Equilibrium Labor Market Search and Health Insurance Reform

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We present and empirically implement an equilibrium labor market search model where risk-averse workers facing medical expenditure shocks are matched with firms making health insurance coverage decisions. We use our estimated model to evaluate the equilibrium impact of many health care reform proposals, including the 2010 Affordable Care Act (ACA). We use the estimates of the early impact of the ACA as a model validation. We find that income-based subsidies for health insurance premiums are crucial for the sustainability of the ACA, while the ACA can still substantially reduce the uninsured rate without the individual or the employer mandate.

I. Introduction

The Affordable Care Act (ACA), signed into law by President Barack Obama in March 2010, represents the most significant reform to the US health insurance and health care markets since the establishment of

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Medicare in 1965.[1] The health care reform in the United States was driven partly by two factors: first, a large fraction of the US population did not have health insurance (close to 18% for 2009); second, the United States spent a much larger share of the national income on health care than the other Organization for Economic Cooperation and Development (OECD) countries (health care accounted for about one-sixth of the US GDP in 2009).[2] There are many provisions in the ACA whose implementation was phased in over several years, and some of the most significant changes started taking effect from 2014. In particular, four of the most important pillars of the ACA are as follows:[3]

1. Individual mandate: all individuals must have health insurance that meets the law's minimum standards or face a penalty when filing taxes for the year, which will be 2.5% of income or $695, whichever is higher.[4]
2. Employer mandate: employers with 50 or more full-time employees will be required to provide health insurance or pay a fine of $2,000 per worker each year if they do not offer health insurance, where the fines would apply to the entire number of employees minus some allowances.

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[1] The ACA refers to the Patient Protection and Affordable Care Act (PPACA) signed into law by President Obama on March 23, 2010, as well as the amendment to the Health Care and Education Reconciliation Act of 2010.

[2] For a comparison between the health care systems of the United States and those of the other OECD countries, see OECD Health Data at http://www.oecd.org/health/healthdata.

[3] Detailed formulas for the penalties associated with violating the individual and employer mandates, as well as those for the premium subsidies, are provided in sec. VIII.B.

[4] These penalties were implemented fully from 2016. In 2014, the penalty was 1% of income or $95, and in 2015 it was 2% of income or $325, whichever was higher. Cost-of-living adjustments were made annually after 2016. If the least inexpensive policy available would cost more than 8% of one's monthly income, no penalties apply; hardship exemptions will be permitted for those who cannot afford the cost. The individual mandate was controversial, and there were numerous lawsuits challenging its constitutionality. The Tax Cut and Jobs Act of 2017 repealed the individual mandate penalty for not having health insurance starting in 2019.

3. Insurance exchanges: state-based health insurance exchanges will be established where the unemployed, the self-employed, and workers who are not covered by employer-sponsored health insurance (ESHI) can purchase insurance. Importantly, the premiums for individuals who purchase their insurance from the insurance exchanges will be based on the average health expenditure of those in the exchange risk pool.[5] Insurance companies that want to participate in an exchange need to meet a series of statutory requirements for their plans to be designated as "qualified health plans."
4. Premium subsidies: all adults in households with income under 138% of the federal poverty level (FPL) will be eligible for receiving Medicaid coverage with no cost sharing.[6] For individuals and families whose income is between 138% and 400% of the FPL, subsidies will be provided toward the purchase of health insurance from the exchanges.[7]

The ACA has faced significant political and legal challenges ever since its enactment. Some policy proposals have attempted to repeal and replace the ACA, such as the American Health Care Act of 2017;[8] there are also other small-scale policy changes, which modify a part of the ACA. An example is the eventually successful repeal of the individual mandate in the Tax Cuts and Jobs Act of 2017, which spurs active policy debates on its long-run consequence; another example is the attempt to reduce subsidies to health insurance premiums. These policy proposals raise important questions regarding the outcomes that may result from possible modifications to the ACA. For example, how would the remainder of the ACA perform if its individual mandate penalty were repealed? Are the premium subsidies necessary for the insurance exchanges to overcome the adverse selection problem? Would the ACA be significantly impacted if

[5] States that opt not to establish their own exchanges will be pooled in a federal health insurance exchange.

[6] This represented a significant expansion of the pre-ACA Medicaid system because before the ACA many states covered adults with children only if their income was considerably lower and did not cover childless adults at all. The US Supreme Court ruled on June 28, 2012, that the law's provision that if a state does not comply with the ACA's new coverage requirements it may lose not only the federal funding for those requirements but all of its federal Medicaid funds is unconstitutional. This ruling allows states to opt out of ACA's Medicaid expansion, leaving each state's decision to participate in the hands of the nation's governors and state leaders. As of June 2015, 30 states (including the District of Columbia) expanded their Medicaid coverage (see http://kff.org/health-reform). In this paper, we will study both the full and the partial implementation of Medicaid expansion.

[7] Whether individuals in states that do not establish their own exchanges who purchase insurance from the federal health insurance exchange can receive the premium subsidies was challenged in the US Supreme Court case King v. Burwell. The Supreme Court ruled to allow all subsidies on June 25, 2015, on a 6-3 decision.

[8] The American Health Care Act of 2017 passed in the House of Representatives but did not pass in the Senate.

the employer mandates were removed? What would happen if the current tax exemption status of the employer-provided insurance premium were eliminated?

The goal of this paper is to present and empirically implement an equilibrium model that integrates the labor market with the major feature of the US health insurance system and to use it to understand the mechanisms through which health insurance reform affects the labor market equilibrium, including the uninsured rate. An equilibrium model that integrates the labor and health insurance markets is necessary for us to understand the general equilibrium implications of the health insurance reform. First, the United States is unique among industrialized nations in that it lacks a national health insurance system and most of the working-age population obtains health insurance coverage through ESHI. According to Kaiser Family Foundation and Health Research and Educational Trust (2009), more than 60% of the nonelderly population received their health insurance sponsored by their employers, and about 10% of workers' total compensation was in the form of ESHI premiums.[9] Second, there have been many well-documented connections between firm sizes, wages, health insurance offerings, and worker turnovers. For example, it is well known that firms that do not offer health insurance are more likely to be small firms, to offer low wages, and to experience higher rates of worker turnover. In the 1997 Robert Wood Johnson Foundation Employer Health Insurance Survey, we find that the average firm size was about 8.8 for employers that did not offer health insurance, in contrast to an average firm size of 33.9 for employers that offered health insurance; the average annual wage was \$20,560 (in 1996 constant US dollars) for workers at firms that did not offer health insurance, in contrast to an average wage of \$29,077 at firms that did; also, the annual separation rate of workers at firms that did not offer health insurance was 17.3%, while it was 15.8% at firms that did.[10] Moreover, in our data sets, workers in firms that offer health insurance are more likely to self-report better health than those in firms that do not offer health insurance.

Our model is based on Burdett and Mortensen (1998) and Bontemps, Robin, and van den Berg (1999, 2000).[11] One of the most desirable features

[9] Among those with private coverage from any source, about 95% obtained employment-related 'health insurance (see Selden and Gray 2006).

[10] We used this data set to estimate our model in previous versions of this paper (Aizawa and Fang 2013, 2015).

[11] These models theoretically explain both wage dispersion among ex ante homogeneous workers and the positive correlation between firm size and wage. Moscarini and Postel-Vinay (2013) demonstrate that the extended version of these models, which allows for firm productivity heterogeneity and aggregate uncertainty, has very interesting but also empirically relevant properties about firm size and wage adjustment over the business cycles. Dizioli and Pinheiro (2016) also extended Burdett and Mortensen (1998) to incorporate health insurance as a productivity factor and show that firms that offer health insurance are larger and pay higher wages in equilibrium.

of these models is that they have a coherent notion of firm size, which allows us to satisfactorily examine the effect of a size-dependent employer mandate as stipulated in the ACA. We depart from these standard models by incorporating health and health insurance; thus, we endogenize the distributions of wages and health insurance provisions, employer size, employment, and workers' health. In our model, workers—who differ by demographic types, such as gender, marital status, and the presence of children—observe their own health status, which evolves stochastically. Workers' health consists of two components, one that is observable by all, including the firms and econometricians, and another that is observable to the worker but unobservable to firms and econometricians. Workers' health status affects both their medical expenditures and their labor productivity. Health insurance eliminates individuals' out-of-pocket medical expenditure risks and may affect the dynamics of their health status. Individuals may obtain health insurance through employers (ESHI), Medicaid if eligible, spousal insurance if available, or individual insurance. The uninsured individuals may still be partially insured through other social safety net programs modeled as a consumption floor. Both the unemployed and the employed workers randomly meet firms and decide whether to accept their job offer with a compensation package that consists of a wage and ESHI (if offered). Firms, which are heterogeneous in their productivity, post compensation packages that include wages (which are allowed to depend on workers' observable health component) and ESHI offerings to attract workers. The cost of providing health insurance, which will be used to determine ESHI premiums, is determined by both the demographic and the health composition of its workforce, in addition to a fixed administrative cost. When deciding on what compensation packages to offer, the firms anticipate that their choice of compensation packages will affect the demographic and health composition of their workforce, as well as their sizes in the steady state.

We characterize the steady-state equilibrium of the model in the spirit of Burdett and Mortensen (1998). We estimate the parameters of the baseline model using data from the 2004 panel of the Survey of Income and Program Participation (hereafter, "SIPP 2004"), the 2001–7 panels of the Medical Expenditure Panel Survey (hereafter, "MEPS 2001–7"), and the 2004–7 samples of the Kaiser Employer Health Benefit Survey (hereafter, "Kaiser 2004–7").[12] The first two data sets are panels on worker-side labor market status, health, and health insurance, while the third one is a cross-sectional firm-level data set that contains information such as firm size and health insurance coverage. Because the data on the supply side (i.e.,

[12] The full name of the data set is the Kaiser Family Foundation and Health Research and Educational Trust Survey on Health Benefits. In earlier versions of this paper (Aizawa and Fang 2013, 2015), we used data from the Robert Wood Johnson Foundation Employer Health Insurance Survey from 1997, which is the last year that it was available.

workers) and the demand side (i.e., firms) of labor markets come from different sources, we estimate the model using the generalized method of moments (GMM). We show that our baseline model delivers a rich set of predictions that can qualitatively and quantitatively account for a wide variety of the aforementioned phenomena observed in the data, including the correlations among firm sizes, wages, health insurance offering rates, turnover rates, and workers' health compositions.

Our empirical analysis highlights various interactions between firms' health insurance provision and workers' health status, which helps to explain these correlations. While it is true that firms, by offering health insurance, can benefit from the tax exemption of the insurance premium, they also attract more unhealthy (in the unobservable component) workers among their new hires, which leads to the standard adverse selection problem. We find that this adverse selection effect substantially reduces the incentive of low-productivity firms to offer ESHI because they tend to disproportionately attract more unhealthy workers. Interestingly, however, we find that the adverse selection problem is partially alleviated over time by the positive effect of health insurance on the dynamics of the observable health component; importantly, given our estimate of this effect on the observed health component (which is consistent with the estimates in the health economics literature reviewed in sec. VI), we find that this positive effect from the improvement of health status of the workforce is captured more by high-productivity firms because of what we term the "retention effect." This simply refers to the fact that high-productivity firms tend to offer more valuable compensation packages (through the combination of higher wages and ESHI) and retain workers longer (for evidence of this mechanism, see Fang and Gavazza 2011). These effects jointly allow our model to generate a positive correlation between wage, health insurance, and firm size, and they moreover explain why the health status of employees covered by ESHI is better than that of uninsured employees on the observed health component in the data.

We use our estimated model to examine the impact of the previously mentioned four key components of the ACA. We find that the full implementation of the ACA would significantly reduce the uninsured rate among the workers in our estimation sample from 21.3% in the pre-ACA benchmark economy to about 6.6%. This large reduction of the uninsured rate is driven mainly by an increase in the fraction of the population purchasing individual private health insurance; specifically, in the pre-ACA benchmark, only 3.4% purchased (unregulated) private individual health insurance, but under the ACA, 11.2% of the population will purchase private health insurance from the regulated health insurance exchange established under the ACA with income-based premium subsidies from the government. The fraction of the population covered by Medicaid also increases from 5.0% in the pre-ACA environment to

9.9% under the ACA. Also, we find a small increase in the fraction of the population covered under one's own ESHI or spousal insurance, from 70.3% in the pre-ACA benchmark to 72.4% under the ACA. We find that because of the employer mandate, the health insurance offering rate for firms with 50 or more workers increases from 93.5% in the benchmark to 98.9% under the ACA; however, the health insurance offering rate for firms with fewer than 50 workers decreases from 48.0% in the benchmark to 40.0% under the ACA. The reason for the reduction in small firms' ESHI offering rate is that the ACA reduces the value of ESHI for workers, particularly those with low income, because of the availability of premium-subsidized health insurance from the regulated health insurance exchange. This effect dominates the countervailing effect of the ACA that it reduces—and in fact almost eliminates—the adverse selection for small firms to offer ESHI. We also find that the size-dependent employer mandate leads to a slight increase in the fraction of firms with fewer than 50 workers, with a small but noticeable clustering of firms with size just below the employer mandate threshold of 50.

For the purpose of model validation, we also investigate the model's ability to account for the early impact of the ACA in the data. We simulate the impact of the ACA implemented in 2015, which differs from the full implementation of the ACA regarding the policy scales for individual and employer mandates, as well as Medicaid expansion. We find that, in general, the model is able to account for the major features in the data—specifically, the observed changes in the health insurance status of the US population.

We further use the estimated model to evaluate a series of alternative policies that are currently considered in policy debates. First, we investigate the effect of the ACA if its individual mandate component were removed, a scenario that the United States now faces from 2019 because of the recent tax reform that repealed the individual mandate. We find that the ACA sans the individual mandate would still achieve a significant reduction in the uninsured rate: in our simulation, the uninsured rate under "ACA without individual mandate" would be 11.4%, significantly lower than the 21.3% under the benchmark. The premium subsidy component of the ACA would have in itself drawn all the unemployed (regardless of their health) and the low-wage employed (again regardless of their health) to the insurance exchange. In fact, if we were to remove the premium subsidies from the ACA instead of the individual mandate, we find that the insurance exchange would suffer from an adverse selection problem so severe as to render it entirely nonactive. "ACA without premium subsidies" leads to only a small reduction of the uninsured rate, to 15.7% from the 21.3% in the benchmark.

Interestingly, we find that under a policy of "ACA without the employer mandate," the uninsured rate would be 7.5%, almost identical to that under the full ACA. We find that although firms with 50 or more workers decrease their ESHI offering rate without the employer mandate penalty, many of their employees obtain other health insurance. Interestingly, this will create a general equilibrium effect that also affects small firms' ESHI offering rate. Overall, the effect of the employer mandate under the ACA is likely to be very limited.

We also simulate the effects of eliminating the tax exemption for the ESHI premium both under the benchmark and under the ACA. We find that the elimination of the tax exemption for the ESHI premium would reduce but not eliminate the incentives of firms—especially the larger ones—to offer health insurance to their workers. We find that the uninsured rate would increase from 21.3% to 31.8% when the ESHI tax exemption is removed in the benchmark economy, and it will increase from 6.6% to 12.4% under the ACA. We also experimented with the effect of prohibiting firms from offering ESHI in the post-ACA environment. We find that it would lead to a large increase in the uninsured rate. We also find that prohibiting firms from offering ESHI also decreases the total welfare and increases the overall government expenditure. These results suggest that ESHI complements—instead of hinders—the smooth operations of the health insurance exchange.

The remainder of this paper is structured as follows. In section II, we review the related literature; in section III, we present the model of the labor market with endogenous determinations of wages and health insurance provisions; in section IV, we describe the data sets used in our empirical analysis; in section V, we explain our identification and estimation strategy; in section VI, we present our estimation results and the goodness of fit; in section VII, we present an assessment of the main mechanisms in our model; in section VIII, we describe the results from several counterfactual experiments; and finally in section IX, we conclude and discuss directions for future research.

II. Related Literature

This paper is related to three strands of the literature. First and foremost, it is related to a small structural empirical literature that examines the relationship between health insurance and labor market.[13] Rust and Phelan (1997) study the interaction between Social Security, Medicare, and ESHI for retirement behavior in a world with incomplete markets. More closely related to our paper, Dey and Flinn (2005) propose and estimate an equilibrium model of the labor market in which firms and workers bargain over both wages and health insurance offerings to

[13] See Currie and Madrian (1999) for a survey of the large reduced-form literature on the interactions between health, health insurance, and labor market.

examine the question of whether ESHI leads to inefficiencies in workers' mobility decisions (which are often referred to as "job lock" or "job push" effects).[14] Our primary contribution to this literature is to develop and estimate an equilibrium model of labor and health insurance markets, which explicitly incorporates firm size, health, medical expenditure, and realistic features of the US health insurance system, such as the sizable presence of ESHI and Medicaid. To examine the effect of size-dependent employer mandate, it is crucial for us to endogenize firm size and quantitatively explain the dependence of ESHI offering on firm size, which is not considered in the literature including Dey and Flinn (2005). Moreover, incorporating health and medical expenditure will be crucial to understanding the equilibrium implications of health care reforms.

The channel that worker turnover discourages a firm's health insurance provision is related to Fang and Gavazza (2011). They argue that health is a form of general human capital, and labor turnover and labor market frictions prevent an employer-employee pair from capturing the entire surplus from investment in an employee's health, generating underinvestment in health during working years and increasing medical expenditures during retirement. In this paper, we develop an equilibrium framework that incorporates this channel, as well as other channels such as adverse selection, that are known to be important factors for health insurance coverage. We then investigate how these channels interact with each other to determine the general equilibrium impacts of the health insurance system on insurance coverage and labor market outcomes.

Second, there are a growing number of empirical analyses examining the likely impact of the ACA, including some papers that study the Massachusetts health reform implemented in 2006, which shares similar features with the ACA. For example, Kolstad and Kowalski (2012); Hackmann, Kolstad, and Kowalski (2012); and Kolstad and Kowalski (2016) use the model-based "sufficient statistics" approach to study the effect on medical expenditure, selection in insurance markets, and labor markets, respectively. Courtemanche and Zapata (2014) found that the Massachusetts reform improves the health status of individuals. They study these issues based on a difference-in-differences approach and require the availability of both pre- and postreform data sets. These approaches are very informative for understanding the overall and likely impact of reform. By structurally estimating an equilibrium model, we complement this literature by providing a quantitative assessment of the mechanisms generating such outcomes. Moreover, we provide the assessment of various other counterfactual policies, such as health care reforms beyond the ACA and the removal of tax exclusion of ESHI premiums.

[14] See Gruber and Madrian (1994) and Madrian (1994) for reduced-form evidence of job locks induced by ESHI.

Pashchenko and Porapakkarm (2013) evaluate the ACA using a calibrated life-cycle incomplete-market general equilibrium model. They consider several individual decisions, such as health insurance, consumption, saving, and labor supply, but they do not model firms' decision of offering health insurance or the firm size distribution. Mulligan (2013, 2015) and Gallen and Mulligan (2018) extensively investigate the various labor market impacts of the ACA via its effect on marginal tax rates. We differ from this set of papers by explicitly modeling health evolution and medical expenditures. Handel, Hendel, and Whinston (2015) study how regulated but competitive health insurance exchanges may affect the welfare of participants, focusing on the trade-offs between the potential welfare loss from the adverse selection versus potential welfare gains from insurance against reclassification risks. Their paper focuses on the functioning of the health insurance exchange and does not consider how the availability of the regulated exchange might impact the behavior of the firms and subsequently affect the risk pools of the exchange itself. In recent work, Aizawa (2019) studies optimal age-specific policies for the ACA health insurance exchange, and Fang and Shephard (2019) study how employee-only ESHI may emerge in the new labor market equilibrium under the ACA.

Third, this paper is related to a large literature estimating equilibrium labor market search models.[15] Van den Berg and Ridder (1998) and Bontemps, Robin, and van den Berg (1999, 2000) empirically implement Burdett and Mortensen's (1998) model. Hwang, Mortensen, and Reed (1998) investigate in a search model where workers have heterogeneous preferences for nonwage amenities and firms endogenously decide on wages and nonwage amenity bundles to compete for workers. They use their model to show that estimates of workers' marginal willingness to pay for amenities, derived from the conventional hedonic wage methodology, are biased in models with search frictions. These search-based empirical frameworks of labor market have been widely applied in subsequent studies investigating the impact of various labor market policies on labor market outcomes. Among this literature, our study is mostly related to Meghir, Narita, and Robin (2015) and Shephard (2017), which also allow for multidimensional job characteristics as in our paper: wage and part-time or full-time in Shephard (2017); wage and formal or informal sector in Meghir, Narita, and Robin (2015); and wage and health insurance offering in our paper. However, in Shephard (2017) a firm's job characteristics are assumed to be exogenous, while in our paper employers endogenously choose job characteristics. In Meghir, Narita, and Robin (2015), firms choose whether to enter the formal or informal sectors, so in some sense their job characteristics are also endogenously determined; however, in

[15] See Eckstein and Wolpin (1990) for a seminal study that initiated the literature.

Meghir, Narita, and Robin (2015), workers are homogeneous, so firms' decision about which sector to enter does not affect the composition of the types of workers they would attract. In contrast, in our model, workers are heterogeneous in their health and thus employers endogenously choose job characteristics—namely, wage and health insurance offering—by taking into account their influence on the initial composition of its workforce as well as the subsequent worker turnover.

III. Equilibrium Model of Wage Determination and Health Insurance Provision

A. *Environment*

Consider a labor market with a continuum of firms with measure normalized to one. There is a continuum of workers whose demographic type is denoted by $\chi \in \{1, 2, \ldots, N\}$. Let $M_\chi > 0$ denote the measures of workers with (permanent) demographic type χ, with $M \equiv \Sigma_{\chi=1}^{N} M_\chi$ denoting the total size of the workforce relative to firms.[16] Workers and firms are randomly matched in a frictional labor market. Time is discrete and indexed by $t = 0, 1, \ldots$.[17] We use $\beta \in (0, 1)$ to denote the discount factor for the workers.

Workers of demographic type χ have constant absolute risk aversion (CARA) preferences:[18]

$$u_\chi(c) = -\frac{\exp(-\gamma_\chi C)}{\gamma_\chi}, \tag{1}$$

where $\gamma_\chi > 0$ denotes the absolute risk-aversion parameter for demographic type χ.[19]

[16] Throughout this paper, we use the terms "workers" and "firms" interchangeably with "individuals" and "employers," respectively.

[17] In our empirical analysis, a "period" corresponds to 4 months.

[18] Note that we assume that health states affect an individual's utility only through their impact on consumption via medical expenditures. Considering the identification and estimation of a utility function specification that allows for the interaction of health states and marginal utility of consumption is an interesting and important area for future research. Moreover, one can also specify the constant relative risk aversion (CRRA) preference, as opposed to the CARA preference, which creates an additional income effect for the demand of health insurance. We also experimented with the CRRA utility function and found that the main results remain the same both qualitatively and quantitatively. The results are available upon request.

