribution are included but not reported.

ature. Finally, following Todd and Wolpin (2006), we will conduct out-of-sample model validation in Section 7.2 to provide further credibility of our counterfactual analysis.

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, because we have many more household observations than firm observations.

Household-Side Parameters Panel A of Table 5 shows selected parameters governing household preferences. The left columns show that Type 1 singles and (Type 1, Type 1) couples have higher relative risk aversion (γ_χ) compared with their Type 2 counterparts; households with mixed types of spouses have γ_{χ} closer to Type 1 households. These estimated γ'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 or psychic cost associated with applying for Medicaid or individual insurance.[47]

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. 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 11).[48]

Relating to Estimates in the Literature 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). In particular, 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) are 49% and 79%, respectively. Similarly, our estimates imply that among those covered by Medicaid, the willingness to pay for Medicaid is

[47] Other studies, e.g., Handel (2013), have also found that these non-pecuniary costs are important in explaining household insurance choices. The high non-pecuniary value of ESHI relative to other insurance options also help to explain why work-status responses to ACA were small.

[48] For example, in 2015, 35% of residents in Medicaid expansion states had high education, while this fraction was only 30% in non-expansion states (Table 1). Our estimates (Panel B of Table 5) suggest that the probability of being Type 1 is much higher among the highly-educated.

Table 6: Selected Firm-Side Parameter Estimates

Region	Northeast		Midwest		West		South	
A. TFP Distribution $T_j \sim Pareto\left(\underline{T}, \alpha_T\right)$								
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 α_T	3.49	(0.26)	3.76	(0.51)	3.90	(0.21)	4.14	(0.19)
B. Skill Bias $\ln\left(\frac{A_j}{1-A_j}\right)\|T_j \sim N\left(\ln\left(\frac{\mu_A}{1-\mu_A}\right) + \nu(\ln\left(T_j\right) - \ln\left(\mu_T\right)), \sigma_A^2\right)$								
μ_A	0.67	(0.122)	0.73	(0.04)	0.74	(0.04)	0.68	(0.02)
σ_A	1.41	(0.198)	1.61	(0.35)	2.19	(0.23)	1.27	(0.22)
ν	0.86	(0.661)	0.93	(0.19)	1.55	(0.85)	1.15	(0.04)
C. Other Selected Parameters								
ρ (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)
σ_η (ESHI decision shock)	1.92	(0.43)	1.87	(1.02)	1.91	(0.77)	1.92	(1.19)

$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).

Firm-Side Estimates 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 ν'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 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 $k \in \{\text{HIX}, \text{ESHI}\}$ 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 In-Sample Model Fit and Out-of-Sample Validation

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 Aux^h 1a is reasonably good. Table 9 reports 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

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

	Status (%)				ln(Earnings)			
	Data		Model		Data		Model	
Year	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

	Uninsured		Medicaid		ESHI		Nonemployed		Full time	
Medi. Expand	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

different from the estimation sample, this validation exercise lends us some confidence of the model in conducting counterfactual policy experiments. 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.

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. These two types of households are largely “segregated” from the risk pool on HIX (e.g.,regulation requires that the premium on an ESHI/HIX market should closely reflect the risk among those insured on that market). A lot of discussion has centered around how to enlarge/improve the risk pool on HIX (currently covering 7.5% of the working-age population),

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

	Data		Model	
Year	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

mostly aimed at encouraging the uninsured (14.4% of the population), especially the healthy ones, to participate in HIX.

A natural alternative is to look beyond the 21.9% HIX+uninsured population and to desegregate the risk pools between ESHI and HIX (Implication 2 in Section 3). This type of thought experiment can be properly conducted in our framework, which explicitly accounts for labor market adjustment. Under the status quo, the pool on ESHI is of lower risk than that on HIX (Table 1). Pooling risk across the two markets may decrease the HIX premium, making health insurance more affordable for households not covered by ESHI or Medicaid. At the same time, it may increase the ESHI premium and hence the cost of labor for firms were they to offer ESHI. As a result, risk-pooling policies may have a broad impact on both the supply and the demand of labor for ESHI and non-ESHI jobs and hence equilibrium wages. The equity-efficiency implication is 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.

In the following, we will first show that ESHI-HIX risk pooling can be achieved via a simple cross-subsidization policy. The policy taxes ESHI insurers and transfers the tax revenue to subsidize HIX insurers; it involves no structural change to the current health insurance system. We will then present the impact of this policy on the baseline economy as well as how the impact varies with Medicaid expansion policies.[49]

[49]Relative to regular health insurance programs, Medicaid has an additional role of providing social benefits to the

8.1 Cross-Subsidization between ESHI and HIX

Risk-pooling between ESHI and HIX does not require merging 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 cross-subsidization scheme that implements such an equilibrium.

