Supplement to "Labor market sorting and health insurance system design"

(*Quantitative Economics*, Vol. 10, No. 4, November 2019, 1401–1451)

Naoki Aizawa
Department of Economics, University of Wisconsin-Madison

Appendix A: Additional tables

A.1 *All parameter estimates*

Table A1. Parameter estimates for individual preferences.

Parameter	Estimates	Std. Error
CARA coeff. for type 1: γ_{τ_1}	1.40	(0.008)
CARA coeff. for type 2: γ_{τ_2}	0.85	(0.005)
consumption floor: $\underline{c}^0$	0.01	(0.0004)
disutility from bad health for type 1: $\eta_h^{\tau_1}$	0.27	(0.006)
disutility from bad health for type 2: $\eta_h^{\tau_2}$	0.08	(0.001)
disutility from work: $\tilde{\eta}_p$	0.0005	(3.5E−06)
disutility from work for unhealthy: $\tilde{\eta}_{hp}$	0.003	(2.4E−05)
nonemployment benefit: b	0.13	(0.001)
standard deviation of preference shock to purchase IHI: σ_{IHI}	0.01	(0.0002)
frac. of type 1 among college graduates: $\Pr(\tau_1\|C)$	0.74	(0.008)
frac. of type 1 among noncollege graduates: $\Pr(\tau_1\|NC)$	0.19	(0.007)
standard deviation of preference shock to work: σ_n	0.03	(0.0001)
terminal payoff for unhealthy: v_T^U	−4.01	(0.18)

Note: (a) The unit of time t is 4 months. (b) The disutility from work and the disutility from work for unhealthy are specified as ($\eta_{pt} = \tilde{\eta}_p \max\{t - \bar{t}, 0\}$) and $\eta_{hpt} = \tilde{\eta}_{hp} \max\{t - \bar{t}, 0\}$ where $\bar{t}$ is fixed as age 45.

Naoki Aizawa: naizawa@wisc.edu

© 2019 The Author. Licensed under the Creative Commons Attribution-NonCommercial License 4.0.
Available at http://qeconomics.org. https://doi.org/10.3982/QE1145

TABLE A2. Parameter estimates for individual latent medical expenditure, health transition, and labor market skills.

Latent Medical Expenditure			Health Transition			Worker Skill		
Parameter	Estimates	Std. Error	Parameter	Estimates	Std. Error	Parameter	Estimates	Std. Error
ω_1^H	−2.80	(0.005)	ϕ_{1H}^H	3.85	(0.005)	α_1^C	−1.03	(0.002)
ω_2^H	0.01	(0.0001)	ϕ_{1U}^U	0.10	(0.004)	α_1^{NC}	−0.96	(0.002)
ω_3^H	0.0000	(7.7E−07)	ϕ_{2U}^H	−0.72	(0.004)	$\alpha_1^{\tau_1}$	0.30	(0.001)
σ_H	0.40	(0.004)	ϕ_{2U}^U	−1.02	(0.007)	α_2^C	0.007	(3.5E−05)
κ^H	0.08	(0.0004)	ϕ_{3U}^H	−0.28	(0.01)	α_2^{NC}	5.0E−4	(2.9E−05)
ω_1^U	−1.50	(0.02)	ϕ_{3U}^U	−0.55	(0.01)	$\alpha_2^{\tau_1}$	2.0E−4	(1.6E−05)
ω_2^U	0.0000	(3.7E−05)	ϕ_{4U}^H	0.15	(0.007)	α_3^C	−4.0E−05	(2.1E−07)
ω_3^U	0.0000	(1.9E−06)	ϕ_{4U}^U	0.25	(0.01)	α_3^{NC}	−1.0E−05	(1.9E−07)
σ_U	0.95	(0.01)	ϕ_{5U}^H	0.006	(5.3E−05)	$\alpha_3^{\tau_1}$	−1.0E−07	(4.6E−08)
κ^U	0.0001	(1.9E−05)	ϕ_{5U}^U	0.014	(6.5E−05)	α_4^U	−0.37	(0.005)
			$\phi_{6U}^{\tau_2}$	0.79	(0.01)			

Note: (a) The forms of latent medical expenditure shocks, health transition processes, and skill functions are in (3), (16), (17), and (4): $m_t = \max\{\exp(\omega_1^{h_t} + \omega_2^{h_t} t + \omega_3^{h_t} t^2 + \epsilon_t^m) - \kappa_{h_t}, 0\}$, $\epsilon_t^m | h_t \sim$ i.i.d. $N(0, \sigma_{h_t}^2)$; $\Pr[h_{t+1} = k | x_t, h_t, m_t, t, \tau] = \frac{\exp(\phi_{1k}^{h_t} + \phi_{2k}^{h_t} x_t \mathbf{1}(m_t>0) + \phi_{3k}^{h_t} x_t m_t \mathbf{1}(m_t>0) + \phi_{4k}^{h_t} m_t \mathbf{1}(m_t>0) + \phi_{5k}^{h_t} t + \phi_{6k}^{\tau})}{\sum_{k'} \exp(\phi_{1k'}^{h_t} + \phi_{2k'}^{h_t} x_t \mathbf{1}(m_t>0) + \phi_{3k'}^{h_t} x_t m_t \mathbf{1}(m_t>0) + \phi_{4k'}^{h_t} m_t \mathbf{1}(m_t>0) + \phi_{5k'}^{h_t} t + \phi_{6k'}^{\tau})}$; $y_{x_t}(p) = \exp(\alpha_1^{ed} + \alpha_1^{\tau} + (\alpha_2^{ed} + \alpha_2^{\tau}) E_t + (\alpha_3^{ed} + \alpha_3^{\tau}) E_t^2 + \alpha_4^{h_t} + p)$. (b) The unit of time t is 4 months.

TABLE A3. Parameter estimate for firm-side, labor market frictions, and others.