[19] Note that our preference specification assumes that an individual's flow utility is based on private consumption. Thus, our model does not capture one of the most important aspects of joint household labor supply, which would allow for joint consumption. This precludes the possibility that spouses make joint labor supply decisions to provide mutual insurance against each other's income and medical expenditure risks. To the extent that such mutual insurance is important in the data, our estimated risk-aversion parameter will be downward biased. See Dey and Flinn (2008) for a more general characterization of the household search model. Evaluating how the health care reform affects this insurance mechanism is left to future work. Moreover, we do not consider a possibility that firms simply offer employee-only insurance coverage, an issue studied in Fang and Shephard (2019) in a joint household search model.

Workers' health.—Workers differ in their health status, denoted by $\mathbf{h} = (h_1, h_2) \in \mathcal{H}$, where $h_1 \in \{H_1, U_1\}$ denotes the binary observed health status, $h_2 \in \{H_2, U_2\}$ denotes the binary unobserved health status, and H_1 and H_2 are interpreted to be healthier than U_1 and U_2, respectively (see n. 43 for details on how we convert the five self-reported health statuses in the data to H_1 and U_1).[20] In our model, a worker's health status has two effects. First, together with the worker's health insurance status, it affects the distribution of health expenditures. Specifically, we model an individual's distribution of medical expenditure m as follows. Let $x \in \{0, 1, 2, 3, 4\}$ denote an individual i's health insurance status, where

$$x = \begin{cases} 0 & \text{if } i \text{ is uninsured,} \\ 1 & \text{if } i \text{ is insured through his or her own ESHI,} \\ 2 & \text{if } i \text{ is insured through an individual private insurance,} \\ 3 & \text{if } i \text{ is insured through Medicaid,} \\ 4 & \text{if } i \text{ is insured through spousal insurance.} \end{cases} \tag{2}$$

An individual will experience a positive medical shock with probability $\Pr[m > 0|(\chi, \mathbf{h}, x)]$, which depends on his or her own demographic type χ, health status $\mathbf{h} \in \mathcal{H}$, and health insurance status $x \in \{0, 1, 2, 3, 4\}$. Conditional on a positive medical shock, his or her medical expenditure is represented by a random variable denoted by $m|(\chi, \mathbf{h}, x)$. Note that we allow both the individual's health and their health insurance status to affect the medical expenditure distributions. In subsequent analysis, we will use $\tilde{m}^x_{\chi\mathbf{h}}$ to denote the random medical expenditure for individuals with health status $\mathbf{h}$ and health insurance status x and use $m^x_{\chi\mathbf{h}}$ to denote the expectation of $\tilde{m}^x_{\chi\mathbf{h}}$.

Second, a worker's health status may affect his or her productivity. Specifically, if an individual works for a firm with productivity p, he or she produces $d_{\chi\mathbf{h}} \times p$ units of output under health status $\mathbf{h} \in \mathcal{H}$.[21]

In each period, a worker's health status changes stochastically according to a Markov process. The period-to-period transition of an individual's health status depends on the demographic type χ and his or her health insurance status x. Specifically, we use $\pi^x_{\chi\mathbf{h}\mathbf{h}'} \in (0, 1)$ to denote the

[20] As should be clear from our analysis below, our theoretical framework can allow for any finite number of health statuses. The choice of having four health statuses is dictated by the sample size limitations.

[21] One can alternatively assume that the productivity loss occurs only if an individual experiences a bad health shock. Because an unhealthy worker is more likely to experience a bad health shock, such a formulation is equivalent to the one we adopt in this paper.

probability that a type χ worker's health status changes from $\mathbf{h}' \in \mathcal{H}$ to $\mathbf{h} \in \mathcal{H}$ conditional on insurance status x; of course, $\sum_{\mathbf{h}\in\mathcal{H}} \pi^{x}_{\chi\mathbf{hh}'} = 1$ for each $\mathbf{h}' \in \mathcal{H}$.

Firms.—Firms are heterogeneous in their productivity. We assume that, in the population of firms, the distribution of productivity is denoted by $\Gamma(\cdot)$ and that it admits an everywhere continuous and positive density function. In our empirical application, we specify Γ to be lognormal with location parameter μ_p and scale parameter σ_p.

After observing their productivity, firms choose a package that consists of wage $w_{h_1^0} \in R_+$ and ESHI, denoted by $E \in \{0, 1\}$, where 1 (respectively, 0) denotes offering (respectively, not offering) ESHI to all of their employees. Note that we allow that a wage offer can depend on a worker's observed health status h_1 at the time of job entry, denoted by h_1^0. We assume that even though the initial wage can depend on the observed health status at the time of job entry, wage must be constant over the course of the employment.

If a firm offers health insurance to its workers, it has to incur a fixed administrative cost $\tilde{C} = C + \sigma_f \epsilon_f$, where $C > 0$, ϵ_f has a type I extreme value distribution with zero mean, and σ_f is a scale parameter. We assume that any firm that offers health insurance to its workers is self-insured and that it pays insurance premiums for all of its workforce in each period to cover the necessary reimbursement of their expected health expenditures in addition to the administrative cost $\tilde{C}$.[22]

Remark 1. Our specification of the firm's problem encapsulates the essences of the optimal wage contract problem and government regulations. We allow workers' wage to depend on their observable health at the time of job entry. While still restrictive, it nonetheless captures the idea that firms may want to screen workers on the basis of workers' observable health status, which may affect firm productivity. Once workers are hired, however, firms will insure workers against possible productivity changes because of their health status change by offering a constant wage within the employment relationship.[23] In practice, the extent to

[22] As will be clear later, introducing a fixed administrative cost $\tilde{C}$ facilitates the model's ability to fit the empirical relationship between the firm size and the health insurance offering rate. In principle, firms should also be able to choose the workers' contributions to the premium if they decide to offer ESHI. We abstract from this because we do not observe the premium payments by the workers from the data.

[23] Characterizing the optimal wage contract, as in Burdett and Coles (2003) and Lentz and Roys (2015), is a very interesting extension. It is important to mention that even without health dynamics, the optimal wage contract can be an upward wage-tenure profile, as highlighted by Burdett and Coles (2003). We decide to restrict the contract space, as it is extremely challenging to estimate such a model, particularly because we lack data about details of the wage contracts. Moreover, we do not use a piece-rate wage contract (e.g., Barlevy 2008) in our wage setting. Although it is more tractable, it also assumes away the firm's ability to insure workers against health-dependent productivity risks. This feature makes the piece-rate wage contract formulation somewhat undesirable when workers are risk averse.

which firms can condition their wage offers to workers' health status is also limited by government regulations, such as the Health Insurance Portability and Accountability Act (HIPAA) and the Americans with Disabilities Act as well as their amendments, which restrict firms' ability to condition hiring, firing, and compensation on the basis of an individual's health status. We capture these restrictions by assuming the presence of a component of unobserved health status h_2, which firms cannot use in the wage offers.[24]

Labor market.—Firms and workers are randomly matched in the labor market.[25] We allow the matching rate to be dependent on the worker's demographic type χ and health status $\mathbf{h}$. In each period, an unemployed worker randomly meets a firm with probability $\lambda_u^{\chi\mathbf{h}} \in (0, 1)$. He or she then decides whether to (1) accept the offer or (2) remain unemployed and search for jobs in the next period. If an individual is employed, he or she meets randomly with another firm with probability $\lambda_e^{\chi\mathbf{h}} \in (0, 1)$. If a currently employed worker receives an offer from another firm, he or she needs to decide whether to (1) accept the outside offer or (2) stay with the current firm. An employed worker can also decide to return to the unemployment pool.[26] Moreover, each match is destroyed exogenously with probability $\delta^{\chi\mathbf{h}} \in (0, 1)$, upon which the worker will return to unemployment. As we discuss in section III.B, we assume that the individual may experience both the exogenous job destruction and the arrival of the new job offer within the same period.[27]

As we discuss below, to smooth the labor supply functions that firms face, we assume that type χ workers, whether unemployed or employed, receive preference shocks for working $\epsilon_{\chi w}$ each period. We assume that $\epsilon_{\chi w}$ is identically and independently distributed across periods, drawn from a normal distribution $N(0, \sigma_{\chi w}^2)$. The introduction of preference shocks $\epsilon_{\chi w}$ plays several important roles. First, it smooths the labor supply functions as a function of wages, as will be made clear below. Second, this in turn allows us to address the technical issue of mass points in the reservation wage distribution because of the discreteness of the health states and

[24] HIPAA is an amendment of the Employee Retirement Security Act, which is a federal law that regulates issues related to employee benefits in order to qualify for tax advantages. A description of HIPAA can be found at the Department of Labor website: http://www.dol.gov/dol/topic/health-plans/portability.htm.

[25] We choose the random search framework over the directed search because the random search will naturally generate a pooling between healthy and unhealthy workers at each firm. This pooling feature is often considered one of the rationales of relying on ESHI.

[26] Returning to unemployment may be a better option for a currently employed worker if his or her health status changed from when he or she accepted the current job offer, for example.

[27] This specification is used by Wolpin (1992) and more recently by Jolivet, Postel-Vinay, and Robin (2006). This allows us to account for transitions known as "job to unemployment, back to job" all occurring in a single period, as we observe in the data.

demographic types (see, e.g., Albrecht and Axell 1984).[28] Third, it also implies that all firms, regardless of their productivity level, will be able to attract some positive measure of workers. These properties are useful to guarantee a continuous wage offer distribution in equilibrium, which substantially simplifies our numerical and quantitative analysis.

To generate a steady state for the labor market, we assume that in each period a type χ individual, regardless of his or her health and employment status, will leave the labor market with probability $\rho_\chi \in (0, 1)$; an equal measure of type χ newborns will enter the labor market as unemployed, and their initial health status is $\mathbf{h}$ with probability $\mu_{\chi\mathbf{h}} \in (0, 1)$ for $\mathbf{h} \in \mathcal{H}$, so that $\Sigma_{\mathbf{h}\in\mathcal{H}}\mu_{\chi\mathbf{h}} = 1$.[29]

Pre-ACA health insurance system.—In the baseline model, which is intended to represent the pre-ACA US health insurance system, we assume that workers can obtain health insurance from employers as ESHI, individual health insurance, spousal health insurance, or Medicaid, as we specified in (2). We now describe them in more details.

For the private individual health insurance in the pre-ACA world—that is, option 2 in (2)—we assume that the premium is based on perfect risk rating; namely, the premium, denoted by $R^{II}(\mathbf{h}, \chi)$, is equal to the expected medical expenditure, multiplied by a loading factor. Analogous to the preference shock we introduced in the individuals' work decisions, we also introduce a preference shock, $\epsilon_{\chi II}$, to individuals' choice problem when they decide whether to purchase private individual health insurance. We assume that $\epsilon_{\chi II}$ follows a normal distribution $N(0, \sigma^2_{\chi II})$. Similar to the preference shock for working, this preference shock allows us to smooth the employment distribution over wage offers, which simplifies the characterization of the firms' problem.

We assume that spousal health insurance is offered with probability $f_{SP}(\chi) \in [0, 1]$ to a type χ uninsured individual if he or she is married. Note that it is not available to single individuals. It is important to point out that although we do not explicitly model the joint labor supply problem, in our counterfactual policy experiments we do require that $f_{SP}(\chi)$ be consistent with the probability of married people of the opposing gender receiving ESHI in the new equilibrium; in this sense, $f_{SP}(\chi)$ will be endogenously determined in our counterfactual policy experiments, as discussed in section VIII. Moreover, Medicaid is offered to individuals who do not have ESHI (whether from their own employer or from their spouse's) with probabilities $f^e_M(\chi, y) \in [0, 1]$ and $f^u_M(\chi) \in [0, 1]$, respectively,

[28] An alternative to inducing smooth labor supply functions is to introduce permanent unobserved heterogeneity—e.g., value from leisure, drawn from a continuous distribution. Our formulation is simpler because it avoids the identification issues of heterogeneity vs. state dependence in the dynamic discrete choice models (see Heckman 1981).

[29] It is ideal if we allow that the death probability depends on health status. We abstract from this possibility because of data limitations.

for employed and unemployed workers. This modeling assumption captures the essence that Medicaid eligibility depends crucially on income y and demographic type χ, especially the presence of children.[30]

Finally, we allow that the uninsured may be partially insured through uncompensated care or any other social safety net, which we model as consumption floor $\underline{c}_\chi$.[31]

REMARK 2. One important simplification is that we do not model saving decisions, which may be a way to self-insure against medical expenditure risks.[32] We make this restriction partly because of the computational complexities and partly because of the findings that the amount of wealth held by the uninsured is very small.[33] Instead, our model features alternative and empirically more relevant margins for the uninsured to address their medical expenditure risks; namely, the uninsured tend to spend much less in health care, and they often rely on uncompensated care for their health care treatments. Our current model explicitly incorporates these two channels by (i) modeling the health expenditure process separately for the insured and the uninsured and (ii) introducing the consumption floor.

Income taxes.—In the baseline model, workers' wages are subject to a nonlinear tax schedule but the ESHI premium is tax exempt. For the after-tax income $T(y)$, we follow the specification in Kaplan (2012), which approximates the US tax code by

$$T(y) = \tau_0 + \tau_1 \frac{y^{1+\tau_2}}{1 + \tau_2}, \tag{3}$$

where $\tau_0 > 0$, $\tau_1 > 0$, and $\tau_2 < 0$.[34]

[30] Note that we do not model the asset testing of Medicaid. This is an important area for future research.

[31] We point out that in our model the consumption floor applies only to the uninsured who experience large medical expenses. In contrast, the consumption floor in Hubbard, Skinner, and Zeldes (1995) and French and Jones (2011) is available to everyone. See n. 70 for an extensive discussion.

[32] Lise (2013) is an exception that includes consumption and saving margin in a similar empirical on-the-job search model, although in his paper the firm side is assumed to be exogenous. In a related work, French, Jones, and von Gaudecker (2017) study the impact of the ACA on saving, retirement, and welfare in a life-cycle model. They find that changes in saving are modest, which may alleviate the concern about this omission, at least in our context.

[33] According to the Survey of Consumer Finances, in 2013, the median value of the liquid assets held by individuals aged between 25 and 59 was $619 if they were uninsured and $5,296 if they were insured. In the post-ACA year of 2016, these numbers barely changed, to $850 and $5,290, respectively. Given these statistics, one can conclude that the self-insurance channel is unlikely to play an important role in our sample and institutional setting. The details of the summary statistics are available from the authors upon request.

[34] Robin and Roux (2002) also studied the impact of progressive income tax within the framework of Burdett and Mortensen (1998).

B. *Timing in a Period*

At the beginning of each period, we should imagine that individuals, who are heterogeneous in their health status, are either unemployed or working for firms offering different combinations of wage and health insurance packages. We now describe the explicit timing assumptions in a period that we use in the derivation of the value functions in section III.C.[35]

1. Type χ individual, whether employed or unemployed and regardless of his or her health status, exits the labor market (i.e., dies) with probability $\rho_\chi \in (0, 1)$.
2. If a type χ employed worker stays in the labor market and is matched with a firm with productivity p, then the following sequence of events occurs:
   a) he or she produces output $pd_{\chi\mathbf{h}}$ if his or her health status is $\mathbf{h} \in \mathcal{H}$;
   b) the firm pays the wage and pays for the expected health expenditure of its workers if it offers ESHI;
   c) he or she receives a medical expenditure shock, the distribution of which depends on his or her beginning-of-the-period health status;
   d) he or she randomly meets with new employers with probability $\lambda_e^{\chi\mathbf{h}}$;
   e) he or she then observes the realization of the health status that will be applicable next period;
   f) a labor supply preference shock $\epsilon_{\chi w}$ is drawn from $N(0, \sigma^2_{\chi w})$;
   g) the current match is destroyed with probability $\delta^{\chi\mathbf{h}} \in (0, 1)$, in which case the worker must decide, given the realization of $\epsilon_{\chi w}$, whether to accept the outside offer, if any, or to enter the unemployment pool;
   h) if the current match is not destroyed, then he or she decides, given the realization of $\epsilon_{\chi w}$, whether to accept the outside offer, if any, to stay with the current firm or to quit into unemployment.
3. Any unemployed worker of type χ experiences the following sequence of events in a period:
   a) he or she receives the "unemployment benefit" $\mathfrak{b}_\chi$;
   b) he or she receives a medical expenditure shock, the distribution of which depends on his or her beginning-of-the-period health status;

[35] We note that this explicit timing assumption may affect our quantitative results. Formulating the model in continuous time can allow us to be agnostic about the order of events; however, the medical expenditure process is much harder to model in a continuous-time model. We choose the discrete-time framework because it makes our empirical implementation more transparent and feasible. For example, as we discuss in sec. V, the discrete-time specification permits us to estimate the medical expenditure and health transition processes separately from the rest of the model.

c) he or she randomly meets with employers with probability $\lambda_u^{\chi\mathbf{h}}$;

d) he or she then observes the realization of the health status that will be applicable next period;

e) a labor supply preference shock $\epsilon_{\chi w}$ is drawn from $N(0, \sigma_{\chi w}^2)$;

f) he or she decides, given the realization of $\epsilon_{\chi w}$, whether to accept the offer, if any, or to stay unemployed.

4. If a type χ individual does not receive ESHI for the next period, then with probability $f_{SP}(\chi)$ he or she will obtain health insurance from their spouse with premium R^{SP} (note that if individuals are single, $f_{SP}(\chi) = 0$). Note that he or she must take up this option.[36]
5. If a type χ individual does not receive ESHI for the next period and does not receive spousal insurance offers, then with probability $f_M^e(\chi, y)$ or $f_M^u(\chi)$, depending on whether the individual is employed, he or she receives the Medicaid coverage ($x = 3$).
6. If the individual is still uninsured, he or she will decide whether to purchase private individual health insurance with price $R^{II}(h, \chi)$. The decision to purchase private individual health insurance is affected by the health insurance preference shock $\epsilon_{\chi II}$, which is drawn from $N(0, \sigma_{\chi II}^2)$.
7. Time moves to the next period.

C. *Equilibrium*

In this section, we characterize the steady-state equilibrium of the model. The analysis here is similar to but generalizes that in Burdett and Mortensen (1998). We first consider the decision problem faced by a worker with observable health status h_1^0 at the time of receiving a job offer $(\tilde{w}_{h_1^0}, E)$, drawn from a postulated distribution of wage and insurance packages by the firms, denoted by $F_{h_1^0}(\tilde{w}_{h_1^0}, E)$, and derive the steady-state distribution of workers of different health status in unemployment and among firms with different offers of wage and health insurance packages. We then solve the firms' optimization problem and provide the conditions for the postulated $\langle F_{h_1^0}(\tilde{w}_{h_1^0}, E) : h_1^0 \in \{H_1, U_1\}\rangle$ to be consistent with equilibrium.

1. Value Functions

We first introduce the notation for several valuation functions. We use $v_{\chi\mathbf{h}}(y, x)$ to denote the expected flow utility of type χ workers with health status $\mathbf{h}$ from income y and insurance status x, and it is given by

[36] According to our data, this assumption is empirically reasonable. There are few uninsured whose spouses own ESHI. The detailed statistics are available from the authors upon request.

$$v_{\chi\mathbf{h}}(y,x)=\begin{cases}\mathrm{E}_{\tilde{m}^0_{\chi\mathbf{h}}}u_\chi\left(\max\left\{\left(T(y)-\tilde{m}^0_{\chi\mathbf{h}}\right),\underline{c}_\chi\right\}\right) & \text{if } x=0,\\ u_\chi(T(y)) & \text{if } x\in\{1,3\},\\ u_\chi(T(y)-R^{II}(\mathbf{h},\chi)) & \text{if } x=2,\\ u_\chi(T(y-R^{SP})) & \text{if } x=4,\end{cases} \tag{4}$$

where $u_\chi(\cdot)$ is specified in (1), $T(y)$ denotes after-tax income as specified in (3), and $\tilde{m}^0_{\chi h}$ denotes the random medical expenditure for an uninsured type χ individual. Note that in (4), we assume that when an individual is insured—that is, $x\neq 0$—his or her medical expenditures are fully covered by the insurance.[37] However, if an individual is uninsured—that is, $x=0$—he or she is partially insured through the consumption floor $\underline{c}_\chi$ when he or she experiences an extremely large medical expenditure.