8.1.1 Risk-Pooling Equilibrium

Under risk pool segregation, the break-even condition holds on ESHI and on HIX separately. To pool risks across ESHI and HIX, the break-even condition should hold across these two markets, i.e., the sum of total expected costs for insurers on ESHI and HIX should be equal to the sum of total premiums on these two markets. Specifically, let $\tilde{r}_b^m$ be the new base premium on HIX, which implies age-adjusted premiums according to

$$\widetilde{r}^m(x) = \Gamma\left(\tilde{r}_b^m, age\right), \tag{17}$$

where $\Gamma(\cdot)$ is the same age-premium rule as in the baseline; let the premium on ESHI be

$$\widetilde{q}^m = \theta \tilde{r}_b^m, \tag{18}$$

where θ is a modifiable policy parameter that governs the degree of premium adjustment. At this point, θ is simply a premium intervening policy parameter, however, we will give it a specific role when we introduce ESHI-HIX cross subsidization. For a given θ, we solve for the new equilibrium wages and insurance premiums, such that under $\tilde{r}_b^m(\theta)$, which implies $\widetilde{r}^m(x;\theta)$ and $\widetilde{q}^m(\theta)$ (Equations 17 and 18), the break-even condition holds across ESHI and HIX. Such an equilibrium effectively pools the risks on ESHI and HIX, and equilibrium prices and outcomes are governed by θ.

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 $k \in \{\text{HIX}, \text{ESHI}\}$ 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.[50] The ESHI-HIX risk pooling equilibrium with $\tilde{r}_b^m(\theta)$ can be implemented

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.

[50]The cost is the loading factor times the expected reimbursement, where the loading factor is fixed at the baseline level.

by imposing taxes $\tau_k^m(\theta)$ defined by

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

For $k \in \{\text{HIX, ESHI}\}$, $\tau_k^m(\theta)$ is a positive (negative) tax if the total cost for the insurer on k is smaller (larger) than the total premium collected on k.[51]

After imposing $\tau_k^m(\theta)$ on insurers on $k \in \{\text{HIX, ESHI}\}$, there is no need for further intervention: HIX and ESHI markets would still operate separately (as they do in the status quo), yet, the equilibrium premiums on HIX and ESHI would be $\widetilde{r}^m(x;\theta)$ and $\widetilde{q}^m(\theta)$, 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 Policy Parameter θ serves to adjust the degree of cross-subsidization between ESHI and HIX: A higher θ implies a larger subsidization flowing from ESHI to HIX. As a starting point, we consider a θ that is just enough to offset the difference between ESHI and HIX in their actuarially fair values and quality of care. We denote this special parameter value as θ^0, which is calibrated at 1.4.[52] The equilibrium achieved under θ^0 is one that simply pools the risk across ESHI and HIX without further adjustment, in that premiums on the two markets are equalized conditional on quality. Then, we experiment with a series of θ'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 θ^0 and $1.5\theta^0$.

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

[51] 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.

[52] Specifically, $\theta^0 = \frac{g_{ESHI}}{g_{HIX}}\frac{ME_{ESHI}}{ME_{HIX}}$, where $\frac{g_{ESHI}}{g_{HIX}} = \frac{0.85}{0.7}$ 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 and amount of care as proxied by the population level medical spending on $k \in \{\text{HIX, ESHI}\}$: 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.

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

	$\theta = \theta^0$					$\theta = 1.5\theta^0$				
A. Δ 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. Δ 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. Δ Earnings$\vert$employed (%)			2.15					1.98		

increases only by 2.8%. The 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.[53] It may be expected that wage differentials $(w_0 - w_1)$ would decrease because obtaining insurance from one's employer becomes less valuable when HIX premiums decrease. However, how w_0 and w_1 would change is less clear ex ante for two reasons. First, for ESHI jobs, labor supply would go down as HIX premiums go down, but 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 as households re-sort across different types of jobs and non-employment. Second, given that higher productivity firms are more likely to offer ESHI, among firms originally providing ESHI, those with relatively lower productivity are more likely to switch into non-ESHI firms in response to increased ESHI premiums. This selection would increase the average firm productivity on both types of jobs.