Parameter	Estimates	Std. Error
Firm side parameters		
standard deviation of firm productivity distribution: σ_p	0.91	(0.12)
fixed cost of providing ESHI (in \$10,000): ξ_{ESHI}	0.18	(0.0005)
scale parameter for the cost of providing ESHI: σ_f	0.30	(0.001)
total measure of workers (relative to firms): M	23.21	(0.08)
Parameters for labor market friction		
job arrival rate: nonemployed, college graduate-type 1: λ_u^{C,τ_1}	0.51	(0.002)
job arrival rate: nonemployed, college graduate-type 2: λ_u^{C,τ_2}	0.30	(0.001)
job arrival rate: employed, college graduate-type 1: λ_e^{C,τ_1}	0.35	(0.001)
job arrival rate: employed, college graduate-type 2: λ_e^{C,τ_2}	0.15	(0.001)
job destruction rate: college graduate: δ^C	0.005	(4.7E−05)
job arrival rate: nonemployed, noncollege graduate-type 1: λ_u^{NC,τ_1}	0.30	(0.002)
job arrival rate: nonemployed, noncollege graduate-type 2: λ_u^{NC,τ_2}	0.28	(0.001)
job arrival rate: employed, noncollege graduate-type 1: λ_e^{NC,τ_1}	0.15	(0.001)
job arrival rate: employed, noncollege graduate-type 2: λ_e^{NC,τ_2}	0.13	(0.0004)
job destruction rate: noncollege graduate: δ^{NC}	0.01	(0.0001)
Other parameter estimates		
standard deviation of wage measurement error	0.19	(0.05)

A.2 *Diagnosis of sensitivity of moments*

As proposed by Andrews, Gentzkow, and Shapiro (2017), I provide the diagnosis to explore which moments are sensitive to parameters in the objective function. Following Gayle and Shephard (2019), I calculate the sensitivity matrix $\Lambda = (\Delta G'\Omega\Delta G)^{-1}\Delta G'\Omega$ where ΔG is the derivative of the targeted moments G with respect to the parameters and Ω is the weighting matrix of the objective function of the estimator. Because the scale of each moment could be very different and not comparable, I multiply each element in Λ by the standard deviation of the corresponding empirical moment. Then I calculate the moment with maximum sensitivity (in the absolute term) and consider any moment whose sensitivity is at least 15% of the maximal as being important. I describe a set of moments as being important if at least two conditional moments (e.g., by age cohort and education) from that set is important according to this criterion.

Table A4 shows report the sensitivity moments of the key parameters affecting demand and supply of health insurance discussed in Section 4.1. See Section 4.2 for a definition of sensitivity moment types. As shown in the table, in general there are multiple sensitivity moments for each parameter. However, importantly, the list of sensitivity moments differ across parameters. For example, the risk aversion parameter includes the distribution of insurance status (M2(a)) as the sensitivity moments, which differs from other key worker-side parameters. These findings are still consistent with the identification discussion in Section 4.1. Overall, the sensitivity analysis supports that different moments have different influences on estimates of model parameters.

TABLE A4. Sensitivity moments for key parameter estimates.

Parameter	Estimates	Std. Error	Sensitivity Moments
CARA coeff. for type 1: γ_{τ_1}	1.40	(0.008)	M1(a), (b); M2(a), (b), (c), (e); M3 (a), (c), (d), (e)
CARA coeff. for type 2: γ_{τ_2}	0.85	(0.005)	M1(a), (b); M2(a), (b), (c), (e); M3 (a), (c), (d), (e); M4 (c)
consumption floor: $\underline{c}^0$	0.01	(0.0004)	M1(b); M2(b), (c), (e); M3 (f)
std. dev. of pref. shock for IHI: σ_{IHI}	0.01	(0.0002)	M1(a), (b); M2(b), (c), (e); M3 (a), (c); M4 (b)
fixed cost of ESHI offer: ξ_{ESHI}	0.18	(0.0005)	M1(b); M2(b), (e); M3 (a), (c), (e); M4 (a), (b)
scale param. for cost of ESHI offer: σ_f	0.30	(0.001)	M1(b); M2(b), (c), (e); M3 (a), (b), (c), (e), (f); M4 (a), (b), (c)
prod. effect of bad health : α_4^U	-0.37	(0.005)	M1(b), (c); M2(b), (c), (e); M3 (a), (e), (f); M4 (b), (c)

Note: See Section 4.2 for a definition of sensitivity moment types.

A.3 *Other tables in counterfactual*

TABLE A5. Optimal policy parameters where equilibrium effects are shut down: understanding mechanisms.

	ACA	Optimal	Optimal: Fixed Offer Dist.	Optimal: Fixed Premium	Optimal: Fixed Offer Dist. and Premium
Policy parameters for premium rating regulation					
MPR: ω_{AGE}	3.00	4.70	4.14	3.00	3.00
Policy parameters for premium subsidies					
const. term of subsidy: ω_a^s	4.08	3.48	2.90	4.01	5.41
income coeff. of subsidy: ω_b^s	−3.88	−1.75	−1.35	−2.09	−3.14
income squared coeff. of subsidy: ω_c^s	−1.15	−0.001	−0.30	−0.001	−0.27
age coeff. of subsidy: ω_d^s	0.0	−0.0215	−0.016	−0.027	−0.0367
age squared coeff. of subsidy: ω_e^s	0.0	−0.000	−0.000	−0.000	−0.000
Policy parameters for tax penalties on the uninsured					
const. term of penalty: ω_a^I	0.03	0.031	0.03	0.03	0.03
income coeff. of penalty: ω_b^I	−0.002	0.00	−0.002	−0.002	−0.002
income squared coeff. of penalty: ω_c^I	0.003	0.00	0.003	0.003	0.003
age coeff. of penalty: ω_d^I	0.0	0.00	0.0	0.0	0.0
age squared coeff. of penalty: ω_e^I	0.0	0.00	0.0	0.0	0.0
Welfare gain (%)	–	5%	2%	3.5%	1.5%

Note: (a) ω_{AGE} determines the MPR. (b) Subsidies are parameterized as $S^{\text{HIX}}(y,t,R^{\text{HIX}}(t)) = \frac{\exp(\omega_a^s+\omega_b^s y_t+\omega_c^s y_t^2+\omega_d^s t+\omega_e^s t^2)}{1+\exp(\omega_a^s+\omega_b^s y_t+\omega_c^s y_t^2+\omega_d^s t+\omega_e^s t^2)} R^{\text{HIX}}(t)$. (c) Tax penalties are parameterized as $\text{IM}^{II}(y,t) = \omega_a^I + \omega_b^I y_t + \omega_c^I y_t^2 + \omega_d^I t + \omega_e^I t^2$. (d) The amount of welfare gain is reported as the percentage of medical expenditure under the full ACA. (e) In implementation, the youngest age in the model takes $t=1$ and the unit of t is 4 months. (f) Column (1) reports the policy parameters under the full ACA. (g) Column (2) reports the policy parameters under the optimal joint design of individual insurance regulations. (h) Column (3) reports the policy parameters under the optimal joint design of individual insurance regulations with the restriction that the offer distribution of compensation package is the same as the full ACA. (i) Column (4) reports the policy parameters under the optimal joint design of individual insurance regulations with the restriction that the HIX premium is the same as the full ACA. (j) Column (5) is the optimal joint design of individual insurance regulations with the restriction that both the offer distribution of compensation package and the HIX premium are the same as the ACA.

TABLE A6. Optimal joint design of of ESHI and individual insurance policies.