Let $U_{\chi\mathbf{h}}(x)$ denote the value for an unemployed worker of type χ with health status $\mathbf{h}$ and health insurance status $x\in\{0,2,3,4\}$ at the beginning of a period, and let $V_{\chi\mathbf{h}}(w_{h_1^0},x)$ denote the value function of a type χ worker with current health status $\mathbf{h}$ who is employed on a job with wage $w_{h_1^0}$ (e.g., his or her observable health at the initial entry to the job is h_1^0) and whose insurance status is $x\in\{0,1,2,3,4\}$. The values $U_{\chi\mathbf{h}}(\cdot)$ and $V_{\chi\mathbf{h}}(\cdot,\cdot)$ are of course recursively related. The value $U_{\chi\mathbf{h}}$ is given by

$$\frac{U_{\chi\mathbf{h}}(x)}{1-\rho_\chi}=v_{\chi\mathbf{h}}(\mathfrak{b}_\chi,x)$$
$$+\beta\mathrm{E}_{\mathbf{h}'|(\mathbf{h},x,\chi)}\left[\begin{array}{l}\lambda_u^{\chi\mathbf{h}}\displaystyle\int\!\!\int\max\left\{\tilde{V}_{\chi\mathbf{h}'}(\tilde{w}_{h_1'},\tilde{E}),\,\tilde{U}_{\chi\mathbf{h}'}+\sigma_{\chi w}\epsilon_w\right\}d\Phi(\epsilon_w)\,dF_{h_1'}(\tilde{w}_{h_1'},\widetilde{E})\\ +(1-\lambda_u^{\chi\mathbf{h}})\tilde{U}_{\chi\mathbf{h}'}\end{array}\right]. \tag{5}$$

In (5), $\tilde{V}_{\chi\mathbf{h}'}(\tilde{w}_{h_1'},\tilde{E})$ denotes the value from accepting a job offer with the wage-ESHI package $(\tilde{w}_{h_0'},\tilde{E})$, which is determined as

$$\tilde{V}_{\chi\mathbf{h}'}(\tilde{w}_{h_1'},\tilde{E})=\begin{cases}\left(\begin{array}{l}f_{SP}(\chi)V_{\chi\mathbf{h}'}(\tilde{w}_{h_1'},4)+[1-f_{SP}(\chi)]\times\\ \left[\begin{array}{l}f_M^e(\chi,\tilde{w}_{h_1'})V_{\chi\mathbf{h}'}(\tilde{w}_{h_1'},3)+[1-f_M^e(\chi,\tilde{w}_{h_1'})]\times\\ \displaystyle\int\max\{V_{\chi\mathbf{h}'}(\tilde{w}_{h_1'},2)+\sigma_{\chi II}\epsilon_{\chi II},V_{\chi\mathbf{h}'}(\tilde{w}_{h_1'},0)\}d\Phi(\epsilon_{\chi II})\end{array}\right]\end{array}\right) & \text{if } \tilde{E}=0,\\ V_{\chi\mathbf{h}'}(\tilde{w}_{h_1'},1) & \text{if } \tilde{E}=1.\end{cases} \tag{6}$$

Let $\tilde{U}_{\chi\mathbf{h}'}$ denote the value from being unemployed, unconditional on insurance status, in the end of this period, and it is given by

[37] This assumption is necessitated by the fact that we have no information about the details of the health insurance policy in our main SIPP data.

$$\tilde{U}_{\chi\mathbf{h}'} = f_{SP}(\chi)U_{\chi\mathbf{h}'}(4) + [1 - f_{SP}(\chi)] \times \left\{ f_M^u(\chi)U_{\chi\mathbf{h}'}(3) + [1 - f_M^u(\chi)] \times \int \max\{U_{\chi\mathbf{h}'}(2) + \sigma_{\chi II}\epsilon_{\chi II}, U_{\chi\mathbf{h}'}(0)\} d\Phi(\epsilon_{\chi II}) \right\}. \tag{7}$$

Note that in (5), $\Phi(\cdot)$ denotes the cumulative distribution function for a standard normal distribution ϵ_w and the expectation $\mathrm{E}_{\mathbf{h}'|(\mathbf{h},x,\chi)}$ is taken with respect to the distribution of $\mathbf{h}'$ conditional on $(\mathbf{h}, x, \chi)$. Expression (5) states that the value of being unemployed for a type χ individual with insurance status x, normalized by the survival rate $1 - \rho_\chi$, consists of the flow payoff $v_{\chi h}(\mathfrak{b}_\chi, x)$ and the discounted expected continuation value, where the expectation is taken with respect to the health status $\mathbf{h}'$ next period, whose transition is given by $\pi^x_{\chi\mathbf{h}'\mathbf{h}}$. The unemployed worker may be matched with a firm with probability $\lambda_u^{\chi\mathbf{h}}$, and the firm's offer $(\tilde{w}_{h_1'}, \tilde{E})$ is drawn from the distribution $F_{h_1'}(\tilde{w}_{h_1'}, \tilde{E})$. If an offer is received, the worker will choose whether to accept the offer by comparing the value of being employed at that firm, $\tilde{V}_{\chi\mathbf{h}'}(\tilde{w}_{h_1'}, \tilde{E})$, and the value of remaining unemployed, $\tilde{U}_{\chi\mathbf{h}'} + \sigma_{\chi w}\epsilon_w$; if no offer is received, which occurs with probability $1 - \lambda_u^{\chi\mathbf{h}}$, the worker's continuation value is $\tilde{U}_{\chi\mathbf{h}'}$. Thus, this formulation says that if the firm posts the contract $(\tilde{w}_{h_1'}, \tilde{E})$, then the value delivered to the worker is $\tilde{V}_{\chi\mathbf{h}'}(\tilde{w}_{h_1'}, \tilde{E})$.

Similarly, $V_{\chi\mathbf{h}}(w_{h_1^0}, x)$ is given by

$$\frac{V_{\chi\mathbf{h}}(w_{h_1^0}, x)}{1 - \rho_\chi} = v_{\chi\mathbf{h}}(w_{h_1^0}, x) \tag{8a}$$

$$+ \beta\lambda_e^{\chi\mathbf{h}} \left\{ \begin{aligned} &(1 - \delta^{\chi\mathbf{h}})\mathrm{E}_{\mathbf{h}'|(\mathbf{h},x,\chi)} \left[\max\{ \tilde{V}_{\chi\mathbf{h}'}(\tilde{w}_{h_1'}, \tilde{E}), \tilde{V}_{\chi\mathbf{h}'}(w_{h_1^0}, E(x)), \tilde{U}_{\chi\mathbf{h}'} + \sigma_{\chi w}\epsilon_w \} d\Phi(\epsilon_w) dF_{h_1'}(\tilde{w}_{h_1'}, \tilde{E})\right] \\ &+ \delta^{\chi\mathbf{h}}\mathrm{E}_{\mathbf{h}'|(\mathbf{h},x,\chi)} \left[\iint \max\{ \tilde{V}_{\chi\mathbf{h}'}(\tilde{w}_{h_1'}, E), \tilde{U}_{\chi\mathbf{h}'} + \sigma_{\chi w}\epsilon_w \} d\Phi(\epsilon_w) dF_{h_1'}(\tilde{w}_{h_1'}, E)\right] \end{aligned} \right\} \tag{8b}$$

$$+ \beta(1 - \lambda_e^{\chi\mathbf{h}})\mathrm{E}_{\mathbf{h}'|(\mathbf{h},x,\chi)} \left[(1 - \delta^{\chi\mathbf{h}})\left[\int \max\{ \tilde{V}_{\chi\mathbf{h}'}(w_{h_1^0}, E(x)), \tilde{U}_{\chi\mathbf{h}'} + \sigma_{\chi w}\epsilon_w \} d\Phi(\epsilon_w)\right] + \delta^{\chi\mathbf{h}}\tilde{U}_{\chi\mathbf{h}'}\right]. \tag{8c}$$

Expression (8) consists of several components. The first component, (8a), is the flow utility. The second component, (8b), is the expected value when receiving an on-the-job offer package $(\tilde{w}_{h_1'}, \tilde{E})$ drawn from the distribution $F_{h_1'}(\tilde{w}_{h_1'}, \tilde{E})$. This component has two subcomponents depending on whether the current job is destroyed. If it is not destroyed, which occurs with probability $1 - \delta^{\chi\mathbf{h}}$, the individual has the option of accepting the new offer, staying with the current job, or quitting into unemployment; on the other hand, if the current job is destroyed, which occurs with probability $\delta^{\chi\mathbf{h}}$, the individual has the option of accepting the new offer or quitting into unemployment. Note that $\tilde{V}_{\chi\mathbf{h}'}(w_{h_1^0}, E(x))$ and $\tilde{U}_{\chi\mathbf{h}'}$ are defined, respectively, in (6) and (7). The third component, (8c), is the expected value when the worker does not receive an on-the-job offer; note that in this expression, $E(x)$ denotes the ESHI offering of the current employer for the employed worker whose insurance status is x, and it is simply given by

$E(x) = 1$ if $x = 1$ and $E(x) = 0$ if $x \neq 1$. Note that in both (5) and (8), we used our timing assumption that a worker's next-period health status depends on his or her insurance status this period even if he or she is separated from the current job at the end of this period (see sec. III.B).

By using the value functions above, it is straightforward to characterize workers' optimal strategies. Note that in our model, both unemployed and employed workers make decisions about whether to accept or reject an offer—and whether to purchase individual health insurance—by comparing the values from different options. Their optimal decisions will depend on their state variables—that is, their employment status including the terms of their current offer $(w_{h_1^0}, E)$ if they are employed and their health status $\mathbf{h}$, as well as the realized preference shocks $(\epsilon_{\chi w}, \epsilon_{\chi II})$. In appendix section A.1 (apps. A–H are available online), we fully characterize these decisions.

2. Steady-State Worker Distribution

We now focus on the steady state of the dynamic equilibrium of the labor market described above. We first describe the condition of worker distribution in the steady-state equilibrium. It is conceptually straightforward to obtain the steady-state worker distribution given workers' optimal strategies and the distribution of firms' compensation package offers. Let $u_{\chi\mathbf{h}}(x)$ denote the measure of unemployed type χ workers with health status $\mathbf{h} \in \mathcal{H}$ and health insurance status $x \in \{0, 2, 3, 4\}$, and let $e^x_{\chi\mathbf{h}}$ denote the measure of employed type χ workers with health insurance status x and health status $\mathbf{h} \in \mathcal{H}$. Moreover, we denote $S^x_{\chi\mathbf{h}}(w)$ as the fraction of employed type χ workers with health status $\mathbf{h}$ working on jobs with wage no more than w and with insurance status $x \in \{0, 1, 2, 3, 4\}$, and we denote $s^x_{\chi\mathbf{h}}(w)$ as the corresponding density of $S^x_{\chi\mathbf{h}}(w)$. Thus, $e^x_{\chi\mathbf{h}} s^x_{\chi\mathbf{h}}(w)$ denotes the density of type χ employed workers with health status $\mathbf{h}$ whose compensation package is $(w, E(x))$.

The steady-state worker distribution is characterized by workers' transition probabilities between unemployment and employment, those across firms and across insurance status, and those across health status. These transition probabilities are cumbersome to write but follow immediately from the worker's optimal strategies. Therefore, we relegate them to appendix section A.2.

From the employment densities $e^x_{\chi\mathbf{h}} s^x_{\chi\mathbf{h}}(w_{h_1^0})$, we can define a few important terms related to firm size. First, given $e^x_{\chi\mathbf{h}} s^x_{\chi\mathbf{h}}(w_{h_1^0})$, the number of type χ employees with health status $\mathbf{h}$ who joined the firm with a compensation package $(w_{h_1^0}, E)$ is simply given by

$$n_{\chi\mathbf{h}}(w_{h_1^0}, E) = \frac{\sum_{x \in \{\tilde{x} : E(\tilde{x}) = E\}} e^x_{\chi\mathbf{h}} s^x_{\chi\mathbf{h}}(w_{h_1^0})}{f_{h_1}(w_{h_1^0}, E)}, \tag{9}$$

where the numerator denotes the total density of workers with health status $\mathbf{h}$ on the job $(w_{h_1^0}, E)$ and the denominator denotes the total density of firms offering a compensation package $(w_{h_1^0}, E)$.

Thus, if a firm offers a compensation package $(\mathbf{w}_{h_1^0}, E) \equiv (w_{H_1}, w_{U_1}, E)$, its total size in the steady state will be given by

$$n(\mathbf{w}_{h_1^0}, E) = \sum_{\chi} \sum_{h_1^0 \in \mathcal{H}_1} \sum_{\mathbf{h} \in \mathcal{H}} n_{\chi\mathbf{h}}(w_{h_1^0}, E) = \sum_{\chi} \sum_{h_1^0 \in \mathcal{H}_1} \sum_{\mathbf{h} \in \mathcal{H}} \frac{\sum_{x \in \{\tilde{x} : E(\tilde{x}) = E\}} e_{\chi\mathbf{h}}^x s_{\chi\mathbf{h}}^x (w_{h_1^0})}{f_{h_1}(w_{h_1^0}, E)}. \quad (10)$$

Expressions (9) and (10) allow us to connect the firm sizes in steady state as a function of the entire distribution of employed workers $\langle e_{\chi\mathbf{h}}(w_{h_1^0}, x) : \chi \in \{1, 2, \ldots, N\}, h_1^0 \in \mathcal{H}_1, \mathbf{h} \in \mathcal{H}, x \in \{0, 1, \ldots, 4\} \rangle$. Notice that the preference shocks $\epsilon_{\chi w}$ in workers' labor supply decisions we introduced in our model smooth the labor supply functions $n(\cdot, E)$ as a function of wages $\mathbf{w}_{h_1^0}$.

3. Firm's Optimization Problem

A firm with a given productivity p decides what compensation package $(\mathbf{w}_{h_1}^E, E) \equiv (w_{H_1}^E, w_{U_1}^E, E)$ to offer, taken as given the aggregate distribution of compensation packages $\mathbf{F}_{h_1}(w_{h_1}, E) \equiv (F_{H_1}(w_{H_1}, E), F_{U_1}(w_{U_1}, E))$. As we discussed in section III, we assume that before the firms make this decision, they each receive an independent and identically distributed draw of a fixed administrative cost $\tilde{C} = C + \sigma_f \epsilon_f$, where $C > 0$, ϵ_f has a type I extreme value distribution with zero mean, and σ_f is a scale parameter.[38] We assume that the $\sigma_f \epsilon$ shock a firm receives is permanent and that it is separable from firm profits.[39]

Given the realization of $\tilde{C}$, each firm chooses $(\mathbf{w}_{h_1^0}, E)$ to maximize the steady-state flow profit inclusive of the administrative costs. It is useful to think of the firm's problem as a two-stage problem. First, it decides on the wage that maximizes the deterministic part of the profits for a given insurance choice, and second, it maximizes over the insurance choices by comparing the shock-inclusive profits with or without offering health insurance. Specifically, the firm's problem is

$$\max\{\Pi_0(p), \Pi_1(p) - \sigma_f \epsilon_f\}, \quad (11)$$

where $\Pi_0(p)$ and $\Pi_1(p)$ denote the firm's expected steady-state profit flow with $E = 0$ and $E = 1$, respectively, and they are given by

[38] Alternatively, we can interpret C as a fixed administrative cost and as an employer's idiosyncratic preference for offering health insurance.

[39] These shocks allow us to smooth the insurance provision decision of the firms.

$$\begin{aligned}\Pi_0(p) &= \max_{\{w^0_{H_1}, w^0_{U_1}\}} \Pi(w^0_{H_1}, w^0_{U_1}, E=0)\\ &\equiv \sum_{\chi} \sum_{h^0_1 \in \mathcal{H}_1} \sum_{\mathbf{h} \in \mathcal{H}} \left[p d_{\chi\mathbf{h}} - (1+\tau_p) w^0_{h^0_1}\right] n_{\chi\mathbf{h}}\left(w^0_{h^0_1}, 0\right),\end{aligned} \tag{12}$$

$$\begin{aligned}\Pi_1(p) &= \max_{\{w^1_{H_1}, w^1_{U_1}\}} \Pi\left(w^1_{H_1}, w^1_{U_1}, E=1\right)\\ &\equiv \sum_{\chi} \sum_{h^0_1 \in \mathcal{H}_1} \sum_{\mathbf{h} \in \mathcal{H}} \left[p d_{\chi\mathbf{h}} - (1+\tau_p) w^1_{h^0_1} - m^1_{\chi\mathbf{h}}\right] n_{\chi\mathbf{h}}\left(w^1_{h^0_1}, 1\right) - C,\end{aligned} \tag{13}$$

where τ_p denotes the payroll tax rate imposed on firms. To understand expression (12), note that $n_{\chi\mathbf{h}}(w^0_{h^0_1}, 0)$ denotes the measure of type χ employees with health status $\mathbf{h}$ who joined the firm with initial compensation package $(w^0_{h^0_1}, E=0)$ that the firm will have in the steady state, as described by (9). Thus, $[p d_{\chi\mathbf{h}} - (1+\tau_p) w^0_{h^0_1}] n_{\chi\mathbf{h}}(w^0_{h^0_1}, 0)$ denotes the firm's steady-state after-tax flow profit from type χ employees with health status $\mathbf{h}$ who joined the firm with initial compensation package $(w^0_{h^0_1}, E=0)$. Expression (13) can be similarly understood after recalling that $m^1_{\chi\mathbf{h}}$ denotes the expected medical expenditure of a type χ worker with health status $\mathbf{h}$ and health insurance. Note that in (13), the payroll tax is assessed only on wages and not on the ESHI premium $m^1_{\chi\mathbf{h}}$, reflecting the tax-exemption status of the ESHI premium in the benchmark economy.[40] For future reference, we will denote the solutions to problems (12) and (13) as $\mathbf{w}^{*0}_{h^0_1}(p)$ and $\mathbf{w}^{*1}_{h^0_1}(p)$, respectively.[41] Note that in problems (12) and (13), the firms are restricted to offer compensation packages that do not depend on workers' family characteristics or the unobservable component of their health status, a restriction that we discussed and motivated in section III.

Because of the assumption that ϵ_f is drawn from an independent and identically distributed type I extreme value distribution with zero mean, firms' optimization problem (11) thus implies that the probability that a firm with productivity p offers health insurance to its workers is

$$\Delta(p) = \frac{\exp(\Pi_1(p)/\sigma_f)}{\exp(\Pi_1(p)/\sigma_f) + \exp(\Pi_0(p)/\sigma_f)}, \tag{14}$$

where $\Pi_0(p)$ and $\Pi_1(p)$ are respectively defined in (12) and (13).

Equations (12)–(14) clarify the determinants of ESHI provisions in our model. Importantly, the cost of ESHI provision is endogenous,

[40] In reality, there is a cap on the Social Security portion of the payroll tax. The linear specification ignores this, but we believe this simplification will have little impact on our results because our focus is on relatively less skilled workers in this paper.

[41] Note that Bontemps, Robin, and van den Berg (1999, 2000) prove theoretically that firms use pure strategy wage offers in the Burdett and Mortensen (1998) model with continuous firm heterogeneity, instead of the mixed strategy in their model with homogeneous or discrete productivity type.

depending on the type of workers that firms will be able to attract and retain. Moreover, the ESHI provision affects workers' composition by influencing their health status, which in turn affects the productivity of workers. We will further clarify these interactions in section VII.

4. Steady-State Equilibrium

We can now define the steady-state equilibrium, though we relegate its formal definition to appendix section A.3. Essentially, it consists of the following four conditions: (i) given $\mathbf{F}_{h_1}(w_{h_1}, E)$, a worker's value function and optimization behaviors are described by equations (5) and (8); (ii) the steady-state worker distribution $(u_{\chi\mathbf{h}}(x), e^x_{\chi\mathbf{h}}, S^x_{\chi\mathbf{h}}(w_{h_1}))$ is determined by a worker's transition probabilities implied by the worker's value function and optimization behaviors and by $\mathbf{F}_{h_1}(w_{h_1}, E)$; (iii) a firm's choice of compensation packages is determined by (12)–(14); and (iv) an equilibrium offer distribution of compensation package must satisfy $F_{h_1}(w_{h_1}, 1) = \int_0^\infty \mathbf{1}(w^{*1}_{h_1}(p) < w)\Delta(p)\, d\Gamma(p)$ and $F_{h_1}(w_{h_1}, 0) = \int_0^\infty \mathbf{1}(w^{*0}_{h_1}(p) < w)[1 - \Delta(p)]\, d\Gamma(p)$ for $h_1 \in \{H_1, U_1\}$.

To discuss the existence and the uniqueness of equilibrium, we first refer to Bontemps, Robin, and van den Berg (1999, 2000), which is an extension of Burdett and Mortensen (1998) with continuous firm productivity and continuous worker heterogeneity. They show equilibrium existence under some parametric assumptions; they moreover show that, as long as a worker's reservation wage is uniquely determined, the equilibrium wage offer distribution is uniquely determined. Our model has two additional complexities relative to theirs. First, because of the introduction of a multidimensional compensation package and the heterogeneous worker preference on the contract, we cannot analytically characterize the steady-state worker distribution. Second, allowing the health insurance effect on health can be thought of as a form of general human capital training, and provisions of ESHI by one firm may lower the cost of providing ESHI by other firms. This externality effect can be a potential source of equilibrium multiplicity. However, as we show below, most of the workers in our sample are observably healthy; as a result, the impact of this externality will be limited. Because of these complexities, we need to rely on numerical approaches to discuss the existence and the uniqueness. We describe the details of the numerical algorithm we use to find an equilibrium in appendix B. Throughout extensive numerical simulations, we always find a unique equilibrium for our baseline empirical model using our solution algorithm.

IV. Data Sets

In this section, we describe our data sets and sample selection. To estimate the model, it is ideal to use an employee-employer matched data set that contains information about a worker's labor market outcome and its dynamics, health, medical expenditure, and health insurance, as well as a firm's insurance coverage rate and size. Unfortunately, such a data set does not exist in the United States. Instead, we combine three separate data sets for our estimation: (1) SIPP 2004, (2) MEPS 2001–7, and (3) Kaiser 2004–7.

A. *Survey of Income and Program Participation*

Our main data set for individual labor market outcome, health, and health insurance is SIPP 2004.[42] SIPP 2004 interviews individuals every 4 months up to 12 times, so that an individual may be interviewed over a 4-year period. It consists of two parts: (1) core module and (2) topical module. The core module, which is based on interviews in each wave, contains detailed monthly information regarding individuals' demographic characteristics and labor force activity, including earnings, number of weeks worked, average hours worked, and employment status, as well as whether the individual changed jobs during each month of the survey period. In addition, information for health insurance status is recorded in each wave; it also specifies the source of insurance so that we know whether it is an employment-based insurance, a private individual insurance, or Medicaid, and we also know whether it is obtained through the individual's own or the spouse's employer. The topical module contains yearly information about the worker and his or her family member's self-reported health status and out-of-pocket medical expenditure at interview waves 3 and 6.[43]

Sample selection criteria.—To have an estimation sample that is somewhat homogeneous in skills as we assume in our model, we restrict our sample to individuals whose ages are between 26 and 46. In addition, we keep only individuals who are not in school, are in the labor force, are not self-employed, do not work in the public sector, do not currently receive Social Security income, do not engage in the military, and have health insurance status that belongs to one of those categories defined in our model. We restrict our samples to individuals who are at most high school graduates. Finally, we drop the top and bottom 3% of salaried workers. Our final estimation sample that meets all of the above selection criteria consists of a total of 11,271 individuals.

[42] The SIPP 2004 panel is available at https://www.census.gov/programs-surveys/sipp/data/2004-panel.html.

[43] In both SIPP and MEPS, we use the self-reported health status to construct whether the individual is healthy or unhealthy on the basis of the observed health. The self-reported health status has five categories. We categorize "excellent," "very good," and "good" as "healthy" and "fair" and "poor" as "unhealthy."

B. Medical Expenditure Panel Survey

The weakness of using SIPP data for our research is the lack of information for total medical expenditure. To obtain the information, we use MEPS. We use its Household Component (HC), which interviews individuals every half-year up to five times, so that an individual may be interviewed over a 2.5-year period.[44] Medical expenditure is recorded at annual frequency. Several health status–related variables are recorded in each wave. Moreover, health insurance status is recorded at the monthly level. We use the same sample selection criteria as SIPP 2004. As discussed below, we need to exploit the panel structure of the data to estimate the medical expenditure process. For this purpose, we use years of MEPS data between 2001 and 2007 to maintain enough samples. The sample size is 23,840.

C. Kaiser Family Employer Health Insurance Benefit Survey

In addition, we also need information for employer size and associated health insurance offering rate, which is not available from the worker-side data. The data source we use is Kaiser 2004–7. It is a national survey of public and private firms, containing information about a firm's characteristics, such as industry, firm size, and employee demographics, as well as information about health insurance offering, health insurance plans, employee eligibility and enrollment in health plans, and plan type. We restrict the sample to firms that belong to the private sector. The final sample size is 18,782.