Panel B shows the percentage point (ppt) changes in insurance and work statuses across all individuals and by demographics. Under both θ's, the cross-subsidization policy increases the fraction of individuals covered by HIX and lowers that covered by ESHI, leading to a reduction in the uninsured rate in all demographic groups. It should be noted that insurance status changes are small in magnitudes. For example, despite the significant decrease in HIX premiums (Panel A), the increase in HIX enrollment is less than 1 ppt. This is because the relevant price a household faces is the premium net of HIX subsidies from the government as described in Section 2. The same decrease in the

[53] To save space, we report the % change in wages averaged across the 5×2 skill-hour categories and across 28 states, i.e., $\frac{1}{5\times2\times28}\sum_{s,h,m}\left(\frac{w_{shz}^{m,new} - w_{shz}^{m,base}}{w_{shz}^{m,base}}\right)$ for $z = 0$ (non-ESHI) and $z = 1$ (ESHI).

HIX premium would lead to differential impacts on net premiums faced by different households, as illustrated by Table 14 in the appendix.[54] In particular, higher-income households, who are ineligible for HIX premium subsidies, would see a larger decrease in net HIX premiums; however, they are also much more likely to be covered by ESHI. In contrast, subsidy-eligible households would see a smaller change or even no change in net premiums.

We also find that the policy has a small positive effect on employment, in that the fraction of full-time workers is slightly larger while the 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. In particular, our model is able to capture the welfare impact arising from wage adjustment because it explicitly considers the connection between the health insurance system and the labor market in an equilibrium setting. 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.[55] 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: Type-1 households, who are more risk averse, are also more likely to win. Relative to households with lower education, those with high education are more likely to win and to win more, partly because high-education households are more likely to be Type 1 (Table 5). In addition, there are two reasons. First, households with high education are more likely to work on ESHI jobs, wages of which are increased (Table 11). Second, these households are less likely to qualify for HIX subsidies and hence more likely to benefit from the decrease in HIX premiums. Although risk segregation *in itself* implies a regressive welfare effect (Implication 2 in Section 3), this effect is largely alleviated and even outweighed by the progressive HIX premium subsidy policy. As HIX premiums decrease, premium subsidies calculated under the current formula would become less

[54]Table 14 calculates, when the HIX premium decreases by 6.3% or 33.6% from the national average, how would the net premium change for an age-40 childless household, holding fixed its income at a given level, and how much the government would save in subsidies if the household enrolls in HIX.

[55]Ex ante welfare is defined as $\mathbf{V}(x, m, \boldsymbol{\chi}, \mathbf{s}) \equiv E \max_{(\mathbf{h},\mathbf{z})} \{V(x, m, \boldsymbol{\chi}, \mathbf{s}, \mathbf{h}, \mathbf{z}) + \epsilon_{\mathbf{h},\mathbf{z}}\}$. 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
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
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
Savings in Gov. expenditure per hh ($)	14.5		40.9	
Savings in HIX subsidies per enrolled hh ($)	229.0		759.1	

progressive, leading to very small or even no change in net HIX premiums faced by lower-income households (see Section 2 and Table 14). To examine the effect of our counterfactual policy imposed on the baseline economy, we have deliberately kept the baseline HIX premium subsidy formula. Under this formula, decreases in HIX premiums would lead to savings in government spending, as we discuss below.

Government net spending in the health insurance system decreases by $14 per household (hh) under $\theta = \theta^0$ and by $41 per hh under $\theta = 1.5\theta^0$. 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), and savings come mostly from decreases in HIX premium subsidies because subsidies are linked directly to premiums. Our model is silent about how these savings might be used, but if they were used as transfers to low-skilled households in some format, these households would see larger welfare gains from ESHI-HIX cross subsidization than what is reported in Table 12.

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.[56] 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

[56]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

	$\theta = \theta^0$				$\theta = 1.5\theta^0$			
Group of States	MEP Compliers		Non-Compliers		MEP Compliers		Non-Compliers	
	a	b	c	d	a'	b'	c'	d'
Medicaid Expansion	No	**Yes**	**No**	Yes	No	**Yes**	**No**	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

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 $\theta = \theta^0$ (left panel, columns a to d) and $\theta = 1.5\theta^0$ (right panel, columns a' to d'). Within each panel, the first two columns are for the 15 MEP complying states, with the first (second) column showing the effect of ESHI-HIX cross subsidization without (with) Medicaid expansion.[57] 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 θ, the effect of ESHI-HIX cross subsidization is larger in MEP non-complying states in terms of declines in uninsured rates, welfare gains, and savings in government expenditure (e.g., Column a vs. Column c, and Column b vs. Column d). Policy effects differ across these two groups of states because of differences in their population composition, state-specific unobservables and state-specific policies other than Medicaid. For example, complying states have a larger fraction of highly-educated individuals; for a given Medicaid expansion status, the uninsured rate is higher in MEP non-complying states before cross subsidization. Finally, there is some limited interaction between Medicaid expansion and ESHI-HIX cross subsidization. Given θ 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 (e.g., Column a vs. Column b, and Column c vs. Column d).