Policy Instruments	ACA	Optimal Individual Insurance Regulation	Optimal: ESHI and Individual Insurance Policies
Policy parameters for premium subsidies			
const. term of subsidy: ω_a^s	4.08	3.48	4.375
income coeff. of subsidy: ω_b^s	−3.88	−1.75	−0.15
income squared coeff. of subsidy: ω_c^s	−1.15	−0.001	−0.001
age coeff. of subsidy: ω_d^s	0.0	−0.0215	−0.026
age squared coeff. of subsidy: ω_e^s	0.0	−0.000	−0.000
Policy parameters for ESHI tax credits			
const. term of ESHI subsidy: ω_a^s	–	–	−1.105
income coeff. of ESHI subsidy: ω_b^s	–	–	−0.026
income squared coeff. of ESHI subsidy: ω_c^s	–	–	−0.005
age coeff. of ESHI subsidy: ω_d^s	–	–	0.001
age squared coeff. of ESHI subsidy: ω_e^s	–	–	0.000
Welfare gain (%)	–	5%	11%

Note: (a) HIX subsidies are parameterized as $S^{\text{HIX}}(y,t,R^{\text{HIX}}(t)) = \frac{\exp(\omega_a^s+\omega_b^s y_t+\omega_c^s y_t^2+\omega_d^s t+\omega_e^s t^2)}{1+\exp(\omega_a^s+\omega_b^s y_t+\omega_c^s y_t^2+\omega_d^s t+\omega_e^s t^2)} R^{\text{HIX}}(t)$. (b) ESHI subsidies are parameterized as $S^{\text{ESHI}}(y,R^{\text{ESHI}}(p),t) = \frac{\exp(\omega_a^E+\omega_b^E y_t+\omega_c^E y_t^2+\omega_d^E t+\omega_e^E t^2)}{1+\exp(\omega_a^E+\omega_b^E y_t+\omega_c^E y_t^2+\omega_d^E t+\omega_e^E t^2)} R^{\text{ESHI}}(p)$. (c) In implementation, the youngest age in the model takes $t=1$ and the unit of t is 4 months. (d) MPR and individual mandates are fixed at the value obtained at the optimal joint design of individual insurance regulations reported in Table 14. (e) Column (1) reports the policy parameters under the full ACA. (f) Column (2) reports the policy parameters under the optimal joint design of individual insurance regulations. (g) Column (3) reports the policy parameters under the optimal joint design of individual insurance and ESHI.

APPENDIX B: DERIVATION OF STEADY-STATE DISTRIBUTION OF NONEMPLOYED

The steady-state distribution of nonemployed $u(\mathbf{x_t})$ is determined as

$$\begin{aligned}\frac{u(\mathbf{x_t})}{1+n} &= \underbrace{\sum_{h_{t-1}} u\big(\mathbf{x^B_{t-1}}\big) \sum_{\text{HI}_t} hi_0\big(\text{HI}_t|\mathbf{x^B_{t-1}}\big) H_0\big(\hat{h}|\mathbf{x^B_{t-1}}, \text{HI}_t\big)\, \text{NN}(\mathbf{x_t})}_{\text{the inflow from nonemployed staying nonemployed}} \\ &+ \underbrace{\sum_{h_{t-1}} \sum_{O} \int g\big(\mathbf{x^A_{t-1}}, \theta, O\big) \sum_{\text{HI}'_t} hi_1\big(\text{HI}'_t|\mathbf{x^A_{t-1}}, \theta, O\big) H_1\big(\hat{h}|\mathbf{x^A_{t-1}}, \theta, \text{HI}'_t\big)\, \text{EN}(\mathbf{x_t}, \theta, O)\, d\theta}_{\text{the inflow from employed}},\end{aligned} \tag{25}$$

where $\mathbf{x^A_{t-1}} = (ed, \tau, E_{t-1}, h_{t-1}, t-1)$ and $\mathbf{x^B_{t-1}} = (ed, \tau, E_t, h_{t-1}, t-1)$. Again, I define two transition probabilities terms: $\text{NN}(\mathbf{x_t})$ is the *probability* that the unemployed with characteristics $\mathbf{x_t}$ will stay as the unemployed in the next period; $\text{EN}(\mathbf{x_t}, \theta, O)$ is the *probability* that an employed individual with characteristics $\mathbf{x_t}$ who has a job with compensation package (θ, O) will transition into being nonemployed:

$$\mathrm{NN}(\mathbf{x_t}) = 1 - \lambda_u^{\mathbf{x_t}} + \lambda_u^{\mathbf{x_t}} \int \big(1 - A(\mathbf{x_t}, \theta, O)\big)\, dF^{ed}(\theta, O),$$

$$\begin{aligned}\mathrm{EN}(\mathbf{x_t}, \theta, O) = {} & \big(1 - \delta^{\mathbf{x_t}}\big)\big(1 - \lambda_e^{\mathbf{x_t}}\big)\big(1 - A(\mathbf{x_t}, \theta, O)\big) \\ & + \left[\delta^{\mathbf{x_t}}\big(1 - \lambda_e^{\mathbf{x_t}}\big) + \delta^{\mathbf{x_t}} \lambda_e^{\mathbf{x_t}} \int \big(1 - A\big(\mathbf{x_t}, \theta', O'\big)\big)\, dF^{ed}\big(\theta', O'\big)\right] \\ & + \big(1 - \delta^{\mathbf{x_t}}\big)\lambda_e^{\mathbf{x_t}} \int \Pr\big(V_0^t(\mathbf{x_t}) + \epsilon_t^n \\ & \geq \max\big\{V_1^t(\mathbf{x_t}, \theta, O), V_1^t\big(\mathbf{x_t}, \theta', O'\big)\big\}\big)\, dF^{ed}\big(\theta', O'\big).\end{aligned}$$

The inflow into $u(\mathbf{x_t})$ consists of two components: the inflow from the unemployed (the first line in (25)) and the inflow from employed workers who become nonemployed (the second line in (25)).