D. Summary Statistics

Table 1 reports the summary statistics of the key variables in the SIPP 2004 data. In panel A, we report the distribution of health insurance status for the overall sample and for subsamples defined by gender, marital status, and whether the individual has children. In the overall sample, 25.7% of individuals are uninsured; roughly 65% have ESHI, either through their own (51%) or through their spouses' (13.7%) employer. The fraction of individuals with individual insurance is remarkably small: only 2% of individuals own individual coverage. This fact reflects that most individuals owning individual health insurance coverage under the pre-ACA economy are self-employed, who are excluded from our analysis. This pattern of insurance status distribution holds in the subsamples; the only exception is the singles subsample, where the fraction of uninsured is much higher at

[44] MEPS HC is publicly available at http://www.meps.ahrq.gov.

TABLE 1
Summary Statistics: SIPP 2004

Variable	All		Male		Female		Single		Married		Without Child		With Child	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
	A. Distribution of Insurance Status													
Uninsured	.257	.437	.294	.456	.212	.409	.325	.469	.214	.410	.299	.458	.237	.425
ESHI	.510	.500	.558	.497	.451	.498	.543	.498	.489	.500	.572	.495	.480	.500
Individual insurance	.019	.138	.018	.131	.022	.145	.018	.132	.020	.141	.025	.155	.017	.129
Medicaid	.077	.266	.045	.208	.115	.319	.114	.318	.053	.224	.035	.184	.096	.295
Spousal insurance	.137	.344	.085	.279	.202	.401	.000	.000	.223	.416	.069	.253	.170	.376
	B. Fraction of Individuals with Healthy Observed Component in Each Insurance Status													
Average	.923	.267	.925	.263	.920	.272	.905	.293	.933	.249	.919	.273	.924	.265
Uninsured	.911	.284	.917	.276	.901	.299	.900	.300	.922	.268	.897	.304	.920	.271
ESHI	.942	.234	.943	.233	.941	.236	.925	.263	.954	.210	.935	.246	.946	.227
Individual insurance	.926	.263	.971	.171	.882	.327	.917	.282	.932	.255	.893	.315	.950	.221
Medicaid	.810	.393	.773	.421	.882	.327	.825	.381	.791	.408	.775	.423	.817	.388
Spousal insurance	.934	.249	.909	.289	.947	.225	NA	NA	.934	.249	.962	.194	.928	.258
	C. Average (4-Month) Income in Each Insurance Status (per $10,000)													
Average	.953	.452	1.061	.468	.805	.383	.868	.420	1.006	.463	.949	.433	.955	.461
Uninsured	.731	.343	.813	.359	.561	.226	.698	.331	.763	.351	.739	.338	.727	.346
ESHI	1.088	.449	1.182	.466	.945	.378	.996	.421	1.151	.457	1.047	.428	1.112	.459
Individual insurance	.903	.534	1.049	.560	.735	.456	.770	.551	.978	.516	.877	.566	.923	.516
Medicaid	.595	.304	.736	.368	.512	.221	.552	.252	.653	.356	.601	.307	.594	.304
Spousal insurance	.915	.429	1.152	.425	.772	.363	NA	NA	.915	.429	.986	.450	.901	.423
Fraction employed	.940	.238	.962	.191	.912	.284	.930	.254	.945	.227	.940	.237	.939	.239

Note.—NA = not applicable.

32.5%, mostly because they do not have the option of obtaining spousal ESHI. In panel B, we report the fraction of individuals with healthy observed health component in each insurance status. It shows that the fraction of individuals with healthy observed health component among those with either their own or spousal ESHI is higher than that among the uninsured or among those with Medicaid. In panel C, we report the average 4-month wage (in units of $10,000) of individuals in each health insurance status.[45] It shows, as we described in the introduction, that individuals who have ESHI tend to receive higher wages than those who are uninsured or are insured by Medicaid. The last row of table 1 reports the employment rates. The employment rates are quite high—94% for the overall sample—but there are small variations across the subsamples. These descriptive statistics suggest that there is a systematic pattern regarding health, health insurance status, and labor market status.

In table 2, we report the comparison of summary statistics for the individuals in MEPS 2001–7 and those in SIPP 2004. The fractions of workers with healthy observables are somewhat lower in MEPS than in SIPP. The fractions of uninsured are higher in MEPS than in SIPP. We also report the average medical expenditure by insurance status and observed health component in the MEPS data. It shows that the average medical expenditure is about $2,180 for the overall sample, but the average medical expenditure is much higher among those with insurance and with unhealthy observed health component (at $7,080) and much lower among those without insurance and with healthy observed health component (at $680). Our estimates of the medical expenditure process in section V.B will confirm these differences.[46]

In table 3, we provide the summary statistics for our firm-side data set, Kaiser 2004–7. It shows that large firms are much more likely to offer ESHI than smaller firms. Fifty-six percent of the firms with fewer than 50 workers offer health insurance, in contrast to 93% of the firms with 50 or more workers. Firms that offer ESHI average about 30 workers, while those that do not offer ESHI average about eight workers. Although Kaiser does not provide the detailed wage information, they report the quantile of wages among employed workers. It is shown that firms offering health insurance consist of a larger portion of higher-wage workers.[47] Therefore, although we restrict samples to relatively unskilled workers in SIPP, the

[45] We normalize the wages and medical expenditures to 2007 dollars.

[46] We do not observe total medical expenditures in the SIPP data, thus preventing us from comparing the MEPS and SIPP samples on the statistics related to the medical expenditures.

[47] This pattern is also confirmed in other data sets, such as the 1997 Robert Wood Johnson Employer Health Insurance Survey. See our previous working papers (Aizawa and Fang 2013, 2015) that used this data set.

TABLE 2

Summary Statistics: Comparison between MEPS 2001–7 and SIPP 2004

	All				Male				Female			
	MEPS		SIPP		MEPS		SIPP		MEPS		SIPP	
Variable	Mean (1)	SD (2)	Mean (3)	SD (4)	Mean (5)	SD (6)	Mean (7)	SD (8)	Mean (9)	SD (10)	Mean (11)	SD (12)
Fraction of healthy (observed) workers	.879	.326	.923	.267	.894	.307	.925	.263	.862	.345	.920	.272
Fraction of uninsured	.322	.467	.257	.437	.345	.476	.294	.456	.294	.456	.212	.409
Average annual medical expenditure ($10,000)	.218	.851			.168	.831			.277	.871		
Among insured and (observed) healthy	.221	.614			.161	.521			.289	.697		
Among uninsured and (observed) healthy	.068	.320			.055	.363			.088	.245		
Among insured and (observed) unhealthy	.708	2.284			.710	2.515			.707	2.074		
Among uninsured and (observed) unhealthy	.249	.982			.242	1.149			.256	.781		

TABLE 3
Summary Statistics: Kaiser 2004–7

Variable	Mean	Standard Deviation
Average firm size	21.020	54.542
(For those that offer ESHI)	29.961	68.577
(For those that do not offer ESHI)	7.909	12.325
Fraction of firms offering ESHI	.595	.491
(Among firms with fewer than 50 workers)	.569	.495
(Among firms with more than 50 workers)	.934	.247
Fraction of employees with annual salaries $21,000 or less	.21	.31
(For those that offer ESHI)	.12	.23
(For those that do not offer ESHI)	.32	.36
Fraction of employees with annual salaries $50,000 or more	.23	.28
(For those that offer ESHI)	.27	.29
(For those that do not offer ESHI)	.18	.26

compensation patterns seem to be quite consistent between the worker-side and the firm-side data sets.

V. Estimation Strategy

In this section, we present our strategy to structurally estimate our baseline model using the data sets we described above. We estimate parameters regarding health transitions and medical expenditure distribution without using the model. The remaining parameters are estimated via a generalized method of moments where moments come from different data sources. We construct worker-side moments, such as the cross-sectional distribution of health insurance coverages and wages as well as individuals' labor market transitions from the SIPP data, and we construct firm-side moments, such as the firm size distribution and firms' ESHI offering rates conditional on their size from the Kaiser data. Loosely speaking, the parameters are chosen to best fit the data from both sides of labor markets. This is the main difference from the existing estimation procedure for related models used in Bontemps, Robin, and van den Berg (1999, 2000) and Shephard (2017), where model parameters are chosen to fit worker-side data alone.[48]

[48] Consequently, they can estimate the productivity distribution nonparametrically so that the model's prediction of workers' wage distribution perfectly fits with the data. Specifically, in Bontemps, Robin, and van den Berg (1999, 2000) and Shephard (2017), worker-side parameters are estimated from the likelihood function of individual labor market transitions. Then, the firm productivity distribution is estimated to perfectly fit the wage distribution observed from the worker side by utilizing the theoretical relationship between wage offer and firm productivity implied from the model. Note that one can still apply semiparametric multistep estimation to fit both worker- and employer-side moments if one has access to employee-employer matched panel data. For example, Postel-Vinay and Robin (2002) and Cahuc, Postel-Vinay, and Robin (2006) nonparametrically estimate workers' sampling distribution of job offers from each firm to match the observed wage distribution. Given the estimated sampling distribution, they then estimate the productivity distribution of firms to perfectly fit the employer-size distribution.

A. *Empirical Specifications*

To estimate our model, we need to impose several functional form assumptions to our equilibrium model. First, in the empirical model, the demographic vector χ we consider is on the basis of gender (male vs. female), marital status (married vs. single), and children status (has children vs. no children); specifically, the demographic vector χ belongs to one of the following seven types: (i) single men, (ii) married men without children, (iii) married men with children, (iv) single women without children, (v) single women with children, (vi) married women without children, and (vii) married women with children.[49]

Second, we proxy the observable component of the health status by the individual's self-reported health status. We interpret the unobserved health component as a persistent characteristic that affects medical expenditures. We provide the details of how we estimate the unobserved health component h_2 in section V.B. Moreover, in the empirical model, we restrict the health insurance to affect only the transition of the observed health component h_1, and the unobserved component of health is time invariant.

Remark 3. To estimate the health transition, we assume that the observed health component follows equation (26) specified below, while the unobserved health component is time invariant. As we discuss in section VI.A, the health economics literature tends to find that the health insurance status affects the dynamics of self-reported health status, which is the measure underlying our observed health component. They also report that the impact of health insurance on certain health measures (e.g., blood pressure and cholesterol) are not statistically significant. Based on these findings in the literature, we take a conservative approach that only the observed health component is affected by the health insurance status. In addition, it is important to note that one can relax the assumption that the unobserved health component is time invariant as long as we have long panel data. We believe that this assumption is less crucial given that the literature estimating the unobserved medical expenditure shocks tends to find that it is very persistent.[50]

Third, in our general model (see [2]), the insurance status x can take values from $\{0, 1, 2, 3, 4\}$, where 0 indicates no insurance and the other values indicate different sources of insurance. We define the insurance indicator $\hat{x}$ as

[49] We do not condition on the presence of children for single men mainly because the sample size of single men with children is very small.

[50] See French and Jones (2011) and French, Jones, and von Gaudecker (2017) and the references cited therein.

$$\hat{x}(x) = \begin{cases} 0 & \text{if } x = 0, \\ 1 & \text{if } x \in \{1, 2, 3, 4\}, \end{cases} \tag{15}$$

where $\hat{x} = 0$ indicates being uninsured and $\hat{x} = 1$ indicates being insured. In the empirical specification, we assume that medical expenditure distributions and the health improvement effect depend on x only through $\hat{x}$. We parameterize the probability of a positive medical shock ($\Pr[m > 0 | (\chi, \mathbf{h}, \hat{x})]$) as

$$\Pr[m > 0 | (\chi, \mathbf{h}, \hat{x})] = \frac{\exp\left(\sum_{\tilde{h}_1 \in \{H_1, U_1\}, \tilde{x} \in \{0,1\}} \alpha_{m\chi}^{\tilde{h}_1, \tilde{x}} 1\{h_1 = \tilde{h}_1, \hat{x} = \tilde{x}\} + \zeta_{1m\chi} 1\{h_2 = U_2\}\right)}{1 + \exp\left(\sum_{\tilde{h}_1 \in \{H_1, U_1\}, \tilde{x} \in \{0,1\}} \alpha_{m\chi}^{\tilde{h}, \tilde{x}} 1\{h_1 = \tilde{h}_1, \hat{x} = \tilde{x}\} + \zeta_{1m\chi} 1\{h_2 = U_2\}\right)}, \tag{16}$$

and, conditional on a positive medical shock, we assume that the realization of his or her medical expenditure is drawn from a lognormal distribution specified as

$$m | (\chi, \mathbf{h}, \hat{x}) \sim \exp\left(\sum_{\tilde{h}_1 \in \{H_1, U_1\}, \tilde{x} \in \{0,1\}} \beta_{m\chi}^{\tilde{h}_1, \tilde{x}} 1\{h_1 = \tilde{h}_1, \hat{x} = \tilde{x}\} + \zeta_{2m\chi} 1\{h_2 = U_2\} + \epsilon_{\chi h_1}^{\hat{x}}\right), \tag{17}$$

where $\epsilon_{\chi h_1}^{\hat{x}} \sim N(0, \sigma_{\chi h_1}^{\hat{x}2})$. We report our estimates of the medical expenditure process for adults in table 4. We also treat the medical expenditure process for the adult and the child separately. We assume that the medical expenditure process of the child depends only on insurance status.[51]

Because of data limitations, we also assume that the health insurance effect on health, $\pi_{\chi \mathbf{hh}'}^{x}$, is identical for any insured status (i.e., $x = 1, 2, 3, 4$)—that is, it depends only on $\hat{x}(x)$; moreover, it depends on demographic type χ only via gender. We henceforth denote it by $\pi_{\chi \mathbf{hh}'}^{\widehat{x}}$ for $\hat{x} \in \{0, 1\}$.

Remark 4. Note that these specifications assume that the source of insurance coverage does not affect medical expenditure distribution or the health insurance transition. These assumptions are necessitated by the sample size limitations. Some sources of coverage—in particular, individual private insurance—have a very small sample size. In principle, with larger samples one can relax this assumption and estimate the processes separately by insurance status.

Fourth, in the general model we describe above, we allowed several structural parameters, such as the offer arrival rates $\lambda_u^{\chi \mathbf{h}}$ and $\lambda_e^{\chi \mathbf{h}}$ and job destruction rates $\delta^{\chi \mathbf{h}}$ to be $(\chi, \mathbf{h})$ specific; in the empirical model, we impose the following parsimonious specifications on these parameters:

[51] We assume that the total medical expenditure of an individual with children is the sum of the adult's own medical expenditure and the children's medical expenditure. If individuals are married, we assume that they need to pay only half of the medical expenditure (and the health insurance premium) of their children.

$$\lambda_u^{\chi\mathbf{h}} = \frac{\exp[\lambda_{u0} + \lambda_{u1}1(h_1 = U_1) + \lambda_{u2}1(\text{Female}) + \lambda_{u3}1(\text{HasChildren}) + \lambda_{u4}1(\text{Married})]}{1 + \exp[\lambda_{u0} + \lambda_{u1}1(h_1 = U_1) + \lambda_{u2}1(\text{Female}) + \lambda_{u3}1(\text{HasChildren}) + \lambda_{u4}1(\text{Married})]}, \quad (18)$$

$$\lambda_e^{\chi\mathbf{h}} = \frac{\exp[\lambda_{e0} + \lambda_{e1}1(h_1 = U_1) + \lambda_{e2}1(\text{Female}) + \lambda_{e3}1(\text{HasChildren}) + \lambda_{e4}1(\text{Married})]}{1 + \exp[\lambda_{e0} + \lambda_{e1}1(h_1 = U_1) + \lambda_{e2}1(\text{Female}) + \lambda_{e3}1(\text{HasChildren}) + \lambda_{e4}1(\text{Married})]}, \quad (19)$$

$$\delta^{\chi\mathbf{h}} = \frac{\exp[\delta_0 + \delta_1 1(h_1 = U_1) + \delta_2 1(\text{Female}) + \delta_3 1(\text{HasChildren}) + \delta_4 1(\text{Married})]}{1 + \exp[\delta_0 + \delta_1 1(h_1 = U_1) + \delta_2 1(\text{Female}) + \delta_3 1(\text{HasChildren}) + \delta_4 1(\text{Married})]}. \quad (20)$$

The above specifications allow the possibility that the observed health component impacts the labor market frictions, possibly capturing the idea that the unhealthy individuals can spend less time looking for jobs or exert less efforts to retain the current jobs.

Fifth, we similarly assume that the productivity effect of health is channeled through the observed health component and constant for all demographic types χ; that is, we specify that

$$d_{\chi\mathbf{h}} = \begin{cases} d_{U_1} & \text{if } h_1 = U_1, \\ 1 & \text{if } h_1 = H_1. \end{cases} \quad (21)$$

Specifications (18)–(21) assume that the unobserved health component does not directly affect the worker's labor market parameters, even though it affects their medical expenditures. One reason for these restrictions is the difficulty of identifying these parameters if they are unrestricted. In addition, we also believe that these restrictions are plausible, at least in our context, given the recent finding by Blundell et al. (2017) that self-reported health status is the single most important indicator of individual health status to predict his or her labor market outcomes (e.g., employment).

Sixth, in our empirical model we allow the "unemployment benefits" $\mathfrak{b}_\chi$ to freely vary by demographic type χ. However, we assume that risk aversion γ_χ varies only by gender. Also, for simplicity we assume that $(\sigma_{\chi w}, \sigma_{\chi II}, \underline{c}_\chi)$ do not vary by demographic type χ. If a worker does not have access to his or her own or spousal ESHI, we also model the probabilities of Medicaid eligibility $f_M^e(\chi, y)$ for employed workers and $f_M^u(\chi)$ for unemployed workers, which take the following forms:

$$f_M^e(\chi, y) = \frac{\exp[\alpha_{m0}^e 1(\text{HasChildren}) + \alpha_{m1}^e 1(\text{NoChildren}) + \alpha_{m2}^e y + \alpha_{m3}^e y^2]}{1 + \exp[\alpha_{m0}^e 1(\text{HasChildren}) + \alpha_{m1}^e 1(\text{NoChildren}) + \alpha_{m2}^e y + \alpha_{m3}^e y^2]}, \quad (22)$$

$$f_M^u(\chi) = \frac{\exp[\alpha_{m0}^u 1(\text{HasChildren}) + \alpha_{m1}^u 1(\text{NoChildren})]}{1 + \exp[\alpha_{m0}^u 1(\text{HasChildren}) + \alpha_{m1}^u 1(\text{NoChildren})]}. \quad (23)$$

Seventh, we specify that in the pre-ACA benchmark the individual private insurance premium is perfectly risk-rated by individuals' demographic χ and health type $\mathbf{h}$, and it is determined by

$$R^{II}(\mathbf{h}, \chi) = (1 + \xi_{II}) m_{\chi\mathbf{h}}^2, \quad (24)$$

where $\xi_{II} > 0$ denotes the loading factor in the pre-ACA individual private insurance market.

Moreover, we impose additional parametric assumptions. First, the model period is set to be 4 months, driven by the fact that we can observe the transition of health insurance status only at 4-month intervals in the SIPP data. In this paper, we do not try to estimate β but set $\beta = 0.99$ so that the annual interest rate is about 3%.[52] Moreover, we set the exogenous death rate ρ_χ to be 0.001 for any demographic type.[53] We also set the distribution of demographic type M_χ/M directly from the SIPP data.[54]

We assume that all newborn workers have the healthy observed health component.[55] However, we set the distribution of the newborn workers' unobserved health component to be equal to the steady-state distribution of the unobserved health types, which we calculate on the basis of the estimates of our first step (see below for details) based on medical expenditure distributions. In the estimation, we also set the spousal insurance premium R^{SP} to be equal to the average medical expenditure of individuals who have spousal insurance in the data, and we set the probability of being offered spousal insurance, $f_{SP}(\chi)$, to be the proportion of the married opposite gender who have ESHI in the data.[56] Finally, the after-tax income schedule (3) is estimated by using the same approach as Kaplan (2012); that is, $\tau_0 = 170.258$, $\tau_1 = 2.672$, and $\tau_2 = -0.142$.[57] We also set that firm's payroll tax rate as $\tau_p = 0.0765$.

B. *First Step*

In step 1, we estimate the parameters determining individuals' medical expenditure distributions and health transitions. The parameters related to the health expenditure distributions include—for each $h_1 \in \{H_1, U_1\}$, $\hat{x} \in \{0, 1\}$, χ (only by gender)—the parameters $(\alpha_{m\chi}^{h_1,\hat{x}}, \zeta_{1m\chi})$ that characterize the probability of receiving a medical shock in (16) and the parameters $(\beta_{m\chi}^{h_1,\hat{x}}, \zeta_{2m\chi}, \sigma_{\chi\mathbf{h}}^{\hat{x}2})$ for the lognormal distribution of medical expenditures as specified in (17). They are estimated by GMM using the MEPS data. We also estimate the health transitions $\pi_{\chi\mathbf{h}\mathbf{h}'}^{\hat{x}}$ without explicitly using the model.

[52] It is known from Flinn and Heckman (1982) that it is difficult to separately identify the discount factor β from the flow unemployed income b in standard search models.

[53] This roughly matches the average 4-month death rate in the age range of 26–46, which is the sample of individuals we include in our estimation.

[54] The magnitude of M, the measure of workers relative to firms, will be estimated, and it is reported in table 6.

[55] In the previous versions of this paper, we estimated the model allowing that the proportion of newborn healthy individuals may be less than one. We always find that it is very close to one, which leads us to choose this normalization.

[56] It is important to point out here that although these numbers are fixed in the estimation, we allow them to be endogenously adjusted when we solve the new equilibrium in our counterfactual analyses in sec. VIII.

[57] We estimate the after-tax income schedule parameters based on annual income and then adjust the schedule appropriately to apply to 4-month incomes in our model environment (for details, see app. D).