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

[57] 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 a shows the difference between E1 and E0.

or without Medicaid expansion. On the one hand, with Medicaid expansion, fewer people would be uninsured, which leaves smaller room for improvement arising 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.[58] Our finding suggests that the second force is stronger than the first.

9 Conclusion

We have developed and estimated an equilibrium model of the labor market and health insurance markets to examine the inefficiency associated with risk pool segregation across various health insurance channels in the U.S. The model features rich heterogeneity across local markets, workers, and firms. We estimate the model exploiting policy variation associated with the ACA. The estimated model matches the data well, including patterns in the hold-out sample.

Via counterfactual policy experiments, we find risk pool segregation of the U.S. health insurance system has led to a sizable welfare loss for households and wasteful government spending. These losses arise from the fact that the risk pool on HIX is more adversely-selected than that on ESHI, which implies a higher premium on HIX than that on ESHI (conditional on quality) under risk pool segregation. This premium differential has led to misallocation on the labor market. We find that ESHI-HIX cross subsidization could break the risk pool segregation, improve household welfare and lower government expenditure. Moreover, the policy would lead to higher welfare gains when it is interacted with Medicaid expansion. These findings suggest that policy tools designed to improve the risk pool structure *across* health insurance channels are promising avenues that warrant further exploration, because they can be welfare-enhancing, cost-effective and easily implementable (e.g., via ESHI-HIX cross subsidization). More generally, these findings have also 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 (e.g., responses from the health care sector), 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

[58] Table 15 in the appendix shows that, with Medicaid expansion, cross-subsidization would lead to smaller changes in insurance premiums and larger increases in ESHI wages.

one's health and hence future productivity. A second extension is to consider sources of inefficiency that we have abstracted from, such as search friction on the labor market (e.g., Dey and Flinn, 2005), choice friction on health insurance markets, and non-competitive insurance markets (e.g., Tebaldi, 2017). Finally, we have abstracted from the potential effect of risk pooling on the quality of insurance products (e.g., generosity of coverage) and enrollees' medical spending choices (moral hazard).[59] Extending our framework along these lines would be promising for future research.

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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

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

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
$D\left(\mathbf{h},\boldsymbol{\chi},x\right) =$

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

where $d_{\chi l}$ is a type-specific disutility of working with status $l = P, F$. φ_{1l} and φ_{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 υ to be estimated, which is a more parsimonious specification than specifying vectors of disutility parameters separately for singles and for couples.

Table 14: Changes in Net Premium and Government Savings in HIX Subsidies per Enrolled Household

		6.33% reduction in HIX premium*		33.61% reduction in HIX premium*	
Age 40	Income	ΔNet Premium (%)	Savings in Gov. Subsidy ($)	ΔNet Premium (%)	Savings in Gov. Subsidy ($)
Single	1.5 FPL	0.00	191.2	0.00	1015.0
	2 FPL	0.00	191.2	0.00	1015.0
	2.5 FPL	0.00	191.2	0.00	1015.0
	3 FPL	-3.80	79.5	-31.82	79.5
	3.5 FPL	-6.33	0.0	-33.61	0.0
	>4 FPL	-6.33	0.0	-33.61	0.0
Couple	1.5 FPL	0.00	382.3	0.00	2030.0
	2 FPL	0.00	382.3	0.00	2030.0
	2.5 FPL	0.00	382.3	0.00	2030.0
	3 FPL	0.00	382.3	0.00	2030.0
	3.5 FPL	0.00	382.3	-22.33	876.9
	>4 FPL	-6.33	0.0	-33.61	0.0

Upper (lower) panel: % change in the post-subsidy HIX premium for an age-40 childless single (coupled) household by income relative to FPL, and the associated savings in gov. HIX subsidy per enrolled hh.
*HIX premium is calculated at the national average for these households.

Table 15: Price Effects of Cross-ESHI-HIX Subsidization by Medicaid Expansion Status

%	$\theta=\theta^0$				$\theta=1.5\theta^0$			
Group of States	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