Appendix C: Derivation of optimal skill price

This section shows how to characterize the optimal skill price using an envelope condition. The approach essentially follows Bontemps, Robin, and Van den Berg (1999, 2000). By applying an envelope condition to (20), we obtain that

$$\Pi_O'(p) = \sum_{\mathbf{x_t}} \left(e_{\mathbf{x_t}}(p) - O \frac{\partial \mathbb{E}\big[\tilde{m}_O^{\mathbf{x_t}}\big]}{\partial p} \right) l\big(\mathbf{x_t}, \theta_O^{ed}(p), O\big).$$

Integrating over $[\underline{p}, p]$, where $\underline{p}$ represents the lowest productivity firms, we obtain that

$$\Pi_O(p) = \Pi_O(\underline{p}) + \int_{\underline{p}}^{p} \sum_{\mathbf{x_t}} \left(e_{\mathbf{x_t}}(p') - O \frac{\partial \mathbb{E}\big[\tilde{m}_O^{\mathbf{x_t}}\big]}{\partial p''} \right) l\big(\mathbf{x_t}, \theta_{\mathrm{HI}}(p'), O\big)\, dp'.$$

By equating this with (20), for $p > \underline{p}$, $\theta_O^{ed}(p)$ satisfy

$$\theta_O^{ed}(p) = \frac{\sum_{\mathbf{x_t}} \big(e_{\mathbf{x_t}}(p) - \mathbb{E}\big[\tilde{m}_O^{\mathbf{x_t}}\big] O\big) l\big(\mathbf{x_t}, \theta_O^{ed}(p), O\big) - \Pi_O(\underline{p}) - \int_{\underline{p}}^{p} \sum_{\mathbf{x_t}} \left(e_{\mathbf{x_t}}(p') - O \frac{\partial \mathbb{E}\big[\tilde{m}_O^{\mathbf{x_t}}\big]}{\partial p''} \right) l\big(\mathbf{x_t}, \theta_O^{ed}(p'), O\big)\, dp'}{\sum_{\mathbf{x_t}} \exp\big(e_w^*(ed, \tau, E_t)\big) l_t\big(\mathbf{x_t}, \theta_O^{ed}(p), O\big)}, \tag{26}$$

which is the form exploited to numerically solve the equilibrium. The $\theta_O^{ed}(\underline{p})$ must be solved by maximizing (20) without relying on (26).

Appendix D: Numerical algorithm

I first describe the numerical algorithm that is used to solve the equilibrium of the pre-ACA model described in Section 2. I discretize the support of Γ, $[\underline{p}, \overline{p}]$, into finite points. Then I solve the equilibrium by the following fixed-point algorithm:

1. I provide an initial guess of the skill price and the fraction of firms offering ESHI for all p on support $[\underline{p}, \overline{p}]$, $(\theta^{ed}_{0,0}(p), \theta^{ed}_{1,0}(p), \Delta_0(p))$.

2. At iteration $\iota = 0, 1, \ldots$, I do the following sequentially, where I index the objects in iteration ι by superscript ι:

(a) Given the current guess of the health insurance costs and the health insurance offer probability $(\langle\theta^{ed}_{0,\iota}(p), \theta^{ed}_{1,\iota}(p)\rangle^{ed}, \Delta_\iota(p))$, I construct an offer distribution of compensation package $F^{ed}(\theta, O)$.

(b) Then I numerically solve individual value functions backwards from the period $T-1$.

(c) Given the value function, I solve the steady-state distribution $g(\tilde{X}_t, \theta, O)$ and $u(\tilde{X}_t)$ sequentially from age $t = 1$.

(d) Using $g(\mathbf{x_t}, \theta, O)$ and $u(\mathbf{x_t})$, I solve $(\langle\hat{\theta}^{ed}_0(p), \hat{\theta}^{ed}_1(p)\rangle^{ed}, \hat{\Delta}(p))$ for each p. For the skill price of the lowest productivity firm $\underline{p}$, I solve the profit maximization based on the grid search. But for other productivity levels $p > \underline{p}$, one can characterize them using (26). Then I solve the ESHI offering rate using (21).

3. After completing step (d) at iteration ι, I check whether the equilibrium object converges.

(a) If $(\langle\theta^{ed}_{0,\iota}(p), \theta^{ed}_{1,\iota}(p)\rangle^{ed}, \Delta(p))$ satisfies $d(\theta^{ed}_{0,\iota}(p), \hat{\theta}^{ed}_0(p)) < \epsilon_{\text{tol}}$, $d(\theta^{ed}_{1,\iota}(p), \hat{\theta}^{ed}_1(p)) < \epsilon_{\text{tol}}$ for $ed \in \{NC, C\}$ and $d(\Delta^{\iota *}(p), \Delta_\iota(p)) < \epsilon_{\text{tol}}$ where ϵ_{tol} is a prespecified tolerance level of convergence and $d(\cdot, \cdot)$ is a distance metric, then the firm's optimal policy converges and we have an equilibrium.

(b) Otherwise, update $(\langle\theta^{ed}_{0,\iota+1}(p), \theta^{ed}_{1,\iota+1}(p)\rangle^{ed}, \Delta_{\iota+1}(p))$ as follows:

$$\theta^{ed}_{0,\iota+1}(p) = w\theta^{ed}_{0,\iota}(p) + (1-w)\hat{\theta}^{ed}_0(p),$$
$$\theta^{ed}_{1,\iota+1}(p) = w\theta^{ed}_{1,\iota}(p) + (1-w)\hat{\theta}^{ed}_1(p)$$
$$\Delta_{\iota+1}(p) = w\Delta_\iota(p) + (1-w)\hat{\Delta}(p),$$

for the prespecified weight $w \in (0, 1)$ and continue Step 2 at iteration $\iota' = \iota + 1$.

For a model of post-ACA economy, I need to make two adjustments in the numerical algorithm above. First, I need to solve the equilibrium insurance premium at HIX. Thus, the fixed-point problem includes $R^{\text{HIX}}(t_0)$ as an equilibrium object, in addition to $(\theta^{ed}_{0,0}(p), \theta^{ed}_{1,0}(p), \Delta_0(p))$. Specifically, in each iteration, I solve the insurance premium using equation (23). Then assign the health insurance premium for each age, satisfying the age ratio between the youngest and the oldest.

Second, I need to consider the presence of firm size dependent penalties, which complicates the firm's problem. This changes step 2(d) in the firm's problem for $O = 0$ in the following way: (d-i) For the skill price of the lowest productivity firm $\underline{p}$, I solve the profit maximization based on the grid search; (d-ii) For the firms with size below 50 predicted in step 2(c), solve the skill price $\hat{\theta}^{ed}_0(p)$ by using the skill price equation (26). (d-iii) For the firms with size at least 50 predicted in step 2(c), solve the firm's problem in the following way; (d-iii-1) Search for the combination of $(\hat{\theta}_0^{NC}(p), \hat{\theta}_0^{C}(p))$ that generates the firm size being a slightly below 50 (in practice, 49.9) while maximizing the profit. I do this by grid search. (d-iii-2) Solve the profit-maximizing problem which explicitly includes the tax penalty. The profit maximizing skill price is found through grid search. (d-iii-3) Compare the profit from (d-iii-1) with (d-iii-2). If the former is larger, then repeat the same exercise for the next productivity level; otherwise, go to step (d-iv). (d-iv) Solve the skill price using the modified optimal skill price function, which now takes into account the employer mandate: $\theta_0^{ed}(p) = \frac{\sum_{\mathbf{x_t}} e_{\mathbf{x_t}}(p) l(\mathbf{x_t}, \theta_0^{ed}(p), 0) - \Pi_0^*(p^*) - \int_{p^*}^{p} \sum_{\mathbf{x_t}} e_{\mathbf{x_t}}(p') l(\mathbf{x_t}, \theta_0^{ed}(p'), 0)\, dp' - \mathrm{EM}^{\mathrm{ACA}}(l)}{\sum_{\mathbf{x_t}} \exp(e_w^*(ed, \tau, E_t)) l_t(\mathbf{x_t}, \theta_0^{ed}(p), 0)}$ where $p^*$is the maximum productivity level obtained at step (d-iii). The derivation of this equation is similar to the one in Appendix C in the Supplementary Material but reflects the employer penalty.