Specifically, for each $h_1 \in \{H_1, U_1\}$, $\hat{x} \in \{0, 1\}$, and χ, we construct five moments, namely, the mean and variance of the medical expenditures, the fraction of individuals with zero medical expenditure, the fraction of individuals with zero medical expenditures in both years, and the covariance of the medical expenditures over the 2 years. We include the latter two dynamic moments to identify the effect of the time-invariant unobserved health status $h_2 \in \{H_2, U_2\}$ on medical expenditures.[58] We classify individuals into four categories based on observed health component, $h_1 \in \{H_1, U_1\}$, and observed insurance coverage status $\hat{x} \in \{0, 1\}$.[59] Then, we fit the theoretical moments, which are derived from our model with periods consisting of 4 months, with empirical moments at the annual level.[60] Importantly, equations (16) and (17) include the unobserved health component $h_2 \in \{H_2, U_2\}$ that the econometrician does not observe from the data. In estimating the medical expenditure process (16) and (17), we deal with the selection of the unobserved health component as follows. We let $\Pr(h_2 = U_2 | \langle h_{1t}, \hat{x}_t \rangle_{t=1,2}, \chi)$ depend on the individual's observed characteristics $\{\langle h_{1t}, \hat{x}_t \rangle_{t=1,2}, \chi\}$, such that it varies by both first- and second-year insurance and health status in the panel as well as the observed demographic types. In particular, we specify that the probability of $h_2 = U_2$ takes the following logit form, by demographic type χ (where we include only gender because of data limitations):

$$\Pr(h_2 = U_2 | \{h_{1t}, \hat{x}_t\}_{t=1}^{2}, \chi) = \frac{\exp\left(\alpha_{s0\chi} + \alpha_{s1\chi}\sum_t 1(h_{1t} = H_1) + \alpha_{s2\chi}\sum_t 1(\hat{x}_t = 1) + \alpha_{s3\chi}\sum_t 1(\hat{x}_t = 1 \wedge h_{1t} = H_1)\right)}{1 + \exp\left(\alpha_{s0\chi} + \alpha_{s1\chi}\sum_t 1(h_{1t} = H_1) + \alpha_{s2\chi}\sum_t 1(\hat{x}_t = 1) + \alpha_{s3\chi}\sum_t 1(\hat{x}_t = 1 \wedge h_{1t} = H_1)\right)}, \tag{25}$$

where $\{h_{1t}, \hat{x}_t\}_{t=1}^{2}$ denote, respectively, the individual's first- and second-year annual-level observed health component and the health insurance status. We estimate the parameters in (25) jointly with all the other medical expenditure parameters.[61]

[58] Note that we cannot directly implement the standard linear fixed effect panel regression because the unobserved type affects the overall medical expenditure nonlinearly; it affects the probability of positive expenditure and the realization of positive medical expenditure.

[59] The details of the classification are provided in app. C. We assume that the observed health component and health insurance status stay fixed in the year, which is necessitated by the difficulty in measuring the exact timing of the health care spending as related to the health and health insurance status. An alternative strategy is to use the subsample of individuals whose health and insurance status are unchanged within each year. One drawback of this alternative approach is that it will result in an extremely small estimation sample; in particular, this approach significantly reduces the samples whose health and insurance status change across years, which is the key source of variation to construct the covariance moments.

[60] The weighting matrix we use is the diagonal elements of the inverse of the variance-covariance matrix of the sample moments.

[61] Instead of relying on exclusion restrictions to address the selection on the unobserved health component, our identification of the distribution of the unobserved health component relies on the panel structure of the data, akin to the fixed effect regression.

Note that we do not directly use the estimate of $\Pr(h_2 = U_2 | \langle h_{1t}, x_t \rangle_{t=1,2}, \chi)$ in the later estimation. Instead, from this estimate, we calculate the unconditional proportion of the population with unhealthy unobserved component, $\Pr(h_2 = U_2)$, by integrating over the joint distribution of $(\langle h_{1t}, x_t \rangle_{t=1,2}, \chi)$ observed in the data. The unconditional distribution is used as an input to calculate the steady-state worker distribution in our equilibrium model.[62] We then verify how well our model is able to account for the selection based on the unobserved health component.[63]

We estimate the parameters in health transition matrix $\pi^{\hat{x}}_{\chi h_1 h_1'}$, as further parametrized in section V.A, using the 2004 SIPP data based on maximum likelihood. The key issue we need to deal with is that our model period is 4 months, and while we can observe health insurance status each period (every 4 months), we observe health status only every three periods (a year). We deal with this issue as follows, separately by demographic type χ. Let $\hat{x}_t \in \{0, 1\}$ denote a type χ worker's insurance status at period t, and let $h_{1t} \in \mathcal{H}_1$ and $h_{1t+3} \in \mathcal{H}_1$ denote, respectively, the worker's observed health component in period t and $t + 3$ (when it is next measured); the likelihood of observing $h_{1t+3} \in \mathcal{H}_1$ conditional on $\hat{x}_t$, $\hat{x}_{t+1}$, $\hat{x}_{t+2}$, and $h_{1t} \in \mathcal{H}_1$ can be written out explicitly using the law of total probability:

$$\Pr(h_{1t+3} | \hat{x}_t, \hat{x}_{t+1}, \hat{x}_{t+2}, h_{1t}, \chi) = \sum_{h_{1t+2} \in \mathcal{H}} \sum_{h_{1t+1} \in \mathcal{H}} \pi^{\hat{x}_t}_{\chi h_{1t+1} h_{1t}} \pi^{\hat{x}_{t+1}}_{\chi h_{1t+2} h_{1t+1}} \pi^{\hat{x}_{t+2}}_{\chi h_{1t+3} h_{1t+2}}. \tag{26}$$

We use them to formulate the log likelihood of observed data, which records the health transition every three periods, as a function of one-period health transition parameters as captured by $\pi^{\hat{x}}_{\chi h_1 h_1'}$, for $\hat{x} \in \{0, 1\}$, which corresponds to the health transition probability in our model.[64]

C. Second Step

In the second step, we estimate the remaining parameters $\theta \equiv (\theta_1, \theta_2)$, where $\theta_1 \equiv \langle \gamma_\chi, \mathfrak{b}_\chi, \lambda^{\chi\mathbf{h}}_u, \lambda^{\chi\mathbf{h}}_e, \delta^{\chi\mathbf{h}}, f^e_M(\chi, y), f^u_M(\chi), \sigma_{\chi II}, \xi_{II}, \sigma_{\chi w}, \underline{c}_\chi \rangle$ are parameters that affect worker-side dynamics and $\theta_2 \equiv \langle C, d_{U_1}, M, \mu_p, \sigma_p, \sigma_f \rangle$ are the additional parameters that are mostly relevant to the firm-side moments. First, we discuss the identification of these parameters. Then, we explain how to use the actual data variation to estimate these parameters.

[62] The medical expenditure process of the children is estimated with three conditional moments: the mean and variance of the medical expenditures conditional on the expenditures being positive and the fraction of children with zero medical expenditure for each $\hat{x} \in \{0, 1\}$.

[63] As we discuss in sec. VI.B, an important reason that we do not directly use the estimates of $\Pr(h_2 = U_2 | \{h_{1t}, \hat{x}_t\}^2_{t=1}, \chi)$ in the second-step estimation is that they are not directly comparable to the steady-state distribution in our equilibrium.

[64] Although our estimation procedure for the health impact of health insurance is more restrictive than randomized or quasi-randomized experiments used in some of the recent health literature, our estimates turn out to be largely consistent with those in the literature, as we review in sec. VI.A.

1. Identification

Our model is an extension of the standard Burdett and Mortensen (1998) model whose identification is extensively discussed in the literature (e.g., Bontemps, Robin, and van den Berg 1999, 2000). In this section, we heuristically discuss the identification of the additional parameters related to health and health insurance, on both the worker side and the firm side, that are not present in Burdett and Mortensen (1998).

We first discuss the sources of variation in the data that can identify the worker-side parameters related to the health insurance choices of workers, which include the CARA parameters γ_χ, the consumption floor $\underline{c}_\chi$, the loading factor for individual insurance ξ_{II} (as in eq. [24]), the standard deviation of preference shock to obtaining individual insurance $\sigma_{\chi II}$, and the Medicaid eligibility probabilities $\langle f_M^e(\chi, y), f_M^u(\chi)\rangle$. First, the CARA parameter γ_χ determines the value of health insurance, which will determine the overall uninsured rate. The consumption floor $\underline{c}_\chi$ will also affect the demand for insurance but mainly for low-income individuals. Thus, the insurance coverage rates by income (e.g., wage variations between the insured and the uninsured) and employment provide the source of variation to separately identify γ_χ and $\underline{c}_\chi$. The loading factor parameter ξ_{II} mainly affects the demand of the pre-ACA individual private insurance relative to other insurance options, for a given level of risk aversion. Thus, the fraction of individuals holding individual private insurance among the overall insured population is informative about ξ_{II}. For the standard deviation of the preference shock on having individual insurance $\sigma_{\chi II}$, note that it regulates the smoothness of the relationship between income and individual insurance coverage, which provides the source of variation to identify $\sigma_{\chi II}$. The function of Medicaid offer rates $f_M^e(\chi, y)$ and $f_M^u(\chi)$ are identified from the proportions of Medicaid enrollees across demographic types, income, and employment status. Moreover, the identification of these parameters is further assisted by utilizing the panel structure of data, including the transitions of workers between insurance statuses (e.g., worker transitions between ESHI and non-ESHI jobs).

The firm-side parameters that are related to the health and health insurance provisions include the parameter that measures the productivity effect of health $d_{\chi h1}$ and a firm's mean administrative cost of offering health insurance C, together with the scale parameter of the administrative cost shock σ_f (as in [11]). The identification of the productivity effect of health $d_{\chi h1}$ is due mainly to the fact that it is directly related to a firm's wage offer: as can be seen from the firm's profit function in (12) and (13), wage offers depend on the workers' observed health component at the initial entry. Thus, if workers' observed health component were persistent and unhealthy individuals were less productive, they would receive lower wages. The variation of wages across observed health status is therefore informative about the productivity effect of health. The parameters C and σ_f are identified mainly from the relationship between the firm size and health insurance offering probability from the firm-side data. Specifically, the mean of the administrative cost C is identified from the probability (in level) of small firms offering health insurance; the scale parameter σ_f is identified from the relationship between the probability of offering health insurance and firm productivity (and thus firm size).

Finally, we discuss the identification of the remaining parameters, including the parameters measuring the labor market friction $(\lambda_u^{\chi\mathbf{h}}, \lambda_e^{\chi\mathbf{h}}, \delta^{\chi\mathbf{h}})$, the variance of the preference shock to work $(\sigma_{\chi w})$, flow "income" when in unemployment $(\mathfrak{b}_\chi)$, and firm productivity distribution parameters (μ_p, σ_p). First, the labor market friction parameters $\lambda_u^{\chi\mathbf{h}}$, $\lambda_e^{\chi\mathbf{h}}$, and $\delta^{\chi\mathbf{h}}$ are identified from the labor market transitions from the worker-side data. Note that, compared with the standard labor search model, we additionally have preference shocks to work, which also affect the workers' job transitions. The exclusion restriction to separately identify $\sigma_{\chi w}$ from $(\lambda_u^{\chi\mathbf{h}}, \lambda_e^{\chi\mathbf{h}}, \delta^{\chi\mathbf{h}})$ is the assumption that the preference shock to work is independent of a firm's characteristics. To see this, note from equations (A5) and (A6) that endogenous quits induced by the preference shock depend on employees' current wage and ESHI status. Thus, by using the variation of labor market transition from a previous employer's contract, one can separately identify these parameters. Finally, similar to other labor search models, the flow "income" in unemployment $(\mathfrak{b}_\chi)$ and the firm productivity distribution parameters (μ_p, σ_p) are identified from the observed wage and firm size distributions.

In appendix F, we provide numerical assessments of how changes in some of the key parameters affect the predicted outcomes. It supports the identification intuition described above. Moreover, it provides informal diagnosis about which parameters can be more sensitive to certain moments (Andrews, Gentzkow, and Shapiro 2017).

2. Estimation

Our objective function is based on the GMM that consists of the worker-side data from SIPP and the firm-side data from Kaiser. Specifically, let the targeted moments be

$$\mathcal{M}(\theta) = \begin{bmatrix} \mathbf{m}_w - \mathrm{E}[\mathbf{m}_w; \theta] \\ \mathbf{m}_f - \mathrm{E}[\mathbf{m}_f; \theta] \end{bmatrix}, \tag{27}$$

where $\mathbf{m}_w$ is a vector of worker-side moments and $\mathbf{m}_f$ is a vector of firm-side moments, details of which are described below.

Then, we construct an objective function as

$$\min_{\{\theta\}} \mathcal{M}(\theta)'\mathbf{W}\mathcal{M}(\theta), \tag{28}$$

where the weighting matrix $\mathbf{W}$ is a diagonal matrix of inverse of variance of corresponding moment.[65] Let $\mathbb{M}(\theta) = \mathrm{E}[(\partial\mathcal{M}(\theta))/\partial\theta']$ denote the gradient matrix of the moment conditions with respect to the parameters evaluated at the true parameter values, and let $\Omega = \mathrm{E}[\mathcal{M}(\theta)\mathcal{M}(\theta)']$ denote the variance-covariance matrix of the moment condition. As in Petrin (2002), we first assume that Ω takes a block diagonal matrix because different moments come from different sampling processes. The asymptotic variance of $\sqrt{n}(\hat{\theta} - \theta)$ is then given by

$$[\mathbb{M}(\theta)'\mathbf{W}\mathbb{M}(\theta)]^{-1}\mathbb{M}(\theta)'\mathbf{W}\Omega\mathbf{W}\mathbb{M}(\theta)[\mathbb{M}(\theta)'\mathbf{W}\mathbb{M}(\theta)]^{-1},$$

which we use to calculate the standard errors of the parameter estimates.

We relegate the full list of targeted moments for our GMM estimator to appendix E. Our choice of moments is motivated by our identification arguments presented in section V.C.1. They consist of cross-sectional moments on employment, wage, health, and health insurance status across demographic groups; workers' labor market transitions; firm size; firm size distribution; and ESHI provisions.

VI. Estimation Results

A. *Parameter Estimates*

1. Parameters Estimated in the First Step

Tables 4 and 5 respectively report the step 1 parameter estimates for the medical expenditure processes as described by (16) and (17) and the health transition processes $\pi^x_{\chi\mathbf{hh}'}$. The estimated coefficients imply that unhealthy individuals and individuals with health insurance tend to be more likely to experience medical shocks. Moreover, conditional on experiencing medical shocks, the medical expenditure realizations for the unhealthy individuals and individuals with health insurance tend to have higher means and higher variances. Quantitatively, both the observed and the unobserved health components significantly impact the means and variances of medical expenditures.

In table 5, we report the parameter estimate for the transition matrix for the observed health component, by gender and health insurance status. For the most part, the parameter estimates for the health transitions are consistent with the notion that there is a significant health insurance effect

[65] We do not use the optimal weight matrix because of its potentially poor small-sample properties, as suggested by Altonji and Segal (1996).

TABLE 4

STEP 1 PARAMETER ESTIMATES FOR THE MEDICAL EXPENDITURE PROCESSES FOR ADULTS

PARAMETER	MALE Estimate	MALE Standard Error	FEMALE Estimate	FEMALE Standard Error	CHILDREN Parameter	CHILDREN Estimate	CHILDREN Standard Error
	A. Parameters in Equation (16)						
$\alpha_{m\chi}^{\tilde{h}_1,\tilde{x}}$:							
$\tilde{h}_1 = H_1, \tilde{x} = 1$	−1.3404	.0218	−.9179	.0156	$1(\tilde{x} = 1)$	−.8280	.4762
$\tilde{h}_1 = U_1, \tilde{x} = 1$	−1.6405	.0751	−.3487	.0336			
$\tilde{h}_1 = H_1, \tilde{x} = 0$	−2.5369	.0375	−2.0467	.0288	$1(\tilde{x} = 0)$	.0971	1.5698
$\tilde{h}_1 = U_1, \tilde{x} = 0$	−1.1457	.0261	−1.0000	.0346			
$\zeta_{1m\chi}$:							
$1(\tilde{h}_2 = U_2)$	1.9504	.0857	1.5498	.0483			
	B. Parameters in Equation (17)						
$\beta_{m\chi}^{\tilde{h}_1,\tilde{x}}$:							
$\tilde{h}_1 = H_1, \tilde{x} = 1$	−4.2380	.0197	−4.9455	.0103	$1(\tilde{x} = 1)$	−4.4614	.909
$\tilde{h}_1 = U_1, \tilde{x} = 1$	−3.6970	.0356	−5.3239	.013			
$\tilde{h}_1 = H_1, \tilde{x} = 0$	−5.4492	.0258	−6.2975	.0139	$1(\tilde{x} = 0)$	−4.5638	2.2295
$\tilde{h}_1 = U_1, \tilde{x} = 0$	−4.1777	.0258	−5.6968	.0235			
$\sigma_{\chi \mathbf{h}}^{\tilde{x}}$:							
$\tilde{h}_1 = H_1, \tilde{x} = 1$	1.7462	.0028	1.4918	.0033	$1(\tilde{x} = 1)$	1.8996	.3721
$\tilde{h}_1 = U_1, \tilde{x} = 1$	1.9167	.0015	1.9679	.0015			
$\tilde{h}_1 = H_1, \tilde{x} = 0$	1.9511	.0055	1.7363	.0047	$1(\tilde{x} = 0)$	2.0716	1.1646
$\tilde{h}_1 = U_1, \tilde{x} = 0$	1.5823	.0054	1.7712	.0133			
$\zeta_{2m\chi}$:							
$1(\tilde{h}_2 = U_2)$	1.5423	.0398	2.5641	.0143			
	C. Parameters in Equation (25)						
$\alpha_{s0\chi}$: constant	−1.4243	.0073	−1.2362	.0102			
$\alpha_{s1\chi}$: $1(h_{1t} = H_1)$	.2416	.0152	.7439	.0188			
$\alpha_{s2\chi}$: $1(\hat{x}_t = 1)$	2.5631	.0224	1.5718	.0189			
$\alpha_{s3\chi}$: $1(\hat{x}_t = 1 \wedge h_{1t} = H_1)$	−2.6907	.042	−1.1935	.0324			

NOTE.—See eqq. (16) and (17) for details of the medical expenditure processes. The unit of medical expenditure is $10,000.

TABLE 5
First-Step Parameter Estimate for the Health Transitions $\pi^{x}_{\chi h_1 h_1'}$, by Gender and Health Insurance Status

Parameter	Male Estimate	Male Standard Error	Female Estimate	Female Standard Error
	A. Health Transition Parameters in $\pi^{1}_{\chi h_1 h_1'}$			
$\pi^{1}_{\chi H_1 H_1}$	.9788	.0231	.9799	.0217
$\pi^{1}_{\chi U_1 U_1}$	.5696	.1671	.7142	.1813
	B. Health Transition Parameters in $\pi^{0}_{\chi h_1 h_1'}$			
$\pi^{0}_{\chi H_1 H_1}$	.9740	.0350	.9673	.0494
$\pi^{0}_{\chi U_1 U1}$	.7018	.2040	.7983	.1999

on the dynamics of the observable health component. Specifically, our estimates indicate that $\pi^{1}_{\chi H_1 H_1} > \pi^{0}_{\chi H_1 H_1}$, which implies that workers with health insurance are more likely to stay in the observable healthy component than those without health insurance. Similarly, we find that $\pi^{1}_{\chi U_1 U_1} < \pi^{0}_{\chi U_1 U_1}$, which implies that workers with health insurance are more likely to transition out of the observed unhealthy status to healthy.

It is useful to note that our estimates of the effect of health insurance on observed (self-reported) health are consistent with the experimental evidence found in Finkelstein et al. (2012), where they use the randomized control design in the allocation of Medicaid insurance to oversubscribers in Oregon in 2008. They found that 1 year after being randomly allocated, Medicaid insurance increases the probability that people self-report "good" or "excellent" health (compared with "fair" or "poor" health) by 25% and increases the probability of not screening positive for depression by 10%. The findings about the positive effect of insurance on self-reported physical and mental health persist after 2 years despite the finding in Baicker et al. (2013) that Medicaid has no statistically significant effect on measured blood pressure and cholesterol approximately 2 years after the experiment.[66]

2. Parameters Estimated in the Second Step

Table 6 reports the parameter estimates from step 2, which consist of $\theta_1 \equiv \langle \gamma_\chi, \mathfrak{b}_\chi, \lambda_u^{\chi\mathbf{h}}, \lambda_e^{\chi\mathbf{h}}, \delta^{\chi\mathbf{h}}, f_M^e(\chi, y), f_M^u(\chi), \sigma_{\chi II}, \xi_{II}, \sigma_{\chi w}, \underline{c}_\chi \rangle$ and $\theta_2 \equiv \langle d_{\chi\mathbf{h}}, C, M, \mu_p, \sigma_p, \sigma_f \rangle$. Panel A reports the parameters that are related to the labor market frictions. We find that the offer arrival rate for an unemployed worker $\lambda_u^{\chi\mathbf{h}}$ is 0.504 (=exp(0.016)/[1 + exp(0.016)]) for single men without children who are observably healthy. This estimate implies that it

[66] Also see Courtemanche and Zapata (2014) for similar evidence from Massachusetts health reform. Levy and Meltzer (2008) provide a comprehensive survey on the previous literature that examined the health effect of health insurance.

takes on average about 7.9 months for such an unemployed individual to receive an offer. However, we also find that there is a large heterogeneity of arrival rates. Specifically, we find that individuals whose observed health component is unhealthy or who are female tend to have much lower arrival rates of job offers; on the other hand, married individuals and individuals with children tend to have somewhat higher offer arrival rates while unemployed. We also find that the offer arrival rates for employed workers, $\lambda_e^{x\mathbf{h}}$, are about 0.20 for single men without children who are observably healthy. This implies that it takes on average about 19 months for such a currently employed worker to receive an outside offer.[67] We also find that the on-the-job offer arrival rate tends to be lower for workers whose observable health component is unhealthy or who are female and somewhat higher for married individuals and individuals with children. Also in panel A, our estimates for the probability of exogenous job destruction, $\delta^{x\mathbf{h}}$, imply that there is a 5.4% probability in a 4-month period for a job to be exogenously terminated for single men without children who are observably healthy. But we also find that unhealthy individuals have a higher job destruction rate, indicating that bad health significantly lowers a worker's ability to continue working the job. The exogenous job destruction rates are lower for females, the married, and those with children.

In panel B, we report our estimate of CARA coefficients γ_x. Note that we allow the risk aversion to vary only by gender. We estimate that the CARA coefficient is about 3.71E-4 (recalling that our unit is $10,000) for males and 4.88E-4 for females. Using the 4-month average wages for employed workers reported in table 1, which is about $10,610 for males and $8,050 for females, our estimated CARA coefficients imply relative risk aversions of about 3.50 for males and 6.06 for females. These are squarely in the range of estimates of CARA and relative risk-aversion coefficients in the literature (for a summary of such estimates, see Cohen and Einav 2007), and they are also consistent with the findings by others that women tend to be more risk averse than men in the Western economies (see, e.g., Barsky et al. [1997] for survey evidence and Levin, Snyder, and Chapman [1988] and Borghans et al. [2009] for experimental evidence that women are more risk averse than men).

[67] Dey and Flinn (2005) estimated that the mean wait between contacts for the unemployed is about 3.25 months, while a contact between a new potential employer and a currently employed individual occurs about every 19 months. The differences for the contact rate for the unemployed between our paper and Dey and Flinn (2005) could be because of the fact that a period is 4 months in our paper while it is 1 week in Dey and Flinn (2005). An unemployed individual in both the first month and the fifth month will be considered as being in a continuous unemployment spell, though at weekly frequency he could have been matched with some firms in between. This may lead us to a lower estimate for the contact rate for the unemployed. Another possibility is the differences in the sample selection: our sample includes only individuals with no more than high school degree, while Dey and Flinn's (2005) sample has at least a high school degree.