Appendix E: Parameterization outside the model

E.1 *Income tax*

In this section, I describe how I estimate the tax function using Kaplan's (2012) specification with my estimation samples. I restrict samples to those who are employed. First, I multiply the 4 months wages by three, which I observed in my data used in the estimation, to convert them to annual income. Given the functional form specified in Section 4.2, the tax payment at income y is

$$\mathrm{TAX}(y) = y - T(y) = y - \tau_0 - \tau_1 \frac{y^{(1+\tau_2)}}{1+\tau_2}.$$

By taking the derivative with respect to y,

$$1 - \mathrm{TAX}'(y) = \tau_1 y^{\tau_2},$$

where $\mathrm{TAX}'(y)$ is the marginal income tax rate. Taking the logarithm, I have

$$\log\left[1 - \mathrm{TAX}'(y)\right] = \log \tau_1 + \tau_2 \log y.$$

To estimate τ_1 and τ_2, I regress marginal tax rates for each individual in the baseline sample on labor earnings. Marginal tax rates are calculated using the National Bureau of Economic Research's TAXSIM program, which includes federal income tax, state income tax, and the employee portion of the payroll income tax. Once I obtain τ_1 and τ_2 from the above regression, I set τ_0 to the value that equates the actual average tax rate in the sample (as computed by TAXSIM) to that implied by the above equation. Parameter values are estimated as $\tau_0 = 1309.69$, $\tau_1 = 1.45$, and $\tau_2 = -0.08$.

After obtaining those parameters, we feed them into the model by adjusting the magnitude to fit the 4-month income level. Specifically, the adjustment yields the following after-tax income schedule:

$$T(y) = \frac{1}{3}\left[\tau_0 + \tau_1 \frac{(3y)^{(1+\tau_2)}}{1+\tau_2}\right],$$

where y is the 4-month income level, and τ_0, τ_1 and τ_2 are estimated above using the annual income data.

E.2 *Individual insurance*

The pre-ACA individual insurance premium is specified as a function of health and age so that $R^{\mathrm{HI}}(\mathbf{x_t}) = r_0 + r_0^U 1(h_t = U) + r_1 a_t + r_1^U a_t 1(h_t = U)$. I use the data from MEPS to estimate these parameters using the standard OLS. I obtain the estimates as $r_0 = 0.069$, $r_0^U = 0.02$, $r_1 = -0.00005$, $r_1^U = 0.0015$ where the scale of the premium is \$10,000 and the unit of age is expressed as a 4-months interval.

Appendix F: Estimation algorithm

The estimation is done in the standard nested fixed-point algorithm and described as follows:

1. Guess a vector of parameters q.
2. Given the parameters q, solve the equilibrium of the model and then simulate the data.
3. Evaluate the objective function using the simulated moments:

$$\min_{\{q\}} G(q)'\Omega G(q),$$

where $G(q)$ is the vector of the value of each moment j, $G_j(q)$, and Ω is the weighting matrix, which is the diagonal matrix where each diagonal element is the inverse of the estimated variances of the corresponding sample moment. Each moment $G_j(q)$ is constructed as

$$G_j(q) = \tilde{G}_j - \mu_j(q),$$

where $\tilde{G}_j$ is the sample moment of j and $\mu_j(q)$ is the simulated moment.

4. Repeat steps 1–3 and find q to minimize the objective value.

After obtaining estimates, I compute asymptotic standard errors following Gourieroux, Monfort, and Renault (1993).

Appendix G: Parameterization of policy parameters of the ACA

I describe how I parameterize the stylized version of the ACA in the model. The approach builds on Aizawa and Fang (2013, 2018), which examines the impact of ACA on labor market outcomes. But I extend theirs by incorporating various additional policies and introducing additional approximation to fit the model environment in this paper. Below, I first describe the choice of policy parameters used in the full ACA discussed in Section 6.2, which represents the full implementation of the ACA policies. Then I discuss the policy parameters of the partial ACA or ACA2015 discussed in Section 5.3, where the policy parameters are chosen to correspond to the ones in 2015. The full ACA and the partial ACA differ because the ACA has been gradually implemented.

G.1 *Premium subsidies in HIX*

In the ACA, federal premium subsidies are available to individuals who purchase health insurance from HIX if their incomes are less than 400% of the Federal Poverty Level (FPL), denoted by FPL400.[1] The premium subsidies will be set on a sliding scale such that the premium contributions are limited to a certain percentage of income for specified income levels. If an individual's income is below 133% of the FPL, denoted by FPL133, premium subsidies will be provided so that the maximum individual's premium contribution is equal to 2% of his income; when income is between FPL133 and FPL150, the maximum premium contribution is 3%; when income is between FPL150 and FPL200, it is 4%; when income is between FPL200 and FPL250, it is 6.3%; when income is between FPL250 and FPL300, it is 8.3%; when income is between FPL300 and FPL400, it is 9.5%. Although precisely modeling the ACA subsidies scheme is feasible, I simplify it by approximating it as a smooth polynomial function of income:

$$S^{\mathrm{HIX}}(y, t, R^{\mathrm{HIX}}(t)) = \frac{\exp(\omega_a^s + \omega_b^s y_t + \omega_c^s y_t^2)}{1 + \exp(\omega_a^s + \omega_b^s y_t + \omega_c^s y_t^2)} R^{\mathrm{HIX}}(t), \tag{27}$$

where y is 4-month income. One important advantage of this specification is that the functional form of subsidies is comparable to the class of functional forms considered in the optimal design problem in my analysis. Therefore, this specification allows that the actual choice of the ACA design, based on the approximation, can be in the set of potential policy instruments that the government can implement to optimally design HIX.

In order to parameterize $S^{\mathrm{HIX}}(y, t, R^{\mathrm{HIX}}(t))$ under the ACA, I first simulate many possible combinations of premium and income, then for each pair of premium and income, I calculate the subsidy based on the actual subsidy design under the ACA. Then, by using simulated data of subsidy, premium, and income, I estimate the ACA subsidy parameters using the nonlinear OLS. The estimated parameters are $\omega_a^s = 4.074991$, $\omega_b^s = -3.879924$, and $\omega_c^s = -1.154915$. This polynomial specification fits very well with the actual ACA subsidies design: the R-square of the nonlinear OLS is around 0.98.

G.2 *Pricing regulation in HIX*

In the ACA, they set the maximum premium ratio between the oldest and the youngest $\omega_A = 3$.[2] Therefore, if it binds,

$$\omega_{\mathrm{AGE}} R^{\mathrm{HIX}}(1) = R^{\mathrm{HIX}}(T).$$

[1] I assume that FPL is defined for a single person. In 2007, it is $11,200 annually.

[2] Note that the ACA originally requires the maximum allowable premium ratio to be a factor of 3. That is, if the premium ratio is less than 2, it will not violate this constraint. To consider this possibility, I also solve the equilibrium allowing the possibility that this constraint may not bind in equilibrium. Specifically, I start from an initial guess that age-based rating regulation does not bind in equilibrium and, therefore, the equilibrium insurance premium is determined separately at each age, and then check if the maximum premium ratio is less than 3. It turns out that the MPR is more than 3, indicating that such a case cannot be an equilibrium. Because currently most state HIX follows age-based pricing regulation proposed by the Center for Medicare and Medicaid Services (CMS) and it requires the maximum premium ratio to be 3; throughout this paper, I assume that this constraint is binding.

For simplicity, I assume that the premium is linearly increasing in t.[3] It implies that

$$R^{\text{HIX}}(t) = R^{\text{HIX}}(1) + (\omega_{\text{AGE}} - 1)\frac{(t-1)}{T-1}R^{\text{HIX}}(1).$$

Finally, I need to decide on the magnitude of the loading factor ξ_{HIX} in HIX that appeared in (23). I calibrate ξ_{HIX} based on the ACA requirement that the medical loss ratio must be at least 80%, which implies $\xi_{\text{HIX}} = 0.25$.[4]

G.3 *Penalties associated with individual mandate*

The tax penalty on the uninsured in the ACA (from 2016 when the law is fully implemented) is set that the uninsured need to pay a tax penalty of the greater value of \$695 per year or 2.5% of the taxable income above the Tax Filing Threshold (TFT), which can be written as

$$\text{IM}^{\text{ACA}}(y) = \max\{0.025 \times (y - \text{TFT\_2015}), \$695\}, \tag{28}$$

where y is annual income.

I adjust the above formula along several dimensions. First, I adjust the scale of policy parameters to fit the 2007 economic environment. I estimated the model using data sets in 2004–2007 where the price level is normalized to the 2007 value, while the ACA policy parameters are chosen to suit the economy in 2016. It is well known that the U.S. health care sector has a very different growth rate than that of overall GDP; in particular, there are substantial increases in medical care costs relative to GDP. Thus, I need to appropriately adjust the policy parameters in the ACA to make them more in line with the U.S. economy in 2007. I implement the adjustment as follows: the \$695 amount is adjusted by the ratio of the 2007 Medical Care CPI (CPI_Med_2007) relative to the 2015 Medical Care CPI (CPI_Med_2015); I choose this adjustment given the idea that the penalty amount \$695 is chosen to be proportional to 2015 medical expenditures. I then multiply it by 1/3 to reflect the fact that the period length in the model is 4 months. Second, I adjust the TFT_2015 by the ratio of 2007 CPI of all goods (CPI_All_2007) relative to the 2011 CPI of all goods (CPI_All_2015). I also multiply it by 1/3 to reflect the choice of the 4-month model period in this paper.[5] Finally, I adjust the percentage 2.5% by the differential growth rate of medical care and GDP, that is, I multiply it by the relative ratio of $\frac{\text{CPI\_Med\_2007}}{\text{CPI\_All\_2007}}$ and $\frac{\text{CPI\_Med\_2007}}{\text{CPI\_All\_2007}}$. With these adjustments, the tax penalties on the unin-

[3]In practice, age slope is set based on the proposal by CMS and it has a small convexity between age 35 and 50.

[4]The medical loss ratio is the ratio of the total claim costs that the insurance company incurs to the total insurance premium collected from participants, which will simply be $1/(1+\xi_{\text{HIX}})$ in the model.

[5]I obtain CPI data for both medical care and all goods from the Bureau of Labor Statistics website: http://www.bls.gov/cpi/data.htm.

sured are parameterized as

$$\mathrm{IM}^{\mathrm{ACA}}(y) = \max\left\{0.025\frac{\frac{\text{CPI\_Med\_2007}}{\text{CPI\_All\_2007}}}{\frac{\text{CPI\_Med\_2015}}{\text{CPI\_All\_2015}}} \times \left(y - \frac{1}{3}\text{TFT\_2015} \times \frac{\text{CPI\_All\_2007}}{\text{CPI\_All\_2015}}\right), \frac{1}{3} \times \$695 \times \frac{\text{CPI\_Med\_2007}}{\text{CPI\_Med\_2015}}\right\}.$$

After the adjustment of scaling, I approximate the penalty function by nonlinear smooth function of income, that is,

$$\mathrm{IM}^{\mathrm{ACA}}(y) \approx \omega_a^I + \omega_b^I y_t + \omega_c^I y_t^2.$$

The coefficients of the penalty function is estimated in the same way as the premium subsidies explained above. The estimated parameters will be $\omega_a^I = 0.02743$, $\omega_b^I = -0.001892$, and $\omega_c^I = 0.002782$. This polynomial specification fits very well with the actual ACA penalty designs: the R-square of the OLS is around 0.99.

G.4 *Cost-sharing subsidies*

I specify that the financial characteristics of the silver plan in the model are a $2,000 annual deductible and a 20% coinsurance rate in 2016 price level. Similar to premium and tax penalties, I adjust the magnitude of deductible using 2007 Medical Care CPI. Under the ACA, cost-sharing subsidies are offered to the low-income population participating in silver plans in HIX. The actuarial value of the silver plan is 70%. Then income-based cost-sharing subsidies are provided to increase the actuarial value of the plan. If income is below 150% of FPL, FPL150, the actuarial value of the insurance is set to 94%; if income is between FPL150 and FPL200, the actuarial value of the insurance is set to 87%; if income is between FPL200 and FPL250, the actuarial value is 73%. In this paper, I took the following simple specification to capture the cost-sharing subsidies: below FPL150, cost-sharing subsidies are given so that individuals face a zero deductible and a 6% coinsurance rate; between FPL150 and FPL250, both the deductible and coinsurance rate are increasing linearly with respect to income so that subsidies will be zero at FPL250.