TABLE 6

Parameter Estimate from Step 2

Parameter	Estimate	Standard Error
	A. Labor Market Frictions	
Job offer arrival rate for unemployed $\lambda_u^{\chi\mathbf{h}}$ (eq. [18]):		
Constant: λ_{u0}	.016	.0041
$1(h_1 = U_1) : \lambda_{u1}$	−.200	.0097
1(Female): λ_{u2}	−.646	.0024
1(HasChildren): λ_{u3}	.018	.0021
1(Married): λ_{u4}	.033	.002
Job offer arrival rate for employed $\lambda_e^{\chi\mathbf{h}}$ (eq. [19]):		
Constant: λ_{e0}	−1.370	.0098
$1(h_1 = U_1) : \lambda_{e1}$	−.173	.0204
1(Female): λ_{e2}	−1.297	.0064
1(HasChildren): λ_{e3}	−.348	.003
1(Married): λ_{u4}	.102	.0041
Job destruction rate $\delta^{\chi\mathbf{h}}$ (eq. [20]):		
Constant: δ_0	−2.851	.0011
$1(h_1 = U_1)$: δ_1	.806	.0054
1(Female): δ_2	−.031	.0092
1(HasChildren): δ_3	−.101	.0032
1(Married): δ_4	−.698	.0052
	B. Risk-Aversion Parameters γ_χ (E-4)	
Male	3.708	.0292
Female	4.878	.0017
	C. Flow Consumption of Unemployed b_χ	
Single men	.017	.0022
Married men without children	.018	.0053
Married men with children	.017	.0026
Single women without children	.019	.001
Single women with children	.018	.0012
Married women without children	.022	.0009
Married women with children	.018	.0005
	D. Preference Shocks	
Standard deviation of preference shock to work: $\sigma_{\chi w}$	.165	.0011
Standard deviation of preference shock to private insurance: $\sigma_{\chi II}$	.002	.00002
	E. Firm-Side Parameters	
Productivity effect of bad health: d_{U_1}	.401	.0117
Location parameter of firm productivity distribution: μ_p	−.288	.0035
Scale parameter of firm productivity distribution: σ_p	.579	.0006
Mean of fixed cost of offering ESHI: C	.210	.1569
Smoothing parameter of the fixed cost of offering ESHI: σ_f	.150	.0029

TABLE 6 (*Continued*)

Parameter	Estimate	Standard Error
	F. Other Parameters	
Worker size: M	21.436	.2267
Loading factor in pre-ACA individual insurance market: ξ_{II}	.690	.0046
Consumption floor: $\underline{c}_\chi$	.005	.0022
Medicaid eligibility probability for the employed $f^e_M(\chi, y)$ (eq. [22]):		
1(HasChildren): α^e_{m0}	1.010	.0174
1(NoChildren): α^e_{m1}	−2.947	.7771
Income: α^e_{m2}	2.528	.0142
Income^2: α^e_{m3}	1.325	.0124
Medicaid eligibility probability for the unemployed $f^u_M(\chi)$ (eq. [23]):		
1(HasChildren): α^u_{m0}	1.391	.049
1(NoChildren): α^u_{m1}	−3.466	.1699

In panel C, we report our estimated values for the “monetary income” received while in unemployment $\mathfrak{b}_\chi$ for demographic group χ. We find that the magnitude of $\mathfrak{b}_\chi$ is small overall for all groups, and it ranges from \$170 to \$220 for 4 months. The relatively small estimates of $\mathfrak{b}_\chi$ suggests that a large fraction of the unemployment insurance benefits is probably expensed for job search or other psychological costs associated with being unemployed.

In panel D, we report our estimates of the standard deviations of the preference shocks to work, $\sigma_{\chi w}$, and the preference shocks to private insurance, $\sigma_{\chi II}$. Our estimates indicate that there is a substantial variation in the preference shock to work, while the standard deviation of the preference shock to purchase private insurance is much smaller.

In panel E, we report our estimates of the firm-side parameters. We find that there is substantial productivity loss for workers with unhealthy observable component: the productivity of an unhealthy worker (those who self-reported health as “poor” or “fair”), d_{U_1}, is about 0.40, which implies that there is a 60% productivity loss for unhealthy workers relative to healthy workers.[68] Moreover, we find that the mean of the administration cost for firms to offer ESHI, C, is about \$2,100 per 4 months—that is, about \$6,300 per year. The smoothing parameter of the fixed cost of offering ESHI, σ_f, as specified in (11), is estimated to be about \$1,500, which is of a similar magnitude as the estimate of C. We estimate that the scale and shape parameters of the lognormal productivity distribution are −0.288 and 0.579, respectively, which implies that the mean (4-month)

[68] There is a vast literature examining whether healthy workers have higher productivity using different methods and different data. Most papers share the findings that healthier individuals are more productive. For a thorough survey on the relationships between health and productivity, see Tompa (2002).

productivity of firms is about \$8,864. The fact that the mean accepted 4-month wages in our sample are on average \$9,530 (see table 1) is largely because of the fact that more productive firms attract more workers in the steady state, as our model implies. Our estimate of the loading factor in the individual insurance market is $\xi_{II} = 0.69$, which implies that the predicted medical loss ratio—the ratio of the claim cost over the premium—is about 0.60.[69]

Finally, in panel F we report the estimates of remaining parameters. To fit the average firm size, our estimate of M—the ratio between workers and firms—is about 21.44. This estimate is about the same as the average establishment size of 21.02 reported in table 3. Because of the preference shock to work that we introduced in our model, all firms in our model, regardless of their productivity, will attract some workers in equilibrium. Our estimate of the consumption floor $\underline{c}_X$ is very modest at about \$50 for 4 months.[70] We also estimate that for both the employed and the unemployed, individuals with children are more likely to be eligible for Medicaid; in addition, for the employed, individuals with lower income are more likely to be eligible for Medicaid.

B. *Within-Sample Goodness of Fit*

In this section, we examine the within-sample goodness of fit of our estimates by comparing the model predictions with their data counterparts. Tables 7 and 8 report the model fits for medical expenditure in the first step. Table 7 focuses on the cross-sectional fit for medical expenditures, for adults by gender and by observable health status and health insurance status, and for children by health insurance status. The table shows that our parameter estimates fit the data on the conditional means and variances very well; we also accurately replicate the fraction of individuals with zero medical expenditures conditional, both for adults and for children. Table 8 focuses on the within-individual dynamics of medical expenditures. For this exercise, we exploit the panel feature of MEPS data. For different combinations of observable health component and health insurance

[69] Quantitatively, this prediction is consistent with the finding in Cicala, Lieber, and Marone (2019) that the median medical loss ratio in the individual health insurance markets between 2005 and 2009 was close to 0.70. They also find that the median medical loss ratio threshold among states with some regulation was 0.65.

[70] The estimates of the consumption floor are clearly model specific and depend on what government programs are already included in the analysis. For example, De Nardi, French, and Jones (2010) estimate a consumption floor of \$2,663 (in 1998 dollars) per year in their life-cycle model of elderly savings, but they argue that this includes the value of the Medicaid coverage for the elderly. We explicitly include Medicaid in our analysis, so our estimate of the "consumption floor" for the uninsured is more narrowly focused on emergency care, e.g., and is thus lower. Similarly, French, Jones, and von Gaudecker (2017) argued that their estimate of the consumption floor likely captures the medically needy pathway for Medicaid, debt removal through bankruptcy, or debt forgiveness by hospitals.

TABLE 7
CROSS-SECTIONAL FIT FOR MEDICAL EXPENDITURE: MODEL VS. DATA

Observed Health/ Health Insurance	Mean of Expenditure		Variance of Expenditure		Fraction with Zero Expenditure	
	Data	Model	Data	Model	Data	Model
			A. Male			
$(h_1 = U_1, \hat{x} = 0)$	.174	.171	.352	.352	.337	.333
$(h_1 = U_1, \hat{x} = 1)$	1.093	1.117	11.707	11.707	.109	.108
$(h_1 = H_1, \hat{x} = 0)$	.048	.044	.091	.091	.608	.612
$(h_1 = H_1, \hat{x} = 1)$	.153	.155	.149	.149	.273	.276
			B. Female			
$(h_1 = U_1, \hat{x} = 0)$	.196	.198	.179	.179	.211	.209
$(h_1 = U_1, \hat{x} = 1)$	.860	.846	6.519	6.519	.023	.025
$(h_1 = H_1, \hat{x} = 0)$	.080	.073	.058	.058	.384	.391
$(h_1 = H_1, \hat{x} = 1)$	.286	.294	.515	.515	.107	.101
			C. Children			
$\hat{x} = 0$	.064	.064	.061	.061	.337	.337
$\hat{x} = 1$	.140	.140	.336	.336	.108	.108

NOTE.—The unit of medical expenditure is $10,000 at the annual level.

status in the 2-year panel, we present the model fit for the covariance of positive medical expenditure across the 2 years and the fraction of individuals with zero expenditure in both years. It is shown that we fit all the conditional moments well.[71]

Table 9 reports the fit for the annual transitions of the observable health component, by gender and health insurance status. Recall that in the SIPP data, the self-reported health is surveyed annually and the insurance status is surveyed every 4 months. For simplicity, in table 9 we show the model fit for individuals who were either continuously insured or continuously uninsured throughout the year. It shows that our model fits the data very well. For both males and females, it captured the pattern that insured workers are more likely to transition to be healthy (in the observed health component), but the effect of health insurance in improving health is much more pronounced for females than for males.

Tables 10 and 11 report the model fit for the worker-side moments. In table 10, we show that the model fits reasonably well the cross-sectional distribution of the employed (panel A) and the unemployed (panel B) by demographic types, observable health, and health insurance status; in table 11, we show that the model fits well the mean wages conditional on demographic types, observable health, and health insurance status.

[71] From the 12 potential health and health insurance combinations in the 2 years, we choose six targeted moments with sufficiently large sample size.

TABLE 8
Time Series Fit for Medical Expenditure: Model vs. Data

Observed Health/ Health Insurance in Years t and t'	Covariance of Medical Expenditure over 2 Years		Fraction of Zero Medical Expenditures over 2 Years	
	Data	Model	Data	Model
	A. Male			
$\begin{pmatrix} h_{1t} = U_1, \hat{x}_{1t} = 0 \\ h_{1t'} = U_1, \hat{x}_{2t'} = 0 \end{pmatrix}$	.050	.049	.211	.200
$\begin{pmatrix} h_{1t} = U_1, \hat{x}_{1t} = 0 \\ h_{1t'} = H_1, \hat{x}_{2t'} = 0 \end{pmatrix}$	.012	.014	.284	.306
$\begin{pmatrix} h_{1t} = U_1, \hat{x}_{1t} = 1 \\ h_{1t'} = H_1, \hat{x}_{2t'} = 1 \end{pmatrix}$	.161	.098	.057	.059
$\begin{pmatrix} h_{1t} = H_1, \hat{x}_{1t} = 0 \\ h_{1t'} = H_1, \hat{x}_{2t'} = 0 \end{pmatrix}$	.004	.004	.484	.475
$\begin{pmatrix} h_{1t} = H_1, \hat{x}_{1t} = 0 \\ h_{1t'} = H_1, \hat{x}_{2t'} = 1 \end{pmatrix}$	.015	.013	.270	.261
$\begin{pmatrix} h_{1t} = H_1, \hat{x}_{1t} = 1 \\ h_{1t'} = H_1, \hat{x}_{2t'} = 1 \end{pmatrix}$	.037	.041	.144	.147
	B. Female			
$\begin{pmatrix} h_{1t} = U_1, \hat{x}_{1t} = 0 \\ h_{1t'} = U_1, \hat{x}_{2t'} = 0 \end{pmatrix}$	.055	.049	.099	.104
$\begin{pmatrix} h_{1t} = U_1, \hat{x}_{1t} = 0 \\ h_{1t'} = H_1, \hat{x}_{2t'} = 0 \end{pmatrix}$	.014	.015	.167	.161
$\begin{pmatrix} h_{1t} = U_1, \hat{x}_{1t} = 1 \\ h_{1t'} = H_1, \hat{x}_{2t'} = 1 \end{pmatrix}$	.025	.057	.021	.015
$\begin{pmatrix} h_{1t} = H_1, \hat{x}_{1t} = 0 \\ h_{1t'} = H_1, \hat{x}_{2t'} = 0 \end{pmatrix}$	.003	.004	.248	.244
$\begin{pmatrix} h_{1t} = H_1, \hat{x}_{1t} = 0 \\ h_{1t'} = H_1, \hat{x}_{2t'} = 1 \end{pmatrix}$	.000	.010	.104	.102
$\begin{pmatrix} h_{1t} = H_1, \hat{x}_{1t} = 1 \\ h_{1t'} = H_1, \hat{x}_{2t'} = 1 \end{pmatrix}$	.046	.029	.035	.043

Note.—The unit of medical expenditure is \$10,000 at the annual level.

In table 12, we report the model fit for the one-period transition of workers' labor market transitions, by their observed health status. Although the fit is not perfect, in general the model is able to explain the significant effect of health status on labor market transitions. Our model overpredicts the probability that an employed worker with unhealthy observed health component transitions from a job with ESHI to unemployment, and the model underpredicts the probability that an unhealthy employed worker transitions from a job without ESHI to another job without ESHI.

TABLE 9
FIT FOR ANNUAL HEALTH TRANSITIONS OF OBSERVED HEALTH COMPONENT BY GENDER AND INSURANCE STATUS: MODEL VS. DATA

	MALE		FEMALE	
	Data	Model	Data	Model
	A. Insured throughout the Year			
Healthy to healthy	.963	.938	.956	.941
Unhealthy to unhealthy	.172	.185	.386	.364
	B. Uninsured throughout the Year			
Healthy to healthy	.949	.924	.943	.905
Unhealthy to unhealthy	.222	.346	.556	.509

In table 13, we compare the model's predictions of the targeted employer-side moments listed in appendix E with those in the data. In general, our model fits reasonably well on average, including mean firm size, fraction of firms with fewer than 50 workers, and health insurance coverage rate by firm size. Our model captures the pattern that larger firms are more likely to offer ESHI, as consistent with the data: our model predicts that the ESHI offering rate for firms with fewer than 10 workers is about 44.6% but will rise to 93.5% for firms with more than 50 workers. However, our model underpredicts the ESHI offering rates for firms with 10–30 and 30–50 workers.

Finally, it is useful to point out that, in a sense to be described below, our model also predicts well the distribution of unobserved health components in the population. Note that in the MEPS data, the unobserved health components are recovered as a function of the individuals' combination of observed health components and health insurance status over the 2 years at the annual frequency, but in our model the steady-state distribution of the unobserved health components are defined over the 4-month model period. For this reason, we cannot directly compare the distribution of the unobserved health component in the steady state of the model with the distribution of the unobserved health components recovered from the MEPS. Instead, we examine the model's implication on medical expenditure in the steady-state equilibrium, which is untargeted in our second-step estimation.[72] Because the unobserved health components affect the medical expenditure, the model should be able to predict well the average medical expenditure as long as it generates the selection patterns consistent with the data. Table 14 compares the mean medical expenditure in the model with the mean medical expenditure in the MEPS data. It shows that the model prediction matches the data reasonably well.

[72] This validation approach is very similar to Low and Pistaferri (2015), who also estimate their model in two steps.

VII. Mechanisms

By using the model estimates, we now shed light on how our model can generate the positive correlations among wage, health insurance, and firm size that we discussed in the introduction. In table 15, we use the estimates from section VI to shed light on the detailed mechanisms for why in our model more productive firms have stronger incentives to offer health insurance than less productive firms. For this purpose, we simulate the health composition of the workforce for the firms with the bottom 20% and the top 20% of productivity in our discretized (with 150 grid points) productivity distribution.

Row 1 in panel A of table 15 shows that, in the steady state, the fraction of unhealthy workers based on the observed health in low- and high-productivity firms that offer ESHI is 5.58% and 5.11%, respectively; in contrast, the fraction of unhealthy workers in low- and high-productivity firms that do not offer ESHI is 7.03% and 5.70%, respectively.[73] Thus, high-productivity firms tend to have more observably healthy workers, regardless of whether they provide health insurance. This arises in our model partly because observably healthy workers, both employed and unemployed, receive offers at a higher probability than unhealthy workers, and thus they are more likely to climb the job ladder toward high-productivity firms. In contrast, in row 2 we observe a substantial degree of adverse selection on the unobserved component of the health: for any level of firm productivity, the fraction of workers who are unhealthy in the unobservable health component is higher if a firm offers ESHI than if it does not, though the difference is much more modest for high-productivity firms. This result occurs because in our model we do not allow firms to post wage offers conditional on their unobservable health component and because the unobservable health component is a permanent health type. In panels B–D, we disentangle the advantage of high-productivity relative to low-productivity firms in offering health insurance into three components: (1) the adverse selection effect among new hires, (2) the health improvement effect of health insurance, and (3) the retention effect.

In panel B (row 3), we illustrate that the adverse selection from offering health insurance in terms of the fraction of unhealthy on the unobserved health component among the new hires is less severe for high-productivity firms than for low-productivity firms. Specifically, we show that in the low-productivity firms, the fraction of unobservably unhealthy among the new hires—including those hired directly from the unemployment pool and those poached from other firms (i.e., job-to-job switchers)—is 45.30% if they offer health insurance and 42.40% if they do not; in contrast, in

[73] The same patterns hold conditional on the demographic type χ. They are available upon request from the authors.

the high-productivity firms the fraction of unhealthy is 39.53% if they offer health insurance, which is virtually identical to the case of if they do not offer health insurance (40.32%).[74] Thus, the new hires attracted to low-productivity firms that offer health insurance are indeed somewhat unhealthier, which is a manifestation of adverse selection, but importantly, the new hires to high-productivity firms are significantly healthier than those to the low-productivity firms. This reflects the following facts: high-productivity firms offering health insurance can at the same time offer higher wages; in contrast, low-productivity firms can offer only low wages if they were to offer health insurance. As a result, high-productivity firms can poach a larger fraction of healthy workers from a much wider range of firms. Note that in this model the initial selection based on the observed health component is not a crucial source of adverse selection because firms are allowed to condition their wage offers on workers' observed health component.

In panel C, we show that the adverse selection effect that a firm offering health insurance suffers in terms of the unobserved health component of their new hires can be mitigated by the positive effect of health insurance on the improvement of the observed health component. In row 5, we show that if those new hires stay at the same firms for nine periods (3 years), those hired at firms offering ESHI would be significantly healthier than those in firms not offering ESHI. Then, in panel D we show that the positive effect of health insurance on health, which leads to increased productivity of the workers, is better captured by high-productivity firms.[75] It shows that the job-to-job transition rate for workers in high-productivity firms, regardless of their health status, is significantly lower than that in low-productivity firms. Thus in our model, high-productivity firms enjoy several advantages in offering health insurance to their workers relative to low-productivity firms: first, they face a less severe adverse selection problem among the new hires; second, they are more likely to retain their workers, as their observable health component is improved by insurance, which allows them to capture the increased productivity from the health improvement effect of health insurance as well as the reduction in the expected health care cost.

[74] Using estimates in panel C of table 4, we can calculate the fraction with the unhealthy unobserved component in the population to be about 48.46%, which is much higher than the fraction with the unhealthy observed component in the population, which is 7.7% (see panel B of table 1).

[75] Note that if the arrival rate of job offer for the employed for the healthy individuals is significantly higher than for healthy individuals, then having more healthy individuals may lead to the higher turnover. However, this effect will work mainly for the low-productivity firms, as workers in high-productivity firms are less likely to find a better job.

TABLE 10
CROSS-SECTIONAL DISTRIBUTION OF THE EMPLOYED AND THE UNEMPLOYED BY DEMOGRAPHIC TYPES, OBSERVED HEALTH, AND HEALTH INSURANCE STATUS: MODEL VS. DATA

DEMOGRAPHIC TYPE/ OBSERVED HEALTH	UNINSURED		ESHI		INDIVIDUAL PRIVATE HEALTH INSURANCE		MEDICAID		SPOUSAL INSURANCE	
	Data	Model	Data	Model	Data	Model	Data	Model	Data	Model
	A. Employed Individuals									
Single men:										
Healthy	.061	.056	.110	.110	.004	.008	.004	.000		
Unhealthy	.005	.001	.007	.006	.000	.003	.001	.000		
Married men without child:										
Healthy	.010	.007	.029	.035	.001	.001	.001	.000	.008	.005
Unhealthy	.000	.000	.003	.002	.000	.000	.000	.000	.000	.000
Married men with child:										
Healthy	.066	.037	.164	.188	.004	.004	.010	.007	.032	.031
Unhealthy	.004	.001	.008	.009	.000	.001	.002	.000	.004	.002
Single women without child:										
Healthy	.013	.016	.039	.030	.001	.004	.002	.000		
Unhealthy	.002	.002	.004	.002	.000	.001	.000	.000		
Single women with child:										
Healthy	.023	.027	.052	.054	.001	.005	.019	.008		
Unhealthy	.002	.003	.005	.004	.000	.001	.002	.001		
Married women without child:										
Healthy	.005	.005	.027	.027	.001	.001	.000	.000	.011	.008
Unhealthy	.000	.000	.001	.002	.000	.000	.000	.000	.000	.001
Married women with child:										
Healthy	.024	.021	.080	.117	.005	.004	.006	.006	.059	.040
Unhealthy	.003	.002	.003	.008	.000	.001	.002	.001	.003	.003
	B. Unemployed Individuals									
Single men:										
Healthy	.008	.017			.000	.000	.001	.001		
Unhealthy	.002	.001			.000	.000	.000	.000		
Married men without child:										
Healthy	.002	.001			.000	.000	.000	.000	.001	.001
Unhealthy	.001	.000			.000	.000	.000	.000	.000	.000
Married men with child:										
Healthy	.003	.002			.000	.000	.001	.006	.001	.005
Unhealthy	.001	.000			.000	.000	.002	.000	.001	.000
Single women without child:										
Healthy	.002	.008			.000	.000	.001	.000		
Unhealthy	.001	.001			.000	.000	.001	.000		
Single women with child:										
Healthy	.004	.003			.000	.000	.006	.012		
Unhealthy	.000	.000			.000	.000	.002	.001		

TABLE 10 (*Continued*)

Demographic Type/ Observed Health	Uninsured		ESHI		Individual Private Health Insurance		Medicaid		Spousal Insurance	
	Data	Model	Data	Model	Data	Model	Data	Model	Data	Model
Married women without child:										
Healthy	.001	.001			.000	.000	.001	.000	.002	.002
Unhealthy	.000	.000			.000	.000	.000	.000	.000	.000
Married women with child:										
Healthy	.007	.001			.000	.000	.002	.005	.011	.008
Unhealthy	.000	.000			.000	.000	.001	.001	.001	.001

TABLE 11
Cross-Sectional Wage Distribution by Demographic Types and Health Insurance Status: Model vs. Data

Demographic Type/Observed Health	Uninsured		ESHI		Individual Private Health Insurance		Medicaid		Spousal Insurance	
	Data	Model	Data	Model	Data	Model	Data	Model	Data	Model
Single men:										
Healthy	.785	.770	1.082	1.076	.939	.979	.566	.607	NA	NA
Unhealthy	.746	.729	1.000	1.036	.856	.793	.813	.571	NA	NA
Married men without child:										
Healthy	.756	.823	1.247	1.177	1.061	1.026	.568	.632	1.105	.850
Unhealthy	1.065	.759	1.047	1.155	NA	.867	.823	.595	1.698	.826
Married men with child:										
Healthy	.844	.846	1.245	1.159	1.170	1.098	.804	.664	1.168	.841
Unhealthy	.920	.766	1.244	1.144	NA	.936	.745	.643	1.075	.825
Single women without child:										
Healthy	.598	.719	.920	.921	.446	.785	.528	.580	NA	NA
Unhealthy	.604	.718	.692	.872	.608	.710	.356	.557	NA	NA
Single women with child:										
Healthy	.541	.736	.915	.936	.403	.905	.547	.606	NA	NA
Unhealthy	.429	.750	.765	.907	NA	.791	.481	.596	NA	NA
Married women without child:										
Healthy	.641	.754	.970	.989	.878	.829	.351	.598	.891	.768
Unhealthy	.406	.747	.886	.963	.486	.761	NA	.574	.237	.749
Married women with child:										
Healthy	.551	.770	.993	.969	.873	.892	.460	.623	.757	.758
Unhealthy	.615	.774	.874	.950	.522	.811	.403	.610	.706	.749

Note.—The unit of wage is $10,000 at the 4-month level. NA = not applicable.