G.5 *Penalties associated with employer mandate*

Tax penalties on employers in the ACA are set so that firms with 50 or more full-time employees that do not offer coverage need to pay a tax penalty of $2000 per full-time employee per year, excluding the first 30 employees from the assessment.[6] That is,

$$\mathrm{EM}^{\mathrm{ACA}}(l) = (l - 30) \times \$2000. \tag{29}$$

[6] In July 2013, the government decided to postpone the implementation of the employer mandate until 2015.

As in the case of the individual mandate, I first adjust the above formula by first scaling the \$2000 per-worker penalty using the ratio of the 2007 Medical Care CPI relative to the 2011 Medical Care CPI and by multiplying it by 1/3 to reflect our period length of 4 months instead of a year, that is, for $l \geq 50$,

$$\mathrm{EM}^{\mathrm{ACA}}(l) = \frac{1}{3}\left[(l-30) \times \$2000 \times \frac{\mathrm{CPI\_Med\_2007}}{\mathrm{CPI\_Med\_2015}}\right]. \tag{30}$$

It is important to recognize that the equilibrium skill price distribution may possibly have a mass point because the penalty function takes the form of the step function: the positive measure of firms might choose the firm size to be slightly less than 50 to avoid paying the penalty. Moreover, because skill price can be conditional on education type, there are many combinations of skill prices leading to the firm size 49. This complicates our numerical algorithm, which is discussed in Appendix D in the Supplementary Material.

G.6 *Medicaid provisions*

The ACA stipulates that individuals with income below 133% of the FPL are able to enroll in the free public insurance Medicaid. While it is ideal to model this threshold carefully, given my sample selection, those who are below 133% of the FPL tend to be nonemployed. Moreover, explicitly modeling this threshold complicates the numerical algorithm. Therefore, to simplify the analysis, I assume that only nonemployed individuals will be covered by Medicaid under the full ACA. As mentioned in Section 2.4, we consider the population who were not qualified for Medicaid in the pre-ACA model economy. Thus, this expansion is meant to capture the impact of Medicaid expansion which makes more people eligible under the ACA.

G.7 *Policy parameters of the ACA in 2015*

Although the ACA in 2015 and the full ACA are very similar, there are several important differences, which I model as follows. First, the tax penalty to the uninsured (individual mandate) is set to the maximum of \$325 and 2% of income, as opposed to the maximum of \$695 and 2.5% of income, which is scheduled to be implemented in 2016. Therefore, in order to evaluate the 2015 ACA, I adjust the magnitude of the tax penalty to the uninsured. Using the same functional specification and estimation approach, I obtain $\omega_a^I = 0.0086164$, $\omega_b^I = 0.0058726$, and $\omega_c^I = 0.0012518$. Second, the tax penalty to employers is also only imposed on firms with more 100 workers. They need to pay the a tax penalty of \$2000 per full-time employee per year, excluding the first 80 employees from the assessment. Third, only 60% of states in the United States follow ACA's Medicaid provisions. Because modeling state-based insurance system and both insurance and labor market equilibrium are beyond the scope of the current paper, I assume that in the beginning of the period, the nonemployed are offered Medicaid with probability 60%. If they are not offered, they can decide whether to purchase health insurance from HIX but without any subsidies. The remaining policy components are chosen the same as the one specified as the 2015 ACA.

Appendix H: Supplement for analyses of the optimal joint design of individual insurance regulations

H.1 *Derivation of tax revenue and government expenditure*

In the main draft, the terms associated with government expenditure and revenues are introduced. I show how one can compute these values in equilibrium. First, the tax revenue can be calculated as

$$\mathrm{RV}_{\mathrm{tax}}(\mathbf{T_{HI}}) = \sum_{\mathbf{x_t}} \sum_{\mathrm{HI}} \int T_I(\mathbf{x_t}, \theta, \mathrm{HI}) g(\mathbf{x_t}, \theta, \mathrm{HI})\, d\theta,$$

where $T_I(\mathbf{x_t}, \theta, \mathrm{HI})$ consists of both income and payroll taxes, imposed on both individuals and firms. Next, $\mathrm{RV}_p(\mathbf{T_{HI}})$ is the revenue from tax penalties imposed on the uninsured and on large firms not offering ESHI, given as

$$\mathrm{RV}_p(\mathbf{T_{HI}}) = \sum_{\mathbf{x_t}} \int \mathrm{IM}\big(w_t(\mathbf{x_t}, \theta)\big) hi_1(0|\mathbf{x_t}, \theta, 0) g(\mathbf{x_t}, \theta, 0)\, d\theta$$
$$+ \int_p \mathrm{EM}\bigg(\sum_{\mathbf{x_t}} l\big(\mathbf{x_t}, \theta_0^{ed}, 0\big)\bigg)\big(1 - \Delta(p)\big)\, d\Gamma(p).$$

Finally, the government expenditure consists of premium and coinsurance subsidies to HIX enrollees and Medicaid coverage:

$$\mathrm{EXP}_{\mathrm{sub}}(\mathbf{T_{HI}}) = \sum_{\mathbf{x_t}} \int \big(S^{\mathrm{HIX}}\big(y_t, R^{\mathrm{HIX}}(t)\big) + S^{\mathrm{COI}}(z_t m_t, y)\big) hi_1(2|\mathbf{x_t}, \theta, 0) g(\mathbf{x_t}, \theta, 2)\, d\theta$$
$$+ \sum_{\mathbf{x_t}} S^M(\mathbf{x_t}) u_t(\mathbf{x_t}, 1).$$

H.2 *Additional results for optimal joint design of individual insurance regulations*

H.2.1 *Robustness: The role of the public insurance through the consumption floor* In the main analysis of the paper, I assume that the government expenditure is not affected by the amount of implicit public insurance through the consumption floor. This choice is made to provide a better intuition for understanding the key economic mechanisms in the optimal design problem. In this section, I show the robustness of exercises allowing that the government spending for the implicit insurance is also taken into account in the welfare analysis.

I first calculate that the government expenditure for the implicit public insurance through consumption floor and assume that this is additional government spending. That is, the total government expenditure is now replaced with

$$\mathrm{EXP}(\mathbf{T_{HI}}) = \mathrm{RV}_{\mathrm{tax}}(\mathbf{T_{HI}}) + \mathrm{RV}_p(\mathbf{T_{HI}}) - \mathrm{EXP}_{\mathrm{sub}}(\mathbf{T_{HI}}) - G_{\mathrm{IMP}}(\mathbf{T_{HI}}),$$

where $G_{\mathrm{IMP}}(\mathbf{T_{HI}})$ is the expected health care costs covered by the consumption floor. Then I obtain the corresponding value under the ACA. Under the full ACA, I find that $G_{\mathrm{IMP}}(\mathbf{T_{HI}})$ consists of 3% of the overall government expenditure.