TABLE 12
Workers' Labor Market Transitions by Observed Health Status: Model vs. Data

Observed Health	Data	Model
	A. Unemployment-to-Employment Transition	
Healthy	.48	.41
Unhealthy	.38	.34
	B. Employment-to-Unemployment Transition	
From jobs without ESHI to unemployment:		
Healthy	.03	.04
Unhealthy	.10	.08
From jobs with ESHI to unemployment:		
Healthy	.01	.03
Unhealthy	.01	.07
	C. Job-to-Job Transition	
From jobs without ESHI to jobs with ESHI:		
Healthy	.07	.02
Unhealthy	.01	.02
From jobs without ESHI to jobs without ESHI:		
Healthy	.07	.02
Unhealthy	.09	.01
From jobs with ESHI to jobs with ESHI:		
Healthy	.01	.01
Unhealthy	.00	.01
From jobs with ESHI to jobs without ESHI:		
Healthy	.05	.01
Unhealthy	.04	.01

In appendix F, we provide further assessments to show how other features of the model determine the relationship between wage, health insurance provision, and firm size. We investigate the effects of the fixed administrative cost of offering ESHI, health insurance effect on health, risk aversion, effects of health on productivity, labor market frictions, and adverse selection by conducting numerical comparative statics. We show that each of them has a meaningful and differentiated impact on a firm's incentive to offer ESHI.

VIII. Counterfactual Experiments

In this section, we use our estimated model to examine the impact of the ACA, its key components, and various alternative policy designs. For the ACA, we consider a stylized version that incorporates its main components as mentioned in the introduction: first, all individuals are required to have health insurance or must pay a penalty; second, all firms with more than

TABLE 13

EMPLOYER-SIDE MOMENTS: MODEL VS. DATA

	Data	Model
Average firm size	21.020	20.748
Fraction of firms with fewer than 50 workers	.929	.903
ESHI offering rate for firms with fewer than 10 workers	.467	.446
ESHI offering rate for firms with 10–30 workers	.744	.452
ESHI offering rate for firms with 30–50 workers	.862	.678
ESHI offering rate for firms with more than 50 workers	.934	.935

TABLE 14

MEAN 4-MONTH MEDICAL EXPENDITURE: MODEL (PREDICTED IN THE STEADY-STATE EQUILIBRIUM) VS. DATA (MEPS)

	Data	Model
All population	.074	.072
Male only	.054	.063
Female only	.092	.096

NOTE.—The unit of medical expenditure is $10,000 at the 4-month level.

TABLE 15

UNDERSTANDING WHY HIGH-PRODUCTIVITY FIRMS ARE MORE LIKELY TO OFFER HEALTH INSURANCE THAN LOW-PRODUCTIVITY FIRMS

	Low-Productivity Firms		High-Productivity Firms	
STATISTICS	ESHI	No ESHI	ESHI	No ESHI
	A. Steady-State Distribution of Health Status			
Fraction observed unhealthy in steady state	.0558	.0703	.0511	.0570
Fraction unobserved unhealthy in steady state	.5061	.4557	.4074	.3920
	B. Adverse Selection Effect			
Fraction of unobserved unhealthy among new hires	.4530	.4240	.3953	.4032
	C. Health Improvement of Health Insurance (Observed Health Status)			
One-period-ahead fraction of unhealthy among new hires	.0576	.0629	.0543	.0570
Nine-period-ahead fraction of unhealthy among new hires	.0536	.0786	.0518	.0638
	D. Retention Effect			
Job-to-job transition rate for observed healthy workers	.01884	.02038	.00021	.00039
Job-to-job transition rate for observed unhealthy workers	.00081	.01512	.00001	.00057

NOTE.—For the simulations reported in this table, the low- and high-productivity firms are the firms with the bottom 20% and top 20% of productivity in our discretized productivity distribution support.

50 workers are required to offer health insurance or must pay a penalty; third, we consider that the individual health insurance market is replaced by a health insurance exchange where individuals can purchase health insurance at a community-rated premium; fourth, the participants in the health insurance exchange can obtain income-based subsidies; fifth, individuals whose income is below 138% of the FPL are eligible for Medicaid regardless of their demographic status. Note that the ACA's Medicaid expansion is state specific and about 30 states expanded Medicaid in 2014, although in our analysis we consider it as the national expansion. In section VIII.C.2, we argue that the main qualitative findings will remain valid when Medicaid is only partially expanded.

The introduction of health insurance exchange represents a substantial departure from our benchmark model because the premium in the health insurance exchange needs to be endogenously determined in equilibrium. As a result, we will first describe how we extend and analyze our benchmark model to incorporate the health insurance exchange.

A. *Model for the Counterfactual Experiments*

We provide a brief explanation of the main changes in the economic environment for the model used in our counterfactual experiments. First, an introduction of individual mandate and premium subsidies changes the budget constraint of individuals; as a result, the expected flow utility $v_{\chi\mathbf{h}}(y, x)$ in the counterfactual differs from (4) in the benchmark and is now defined as

$$v_{\chi\mathbf{h}}(y, x) = \begin{cases} \mathrm{E}_{\tilde{m}^0_{\chi\mathbf{h}}} u_\chi(\max\{T(y) - \tilde{m}^0_{\chi\mathbf{h}}, \underline{c}_\chi\} - P_W(y)) & \text{if } x = 0, \\ u_\chi(T(y, \chi)) & \text{if } x \in \{1, 3\}, \\ u_\chi(T(y, \chi) + SUB(y, R^{EX}) - R^{EX}) & \text{if } x = 2, \\ u_\chi(T(y - R^{SP}, \chi)) & \text{if } x = 4, \end{cases} \tag{29}$$

where $x = 2$ now indicates health insurance obtained from the health insurance exchange in place of the private individual insurance market in the benchmark; $P_W(y)$ denotes the penalty to individuals who remain uninsured under the ACA, which depends on income level and will be parameterized below in (35) for the ACA; and $SUB(y, R^{EX})$ denotes income-based subsidies to an individual with income y who purchases health insurance from the exchange, where R^{EX} is the premium in the exchange determined in (32) below, which because of community-rating regulations does not depend on health status $\mathbf{h}$ or gender; and R^{SP} is the spousal insurance premium (to be determined in equilibrium, as described in [34] below). With this modification, the individual optimization problem can be characterized and solved as in the benchmark model.

The introduction of an employer mandate penalty, however, makes a firm's problem much more complicated. Firms with more than 50 workers now face a penalty if they do not offer health insurance. Let $P_E(n)$ denote the amount of the penalty, which depends on the firm size n. We parameterize $P_E(n)$ in (36) for the employer mandate penalty under the ACA. The firm's profit maximization problem will now change to

$$\max\left\{\Pi_0(p), \Pi_1(p) - \sigma_f \epsilon\right\},$$

where

$$\begin{aligned}\Pi_0(p) &= \max_{\left\{w_H^0, w_U^0\right\}} \Pi(w_H^0, w_U^0, E = 0) \\ &\equiv \sum_{\chi} \sum_{h_1^0 \in \mathcal{H}_1} \sum_{\mathbf{h} \in \mathcal{H}} \left(pd_{\chi\mathbf{h}} - w_{h_1^0}^0\right) n_{\chi\mathbf{h}}\left(w_{h_1^0}^0, 0\right) - P_E\left(n\left(\mathbf{w}_{h_1^0}^0, 0\right)\right),\end{aligned} \tag{30}$$

$$\begin{aligned}\Pi_1(p) &= \max_{\left\{w_H^1, w_U^1\right\}} \Pi\left(w_H^1, w_U^1, E = 1\right) \\ &\equiv \sum_{\chi} \sum_{h_1^0 \in \mathcal{H}_1} \sum_{\mathbf{h} \in \mathcal{H}} \left[\left(pd_{\chi\mathbf{h}} - w_{h_1^0}^1 - m_{\chi\mathbf{h}}^1\right) n_{\chi\mathbf{h}}\left(\mathbf{w}_{h_1^0}^1, 1\right)\right] - C,\end{aligned} \tag{31}$$

where $n(\mathbf{w}_{h_1^0}^0, 0) = \sum_{\chi} \sum_{h_1^0 \in \mathcal{H}_1} \sum_{\mathbf{h} \in \mathcal{H}} n_{\chi\mathbf{h}}(w_{h_1^0}^0, 0)$ denotes the total number of workers in the steady state for a firm that offers contract $(\mathbf{w}_{h_1^0}^0, 0)$ and the term $P_E(n(\mathbf{w}_{h_1^0}^0, 0))$ in the expression for $\Pi_0(p)$ denotes the penalty to employers for not offering ESHI to their workers.

The premium in the insurance exchange, R^{EX}, is determined on the basis of the average medical expenditures of all participants in the health insurance exchange, multiplied by $1 + \xi_{EX}$, where $\xi_{EX} > 0$ is the loading factor for health insurance exchange; specifically,

$$R^{EX} = (1 + \xi_{EX}) \frac{\sum_{\chi} \sum_{\mathbf{h} \in \mathcal{H}} m_{\chi\mathbf{h}}^2 \left[u_{\chi\mathbf{h}}(2) + \int e_{\chi\mathbf{h}}^2 s_{\chi\mathbf{h}}^2(w)\, dw\right]}{\sum_{\chi} \sum_{\mathbf{h} \in \mathcal{H}} \left[u_{\chi\mathbf{h}}(2) + \int e_{\chi\mathbf{h}}^2 s_{\chi\mathbf{h}}^2(w)\, dw\right]}, \tag{32}$$

where $m_{\chi\mathbf{h}}^2$ denotes the expected medical expenditure of a type χ individual with health status $\mathbf{h}$ for individuals with insurances purchased from the exchange.

Importantly, in our counterfactual experiments, we recognize that the changes in the firms' ESHI offering decisions will affect the availability and the premium of the spousal health insurance option. Specifically, as in the benchmark economy, we let the probability of being offered spousal health insurance for a married male (respectively, female) be equal to the proportion of the married female (respectively, male) being offered ESHI—that is, for each χ_g—which is either a married male or a married female,

$$f_{SP}(\chi_g) = \frac{\sum_{\chi=\chi_{g'}} \sum_{\mathbf{h}\in\mathcal{H}} \int e^1_{\chi\mathbf{h}} s^1_{\chi\mathbf{h}}(w)\, dw}{\sum_x \sum_{\chi=\chi_{g'}} \sum_{\mathbf{h}\in\mathcal{H}} \left[u_{\chi\mathbf{h}}(x) + \int e^x_{\chi\mathbf{h}} s^x_{\chi\mathbf{h}}(w)\, dw \right]}, \tag{33}$$

where $\chi_{g'}$ denotes married individuals of opposite gender. In (33), the numerator is the measure of workers of type $\chi_{g'}$ who have their own ESHI ($x = 1$), and the denominator is the total measure of type $\chi_{g'}$ workers in the economy. In addition, the spousal insurance premium is equated to the average medical expenditure of the individuals with spousal health insurance, given by

$$R^{SP} = \frac{\sum_\chi \sum_{\mathbf{h}\in\mathcal{H}} m^4_{\chi\mathbf{h}} \left[u_{\chi\mathbf{h}}(4) + \int e^4_{\chi\mathbf{h}} s^4_{\chi\mathbf{h}}(w)\, dw \right]}{\sum_\chi \sum_{\mathbf{h}\in\mathcal{H}} \left[u_{\chi\mathbf{h}}(4) + \int e^4_{\chi\mathbf{h}} s^4_{\chi\mathbf{h}}(w)\, dw \right]}. \tag{34}$$

The steady-state equilibrium for the postreform economy can be defined analogous to that for our benchmark model in section III.C.4 and is provided in appendix G.

Numerical algorithm to solve the equilibrium.—We use numerical methods to solve the equilibrium. The basic iteration procedure to solve the equilibrium for the counterfactual environment remains the same as the one used to solve the benchmark model, but an important change is that now we need to find the fixed point of not only $(\mathbf{w}^{*0}_{h^0_1}(p), \mathbf{w}^{*1}_{h^0_1}(p), \Delta(p))$ but also R^{EX}, R^{SP}, and $f_{SP}(\chi_g)$, the premiums in insurance exchange, the premium for spousal insurance, and the offer probability of spousal insurance, respectively. A technical complication is that the size-dependent employer mandate may lead to the presence of a mass point in the wage offer distribution: firms not offering ESHI may not want to hire slightly more than 50 workers to avoid paying the employer-mandate penalty $P_E(n)$. In appendix G, we discuss how we can address this issue numerically to solve for the equilibrium in this environment.

B. *Parameterization of the Counterfactual Policies*

Before we conduct counterfactual experiments to evaluate the effect of ACA and its components, we need to address several issues regarding how to introduce the specifics of the ACA provisions into our model, such as the penalties associated with the individual and employer mandates and the premium subsidies. First, we estimated our model using data sets in 2004–7, while the ACA policy parameters were chosen to suit the economy in 2011. However, the US health care sector has a very different growth rate than that of the overall GDP; in particular, there have been substantial increases in medical care costs relative to GDP. Thus, we need to appropriately adjust the policy parameters in the ACA to make them more in line with the US economy around 2007. Second, the amount of penalties and subsidies are defined as annual level, while our model period is 4 months. We simply divide all monetary units in the ACA by three to obtain the applicable number for a 4-month period. Third, we need to decide on the magnitude of the loading factor ξ_{EX} that appeared in (32) that is applicable in the insurance exchange. We calibrate ξ_{EX} based on the ACA requirement that all insurance sold in the exchange must satisfy the ACA regulation that the medical loss ratio must be at least 80%. This implies that $\xi_{EX} = 0.25$, which is lower than our estimate about pre-ACA individual insurance loading factor $\xi_{II} = 0.69$.[76]

Below we present the ACA provisions for penalties associated with the individual and employer mandates and the income-based premium subsidies. In appendix H, we describe how we translate the ACA provisions for 2011 into applicable formulas for our 2007 economy.

Penalties associated with individual mandate.—The exact stipulation of the penalty in the ACA if an individual does not show proof of insurance (from 2016 onward, when the law is fully implemented) is that individuals without health insurance coverage pay a tax penalty of the greater of \$695 per year or 2.5% of the taxable income above the tax filing threshold (TFT), which can be written as

$$P_W^{ACA}(y) = \max\{0.025 \times (y - \text{TFT\_2011}), \$695\}, \tag{35}$$

where y denotes annual income.

Penalties associated with employer mandate.—The ACA stipulates that employers with 50 or more full-time employees that do not offer health insurance coverage will be assessed each year a penalty of \$2,000 per full-time employee, excluding the first 30 employees from the assessment. That is,

$$P_E^{ACA}(n) = \begin{cases} (n - 30) \times \$2{,}000 & \text{if } n \geq 50, \\ 0 & \text{otherwise.} \end{cases} \tag{36}$$

Income-based premium subsidies.—The ACA stipulates that premium subsidies for purchasing health insurance from the exchange are available if an individual's income is less than 400% of the FPL, denoted by FPL400.[77]

[76] 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. The medical loss ratio implied by (32) is simply $1/(1 + \xi_{EX})$; thus, an 80% medical loss ratio corresponds to $\xi_{EX} = 0.25$. The ACA requires that $\xi_{EX} \leq 0.25$.

[77] We assume that the FPL is defined as single person. In 2007, it is \$10,210 annually.

The premium subsidies are 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 at 138% of the FPL, denoted by FPL138, premium subsidies will be provided so that the individual's contribution to the premium is equal to 3.5% of his or her income; when an individual's income is at FPL400, his premium contribution is set to be 9.5% of the income. When his or her income is below FPL138, he or she will receive insurance with zero premium contribution through Medicaid. If his or her income is above FPL400, he or she is no longer eligible for premium subsidies. Note that the premium subsidy rule as described in the ACA creates a discontinuity at FPL138: individuals with income below FPL138 receive free Medicaid, but those at or slightly above FPL138 have to contribute at least 3.5% of their income to health insurance purchase from the exchange. To avoid this discontinuity issue, we instead adopt a slightly modified premium support formula as follows:

$$
\begin{aligned}
& SUB^{ACA}(y, R^{EX}) \\
&= \begin{cases} \max\left\{ \begin{aligned} R^{EX} - \Bigg[& 0.035\Phi\left(\frac{y - \text{FPL140}}{\sigma_{SUB}}\right) \\ & + 0.06\frac{(y - \text{FPL138})}{\text{FPL400} - \text{FPL138}}\Bigg] y,\ 0 \end{aligned} \right\} & \text{if } y \in (\text{FPL138}, \text{FPL400}), \\ 0 & \text{otherwise}, \end{cases}
\end{aligned} \tag{37}
$$

where y denotes the annual income and R^{EX} denotes the annual premium for health insurance in the exchange. According to (37), the individual contribution to insurance premium will be close to zero when his or her income is close to 138% of the FPL, similar to those who receive free Medicaid, as long as the smoothing parameter σ_{SUB} is small.[78] Subsequently, as income rises, the individual's maximum premium contribution increases toward 3.5% quickly, and then the individual contribution to insurance premium increases up to 9.5% when his or her income is at 400% of the FPL.

Finally, we capture the Medicaid expansion under the ACA to modify the Medicaid eligibility probabilities for the employed and the unemployed to be as follows:

$$
\begin{aligned}
f_M^{e,ACA}(\chi, y) &= 1 \text{ if } y \leq \text{FPL138}, \\
f_M^{u,ACA}(\chi) &= 1.
\end{aligned}
$$

[78] Note that in (37), 0.035 is multiplied by $\Phi((y - \text{FPL140})/\sigma_{SUB})$, which will be close to zero when y is close to FPL138 and σ_{SUB} is sufficiently small. We need to set σ_{SUB} to ensure that it will not create convexity to the firm's problem. Eventually, we chose $\sigma_{SUB} = 0.01$, but we find that our main results are robust for a range of reasonable choices of σ_{SUB}. One can also specify the subsidies as the polynomial function of premium and income.

That is, the employed will be eligible for Medicaid if their income is below FPL138, and all the unemployed are eligible for Medicaid with probability one.[79]

C. *Results from Counterfactual Experiments*

In this section, we report results from several counterfactual experiments.[80] First, we report results from the steady-state equilibrium when the ACA is fully implemented. We note that, even though components of the ACA were implemented from 2014, the full version of the ACA was never fully implemented, and it is unlikely that the early impact of the ACA would completely resemble the steady-state results of the ACA. We also compare our model's steady-state prediction with the ACA's early impact. Second, we evaluate several reform proposals to the ACA. In particular, we evaluate "ACA without individual mandate" and "ACA without the employer mandate." "ACA without individual mandate" is an important variation of the ACA because the individual mandate of the ACA was repealed by the Tax Cuts and Jobs Act of 2017, even though the full ACA was not. "ACA without the employer mandate" is important because the employer mandate has been, and likely will be again, challenged in court. Third, we conduct a series of additional counterfactual experiments to understand the effects of the various components of the ACA. In the last two counterfactual experiments, we consider the role of the ESHI itself and the role of the tax exemption of ESHI premiums in the US health insurance system.

1. Evaluating the Full Implementation of the ACA

One of the main goals for the ACA is to reduce the fraction of the US population that does not have insurance (i.e., the uninsured rate). In columns 1 and 2 in table 16, we respectively report results from the pre-ACA economy (which we refer to as the benchmark economy) and the ACA. For ease of reading table 16, we divide the statistics into two subgroups. The first subgroup is referred to as the "key labor market statistics," including ESHI offering rates, unemployment rate, and average wages, and the second subgroup is the distribution of the population in different health insurance categories; the third group reports the equilibrium premium in the health insurance exchange.

Benchmark.—In column 1, we show that the steady state of our estimated benchmark economy—that is, the pre-ACA environment—exhibits the

[79] We will also analyze the partial Medicaid expansion in sec. VIII.C.2.

[80] We focus on reporting the results related to the uninsured rate, welfare, and government budget balances. Additional results on the effect of the ACA and its variations on other interesting statistics, such as overall productivity, average health, wage, firm size distribution, health expenditures, etc., are available upon request.