TABLE A7. Optimal policy parameters: the role of government implicit insurance.

Policy Instruments	ACA	Optimal Not Taking Into Account Implicit Public Insurance	Optimal Taking Into Account Implicit Public Insurance
	Policy parameters for premium rating regulation		
MPR: ω_{AGE}	3.00	4.70	4.79
	Policy parameters for premium subsidies		
const. term of subsidy: ω_a^s	4.08	3.48	4.48
income coeff. of subsidy: ω_b^s	−3.88	−1.75	−1.34
income squared coeff. of subsidy: ω_c^s	−1.15	−0.001	−0.001
age coeff. of subsidy: ω_d^s	0.0	−0.0215	−0.02
age squared coeff. of subsidy: ω_e^s	0.0	−0.000	−0.000
	Policy parameters for tax penalties on the uninsured		
const. term of penalty: ω_a^I	0.03	0.031	0.037
income coeff. of penalty: ω_b^I	−0.002	0.00	0.00
income squared coeff. of penalty: ω_c^I	0.003	0.00	0.00
age coeff. of penalty: ω_d^I	0.0	0.00	0.00
age squared coeff. of penalty: ω_e^I	0.0	0.00	0.00

Note: (a) ω_{AGE} determines the MPR. (b) Subsidies are parameterized as $S^{\text{HIX}}(y,t,R^{\text{HIX}}(t)) = \frac{\exp(\omega_a^s+\omega_b^s y_t+\omega_c^s y_t^2+\omega_d^s t+\omega_e^s t^2)}{1+\exp(\omega_a^s+\omega_b^s y_t+\omega_c^s y_t^2+\omega_d^s t+\omega_e^s t^2)} R^{\text{HIX}}(t)$. (c) Tax penalties are parameterized as $\text{IM}^{II}(y,t) = \omega_a^I + \omega_b^I y_t + \omega_c^I y_t^2 + \omega_d^I t + \omega_e^I t^2$. (d) The amount of welfare gain is reported as the percentage of medical expenditure under the full ACA. (e) In implementation, the youngest age in the model takes $t = 1$ and the unit of t is 4 months, ranging in $t \in [1, \dots, 132]$. (f) Column (1) reports the policy parameters under the full ACA. (g) Column (2) reports the policy parameters under the optimal joint design of individual insurance regulations which does not take into account the implicit public insurance through the consumption floor as a part of government expenditure, as reported in Section 6.3. (h) Column (3) reports the policy parameters under the optimal joint design of individual insurance regulations taking into account the implicit public insurance through the consumption floor as a part of government expenditure.

Using this as the revenue constraint, I solve the optimal design problem assuming that this part of government expenditure change according to policy designs and equilibrium. The optimal policy parameter is reported in Table A7. I report the policy parameters under the ACA in Column (1), those under the optimal individual insurance regulations not taking into account implicit public insurance in Column (2) (i.e., the results reported in Table 14), and those under the optimal individual insurance regulations taking into account implicit public insurance in Column (3). Note that whether taking into account implicit insurance affects the revenue constraint. Regardless of consideration of implicit insurance, the qualitative feature of the optimal design is very similar. One important difference is that the tax penalty to the uninsured is higher under the optimal individual insurance regulations taking into account implicit insurance (i.e., parameters in Column (3)). The implicit public insurance through the consumption floor can lead to a moral hazard, which generates the inefficient government spending. Thus, tax penalty can effectively minimize those inefficient spending. The major outcomes from the optimal design exercise and its comparison to the full ACA outcomes are reported in Table A8. Because of higher tax penalty, the uninsured rate is much lower, close to 1.2%. Moreover, the welfare gain is much more significant, around 9%, indicating that this

Table A8. Aggregate outcomes under the optimal design of individual insurance regulations with implicit government spending.

	ACA	Optimal Not Taking Into Account Implicit Public Insurance	Optimal Taking Into Account Implicit Public Insurance
Panel A: Effects on the firm side			
ESHI offer rate: firm size ≥ 50	0.99	0.92	0.79
ESHI offer rate: firm size < 50	0.50	0.49	0.47
ESHI offer rate (average)	0.56	0.54	0.51
Labor productivity (in $10,000)	2.42	2.48	2.48
Panel B: Effects on worker's health insurance and labor market status			
Uninsured rate	0.04	0.027	0.012
Frac. ind. with ESHI	0.82	0.75	0.68
Frac. ind. with HIX	0.07	0.16	0.24
Nonemployment rate	0.07	0.07	0.07
Welfare gain (%)	–	5%	9%

Note: (a) Column (1) reports the main aggregate outcomes under the full ACA. (b) Column (2) is the main aggregate outcomes under the optimal joint design of individual insurance regulations which does not take into account the implicit public insurance through the consumption floor as a part of government expenditure, as reported in Section 6.3. (c) Column (3) reports the main aggregate outcomes under the optimal joint design of individual insurance regulations taking into account the implicit public insurance through the consumption floor as a part of government expenditure.

moral hazard channel has an important welfare implication. Beside these differences, most aggregate outcomes are qualitatively very similar to the one without taking into account this channel (i.e., results in Column (2)).

References

Aizawa, N. and H. Fang (2013), "Equilibrium labor market search and health insurance reform." Working Paper 18698, National Bureau of Economic Research. [9]

Aizawa, N. and H. Fang (2018), "Equilibrium labor market search and health insurance reform." Working Paper, University of Wisconsin-Madison and University of Pennsylvania. [9]

Andrews, I., M. Gentzkow, and J. M. Shapiro (2017), "Measuring the sensitivity of parameter estimates to estimation moments." *The Quarterly Journal of Economics*, 132 (4), 1553–1592. [3]

Bontemps, C., J.-M. Robin, and G. J. Van den Berg (1999), "An empirical equilibrium job search model with search on the job and heterogeneous workers and firms." *International Economic Review*, 40 (1), 1039–1074. [6]

Bontemps, C., J.-M. Robin, and G. J. Van den Berg (2000), "Equilibrium search with continuous productivity dispersion: Theory and nonparametric estimation." *International Economic Review*, 41 (2), 305–358. [6]

Gayle, G.-L. and A. Shephard (2019), "Optimal taxation, marriage, home production, and family labor supply." *Econometrica*, 87 (1), 291–326. [3]

Gourieroux, C., A. Monfort, and E. Renault (1993), "Indirect inference." *Journal of Applied Econometrics*, 8, S85–S118. [9]

Kaplan, G. (2012), "Inequality and the life cycle." *Quantitative Economics*, 3 (3), 471–525. [8]

Co-editor Peter Arcidiacono handled this manuscript.

Manuscript received 31 May, 2018; final version accepted 25 March, 2019; available online 13 May, 2019.