TABLE 16
COUNTERFACTUAL POLICY EXPERIMENTS: KEY STATISTICS UNDER THE BENCHMARK MODEL, THE ACA, AND OTHER HEALTH CARE REFORM PROPOSALS

	Benchmark (1)	ACA (2)	ACA without Individual Mandate (3)	ACA without Employer Mandate (4)	ACA without Premium Subsidy (5)
A. Labor market statistics:					
Fraction of firms offering ESHI	.525	.459	.419	.438	.564
(If firm size is at least 50)	.935	.989	.965	.918	.998
(If firm size is fewer than 50)	.480	.400	.357	.383	.515
Unemployment rate	.079	.079	.079	.079	.078
Average wages of the employed	.989	.992	.997	.995	.969
(Among firms offering ESHI)	1.070	1.110	1.126	1.109	1.045
(Among firms not offering ESHI)	.798	.766	.798	.797	.701
B. Distribution of health insurance status:					
Uninsured	.213	.066	.114	.075	.157
ESHI	.595	.580	.536	.555	.681
Individual insurance	.034	.112	.098	.121	.000
Medicaid	.050	.099	.102	.101	.037
Spousal insurance	.108	.143	.150	.147	.125
Premium in exchange ($10,000)	NA	.150	.175	.151	.419
C. Worker's utility, firm profit, and government expenditure and revenues ($10,000):					
Average worker utility (consumption equivalent)	.597	.611	.610	.610	.602
Average firm profit	.572	.579	.577	.578	.580
Average tax subsidies to ESHI	.021	.020	.018	.019	.023
Average exchange/Medicaid subsidies	.005	.021	.022	.021	.004
Revenue from penalties	.000	.001	.0002	.002	.003

NOTE.—Panel C values are per capita and expressed at the 4-month level. NA = not applicable.

patterns we discuss in the introduction. It shows that 93.5% of the firms with more than 50 workers offer ESHI to their workers, in contrast to 48.0% of the firms with fewer than 50 workers. Overall, 52.5% of the firms will offer ESHI to their workers. The average 4-month wage of the employed workers working in firms offering ESHI is about $10,700, while that for workers in firms not offering ESHI is $7,980. The steady-state unemployment rate is 7.9%. It also shows that the uninsured rate among the population we study is about 21.3% overall; the fractions of individuals who have their own ESHI, private individual insurance, Medicaid, and spousal coverage are 59.5%, 3.4%, 5.0%, and 10.8%, respectively. These patterns match those in the data.

Full implementation of the ACA.—Column 2 reports the counterfactual results from the ACA. We find that the overall fraction of firms offering

ESHI declines from 52.5% under the benchmark to about 45.9% under the ACA. Of course, because of the employer mandate for firms with 50 or more workers, the ESHI offering rates for these large firms increase from 93.5% in the benchmark to over 98.9% under the ACA; however, the ESHI offering rate for firms with fewer than 50 workers decreases significantly from 48.0% under the benchmark to 40.0% under the ACA. The steady-state unemployment rate stays about the same under the ACA as that under the benchmark. The average 4-month wage of the workers in firms offering ESHI has a slight increase from \$10,700 to \$11,100, while that for workers in firms not offering ESHI experiences a slight decrease from \$7,980 to \$7,660; overall, the average wage of the employed worker has a slight increase from \$9,890 to \$9,920.

Importantly, we find that the uninsured rate under the ACA will be significantly reduced when all features of the ACA are fully phased in. The uninsured rate is predicted to be 6.6%. Notably, the fraction of the population with individual insurance increased from 3.4% in the pre-ACA benchmark to 11.2% under the ACA.[81] This represents the largest source of the drop in the uninsured rate under the ACA. The second important source for the reduction in the uninsured rate is Medicaid, as the fraction of the population covered by Medicaid increases from 5.0% in the benchmark to 9.90% under the ACA. Notably, the fraction of individuals covered by their own ESHI slightly dropped from 59.5% in the benchmark to 58.5% under the ACA. The sizable drop of ESHI offer rate among small firms shifts insurance status of their married employees from their own ESHI coverage toward the spousal coverage, contributing to an increase in the overall spousal coverage from 10.8% in the benchmark to 14.3% under the ACA. Thus, the overall impact on the ESHI coverage is very small: 72.4% under the ACA, while it is 70.3% in the benchmark.

To understand the reasons for the decline of the ESHI offering rate of the small firms, it is useful to study how the ACA affects the adverse selection differentially for firms of different productivities when they decide whether to offer ESHI. Table 17 reports simulation results similar to those in table 15. In table 15, we showed that, in the pre-ACA environment, low-productivity firms would experience an adverse selection effect if they offered health insurance, in the sense that they will attract a higher fraction of unhealthy (on the unobservable component) workers among their new hires than if they did not offer health insurance; in contrast, high-productivity firms do not experience adverse selection among their new hires. In table 17, we conduct the same type of numerical exercise under

[81] Note that, even though both are called “individual insurance,” the individual insurance in the pre-ACA world differs from that under the ACA in how they are priced: pre-ACA individual insurance is individually priced according to health, while under the ACA it is community rated.

TABLE 17
Adverse Selection Effect under the ACA: Low-Productivity vs. High-Productivity Firms

	Low-Productivity Firms		High-Productivity Firms	
	ESHI	No ESHI	ESHI	No ESHI
Fraction of unhealthy (unobserved) among new hires	.443	.434	.400	.402

the ACA, and it shows that low-productivity firms no longer suffer from adverse selection in the health of their new hires if they were to offer health insurance. The reason is very simple: because of the expansion of Medicaid and the generous premium subsidies to low-income individuals for purchasing insurance from the exchange, low-productivity firms are no longer attracting new hires from a pool with worse unobservable health under the ACA, which is in stark contrast to the pre-ACA case. Thus, the ACA levels the playing field for low- and high-productivity firms to offer health insurance in terms of the adverse selection problem. However, this effect is dwarfed by a countervailing effect: because of the availability of subsidized health insurance from the exchange, workers' willingness to pay for ESHI and the firms' benefit in terms of increased productivity from offering ESHI are significantly reduced under the ACA, and the reduction is much more pronounced for the low-productivity firms.

2. Early Impact of the ACA: Model vs. Data

Column 2 in table 16 presents the steady-state results when the ACA is fully implemented, including the full expansion of Medicaid at the national level. Because of the Supreme Court ruling described in footnote 6, the actual implementation of the Medicaid expansion of the ACA is only partial. To examine how well the model is able to account for the early impact of the ACA, we report results from a counterfactual experiment with only partial Medicaid expansion.

Specifically, we evaluate the ACA as implemented in 2015 (which we refer to as "ACA 2015") and compare the model's counterfactual predictions with the data. The main differences between ACA 2015 and the full implementation of the ACA are as follows: (*a*) only 30 states expanded Medicaid in ACA 2015; (*b*) the magnitude of the individual mandate tax penalties under ACA 2015 is lower than when it is fully phased in; specifically, instead of $P_W^{ACA}(y)$ specified in (35), the individual mandate penalty in 2015 is given by

$$P_W^{ACA2015}(y) = \max\{0.02 \times (y - \mathrm{TFT\_2011}), \$325\}; \tag{38}$$

(c) only firms with more than 100 workers are subject to employer mandate requirements under ACA 2015; specifically, instead of $P_E^{ACA}(n)$ specified in (36), the employer mandate penalty in 2015 is given by

$$P_E^{ACA2015}(n) = \begin{cases} (n-30) \times \$2{,}000 & \text{if } n \geq 100, \\ 0 & \text{otherwise.} \end{cases} \tag{39}$$

It is straightforward to incorporate b and c. To incorporate a without significantly complicating our framework, we modify the Medicaid eligibility probability under ACA 2015 as follows. Let f_M^{30} represent the proportion of the US population in the 30 states that expanded Medicaid in 2015, and the Medicaid offer probability in ACA 2015 is specified as

$$f_M^{e,ACA2015}(\chi, y) = \max\left\{f_M^e(\chi, y), f_M^{30}\right\} \text{ if } y \leq \text{ FPL138}, \tag{40a}$$

$$f_M^{u,ACA2015}(\chi) = \max\left\{f_M^u(\chi), f_M^{30}\right\}, \tag{40b}$$

where $f_M^e(\chi, y)$ and $f_M^u(\chi)$ denote the probabilities of Medicaid eligibility in the pre-ACA benchmark environment as specified in (22) and (23). We simulate the steady state of our estimated model of the 2004–7 economy under ACA 2015 using the policies of (38)–(40).[82] To compare our counterfactual prediction of the impact of ACA 2015 with the early impact of the ACA in the data, we focus on the predicted changes from the baseline. Focusing on the changes instead of the levels is important because, around the implementation of the ACA, the US economy was just recovering from the Great Recession. For the early impact of the ACA in the data, we obtain the statistics of the distribution of the insurance status in the population in 2012 and 2015 from the American Community Survey (ACS) through Integrated Public Use Microdata Series. Note that ACS does not distinguish individuals' own ESHI from spousal ESHI, and thus we aggregate both own and spousal ESHI into the "ESHI" category.

The result is reported in table 18. We find that our model predicts that the uninsured rate under ACA 2015 decreases by 9.4 percentage points, from 21.3% to 11.9%; this magnitude of change is largely consistent with that in the data, where the uninsured rate decreases by 10.6 percentage points, from 38.6% to 28.0%. Note that the reduction of the uninsured rate in the data is attributed to an increase in all other insurance options. Consistent with the data, our model also finds the substantial increase in both individual and Medicaid coverages. The only difference is that in

[82] Note that under ACA 2015, the individuals whose income is below 138% of FPL cannot obtain subsidies if they buy insurance from the exchange, a situation that is referred to as the "coverage gap." This coverage gap creates the possible discontinuities of the worker's value function in the sense that there may be a possible jump of the value of employed workers without ESHI around 138% of FPL. Again, one can deal with this discontinuity by adjusting the smoothing parameter σ_{SUB} and checking the robustness of the results. Based on our extensive investigation, we do not find this to create significant numerical errors.

TABLE 18
EARLY IMPACT OF THE ACA: MODEL VS. DATA

	Data		Model	
	Pre-ACA (2012)	ACA (2015)	Pre-ACA (2004–7)	ACA (2015)
Uninsured	.386	.280	.213	.119
ESHI	.480	.521	.703	.685
Individual insurance	.037	.071	.034	.118
Medicaid	.097	.127	.050	.078
Unemployment rate	.116	.080	.079	.079

NOTE.—In this table, we define the ESHI as the fraction of individuals who have ESHI either through their own employers or through their spouses. We make this choice because the ACS data does not distinguish whether the source of ESHI coverage is one's own or spousal ESHI.

the data, the ESHI rate increased, while our model predicts a slight decrease of ESHI from 70.3% to 68.5%. This discrepancy, however, likely reflects the impact of the fact that the unemployment rate (shown in the last row of table 18) decreased in the data from 11.6% in 2012 to 8.0% in 2015. Overall, we think our model captures the major changes resulting from the early impact of the ACA as it is implemented in 2015.

3. Evaluating Health Care Reform Proposals

In this section, we discuss the counterfactual simulation results from several proposals to reform the ACA.

ACA without the individual mandate.—The first reform proposal, which we refer to as "ACA without the individual mandate," corresponds to the actual case after the Tax Cut and Jobs Act of 2017 is implemented, which repeals the individual mandate penalty but keeps the other components of the ACA intact. In column 3 of table 16, we report simulation results from this reform proposal, in a hypothetical environment of the ACA without the individual mandate—that is, only health insurance exchange, premium subsidy, and employer mandate components of ACA are implemented.

Surprisingly, we find that the ACA without the individual mandate would also have still significantly reduced the uninsured rate to about 11.4%, which is about 4.8 percentage points higher than under the ACA, yet it still represents a 9.9 percentage point reduction from the 21.3% uninsured rate predicted in the benchmark.

The reason for the sizable reduction in the uninsured rate despite the absence of individual mandate is the generous premium subsidies stipulated under the ACA. Individuals are risk averse, so they would like to purchase insurance if the premium they need to pay out of pocket is sufficiently small. Thus, even in the absence of the individual mandate penalty, low-wage workers in firms not offering ESHI will continue to buy insurance from the exchange with premium subsidy. In unreported results, we know that the workers who decide to forego health insurance when the individual mandate is repealed tend to be those who work in firms with medium wages and who are healthy. These account for the 1.4 percentage point decline in the individual insurance coverage under ACA without individual mandate relative to the full ACA. Because those who decided to go uninsured when there is no individual mandate are precisely those who are healthy, their absence in the exchange exacerbates the adverse selection problem, leading to a substantial increase in the premium in the exchange (from $1,500 under the ACA to $1,750 in the ACA without individual mandate).

Column 3 also shows that repealing the individual mandate of the ACA will result in a substantial reduction of the fraction of firms that offer ESHI, especially for firms with fewer than 50 workers. The reason is very simple: in our model, firms are trying to attract workers by offering compensation packages that are valuable to the workers; in the absence of individual mandate, offering ESHI becomes less valuable to the workers than under the full ACA. Note, however, that the average wages of workers increase when there is no individual mandate penalty, particularly in firms not offering ESHI.

ACA without the employer mandate.—The second reform proposal is "ACA without the employer mandate." The employer mandate in the ACA has been very contentious. The Obama administration twice delayed its implementation. The first delay exempted all firms from the employer mandate penalty in 2014; the second delay exempted all employers with 50–99 workers from the employer mandate penalty in 2015.[83] What would happen if the employer mandate component were eliminated from the ACA? This would roughly correspond to a health care system in the spirit of what is implemented in the Netherlands and Switzerland, where individuals are mandated to purchase insurance from the private insurance market, employers are not required to offer health insurance to their workers, and government subsidizes health care for the poor on a graduated basis.[84]

In column 4 of table 16, we report the results from the counterfactual experiment ACA without employer mandate. Surprisingly, we find that such a system without employer mandate only slightly increases the uninsured rate relative to the full version of the ACA. We find that the uninsured rate under this ACA without employer mandate system would be about 7.5%, just 0.9 percentage points higher than the 6.6% uninsured

[83] See http://obamacarefacts.com/obamacare-employer-mandate.

[84] Strictly speaking, the Swiss health care system expressly forbids employers from providing basic social health insurance as a benefit of employment, though employers can provide supplemental health insurance to their workers. See Fijolek (2012, 8) for a description.

rate predicted under the full ACA. The reasons for the somewhat surprising finding are as follows. First, eliminating the employer mandate decreases the ESHI offer rate of large firms, and the large firms tend to be the firms paying higher wages. Since the willingness to pay for health insurance is higher for high-income individuals, partly because of the individual mandate penalty, the employees in large firms that do not offer ESHI are likely to purchase health insurance from the exchange, thus offsetting the effect from the reduction of the ESHI offering rate on the uninsured rate. Note that when the large firms reduce their ESHI offering rate in the absence of employer mandate penalty, it has a ripple effect on the small firms' incentives to offer ESHI as well. There are two reasons for this. First, the adverse selection problem faced by the smaller firms offering ESHI is somewhat exacerbated when the larger firms offer ESHI at a lower rate. Second, the workers in the larger firms tend to be healthier, so their purchase of insurance from the exchange tends to lower the premium in the exchange, everything else equal. Because of these forces, the smaller firms' ESHI offering rate is also slightly reduced under ACA without employer mandate. However, the reduction in the ESHI offering rate is nearly compensated by the increase in the insurance purchase from the exchange—which likely will result in more premium subsidy by the government—and an increase in the utilization of spousal insurance. In equilibrium, the premium in the exchange stays almost identical to that under the full ACA.

ACA without premium subsidy.—The issue of whether the US Internal Revenue Service may permissibly promulgate regulations to extend tax credit subsidies to insurance coverage purchased through exchanges established by the federal government under section 1321 of the PPACA was the focus of the US Supreme Court case King v. Burwell. Whether and how much premium subsidies matter for the success of the ACA also depend on how employers may respond in their ESHI offering decisions to the premium subsidies.

In column 5 of table 16, we report the results when we evaluate the ACA sans the income-based premium subsidies, dropping both subsidies in exchange and Medicaid expansion. Relative to the full ACA results reported in column 2, the uninsured rate is much larger, at 15.7%. Essentially no one participates in the health insurance exchange without premium subsidy because of adverse selection.[85] These results demonstrate that the premium subsidies are crucial for solving the adverse selection problem in the insurance exchange and contribute importantly to the substantial reduction of the uninsured rate achieved under the full ACA. Moreover, we find that employers respond to the nonfunctioning of the health

[85] Note that the fraction of the population in the individual insurance market is tiny, though it is not literally zero, because of the preference shock for insurance purchase (see sec. III.A).

insurance exchange by offering ESHI at a much higher rate, for both large and small firms.

4. Assessing the Effects of the Components of the ACA and ESHI

In table 19, we report several counterfactual experiments that would allow us to understand the effects of the various components of the ACA. We also investigate the role of ESHI under the ACA by completely shutting down ESHI.

Health insurance exchange only.—In column 1 of table 19, we report the equilibrium of the economy, which differs from the benchmark economy only in that we replace the individual health insurance market in the benchmark with the ACA-style health insurance exchange. The ACA-style health insurance exchange differs from the individual insurance market in the benchmark in terms of pricing regulation, so that it is community rated under exchange, and the loading factor is now 0.25 instead of 0.69

TABLE 19
COUNTERFACTUAL POLICY EXPERIMENTS: EVALUATION OF VARIOUS COMPONENTS OF THE ACA AND NO ESHI

	EX (1)	EX + Sub (2)	EX + IM (3)	EX + EM (4)	No ESHI EX + Sub + IM (5)
A. Labor market statistics:					
Fraction of firms offering ESHI	.521	.410	.562	.523	.000
(If firm size is at least 50)	.980	.828	.990	.996	.000
(If firm size is fewer than 50)	.469	.362	.513	.469	.000
Unemployment rate	.080	.079	.078	.080	.080
Average wages of the employed	.986	1.001	.969	.986	1.045
(Among firms offering ESHI)	1.077	1.116	1.046	1.078	NA
(Among firms not offering ESHI)	.745	.845	.707	.733	1.045
B. Distribution of health insurance status:					
Uninsured	.191	.129	.158	.186	.387
ESHI	.632	.507	.680	.639	.000
Individual insurance	.000	.107	.000	.000	.427
Medicaid	.041	.104	.037	.040	.185
Spousal insurance	.136	.153	.126	.135	.000
Premium in EX ($10,000)	.425	.175	.426	.414	.160
C. Worker's utility, firm profit, and government expenditure and revenues ($10,000):					
Average worker utility (consumption equivalent)	.607	.608	.602	.610	.615
Average firm profit	.576	.577	.579	.577	.568
Average tax subsidies to ESHI	.022	.018	.023	.022	.000
Average exchange/Medicaid subsidies	.004	.023	.004	.004	.053
Revenue from penalties	.000	.000	.003	.000	.009

NOTE.—Panel C values are per capita and expressed at the 4-month level. EM = employer mandate; EX = health insurance exchange; IM = individual mandate; Sub = premium subsidy; NA = not applicable.

as estimated in the benchmark economy. It turns out that having an ACA-style exchange alone does little to the uninsured rate in equilibrium: the equilibrium uninsured rate under this counterfactual is only slightly lower relative to the benchmark economy (19.1% vs. 21.3% in the benchmark as in col. 1 of table 16). Interestingly, the exchange will have almost no participants at all because of the adverse selection problem; the 4-month premium in the exchange is $4,250, more than 2.8 times the premium level under the full ACA. In other words, only replacing the risk-rated individual health insurance market in the pre-ACA benchmark by a community-rated health insurance exchange (albeit one with a much lower loading cost) essentially eliminates the private individual insurance option for those who do not receive ESHI. This effect—somewhat perversely—incentivizes larger firms to offer ESHI at a much higher rate: the ESHI offering rate for firms with more than 50 workers increases from 93.5% in the benchmark to 98.0% in the exchange counterfactual. As a result, more workers obtain ESHI either from their own or from their spouses' employers, resulting in a slight reduction in the overall uninsured rate.

Health insurance exchange with premium subsidy.—In column 2 of table 19, we report the results when we introduce health insurance exchange and health insurance premium subsidies. It shows that the introduction of premium subsidies and exchange leads to a sizable reduction in the uninsured rate to about 12.9%. The exchange is quite active, so that 10.7% of individuals now obtain health insurance from there. However, without employer mandate, the introduction of exchange and premium subsidies also leads to a reduction in the probabilities of firms (particularly the large firms) offering ESHI to their workers: the fraction of firms with 50 or more workers offering ESHI is now 82.8% in contrast to 98.9% under the full ACA as reported in column 2 of table 16. Without the individual mandate, the health insurance exchange is also subject to more severe adverse selection, with healthy individuals who are not eligible for much of the premium subsidy opting to be uninsured. This drives up the equilibrium 4-month premium in the exchange to $1,747, which represents a 16% increase from the $1,502 premium predicted under the full ACA (again, reported in col. 2 of table 16).

Health insurance exchange with individual mandate.—In column 3 of table 19, we report the equilibrium results when we introduce the health insurance exchange and individual mandate. As in the "EX only" case in column 1, adding individual mandate but no premium subsidy, the health insurance exchange will have almost no participants: the equilibrium premium in the exchange is even higher than the willingness to pay for insurance for the unhealthy individuals. This indicates that the proposed individual mandate alone, at least at the current levels of penalty, is not large enough to solve the adverse selection problem in the insurance exchange. Instead, the individual mandate leads more employers to offer health insurance: the ESHI offering rate for firms with fewer than 50 workers increases from 46.9% under the exchange to 51.3% under the exchange with individual mandate and that for firms with 50 or more workers rises from 98.0% to 99.0%. As a result, the uninsured rate is 15.8% in column 3, which represents a 3.3 percentage point decrease from column 1. The fact that the ESHI offering rates increase in this experiment, which imposes individual mandate but not employer mandate, is interesting in itself, and it is a result of the fact that competition among firms for workers will result in an internalization of workers' higher demand for insurance because of individual mandate in firms' behavior in equilibrium models. Here individual mandate increases the value of ESHI to workers, which makes offering ESHI a more effective instrument to compete for workers and in turn leads more firms to offer ESHI in equilibrium.

Health insurance exchange with employer mandate.—In column 4 of table 19, we report the results when we introduce the health insurance exchange and employer mandate into the benchmark economy. We again find that the exchange is essentially not active. There is a reduction of the uninsured rate, from 21.3% in the benchmark to 18.6% in column 4, but the declines of the uninsured rate are mostly due to the increased probability of offering ESHI by firms with 50 or more workers.

No employer-sponsored health insurance.—Finally, in column 6 of table 19, we investigate the effects of eliminating ESHI. This is an interesting exercise, as the United States is the only industrialized nation in which employers are the main source of health insurance for the working-age population. In column 6, we report the results from an experiment where we prohibit firms from offering ESHI; instead, we introduce the health insurance exchange, individual mandate, and premium subsidies as stipulated in the ACA.[86] We find that disallowing ESHI would lead to drastic increases of the uninsured rate; in fact, our model predicts that the uninsured rate would reach 38.7%, which is roughly more than 80% higher than the 21.3% uninsured rate in the benchmark economy. Insurance premium in exchange is $1,596 per 4 months, about 6% higher than the $1,502 level under the full ACA. It thus indicates that if there is no ESHI, the proposed subsidies and individual mandate penalty under the ACA are not large enough to induce individuals to participate in insurance exchange. Interestingly, our result also suggests that ESHI in fact complements—instead of hinders—the smooth operations of the health insurance exchange.

5. Role of Tax Exemption of the ESHI Premium

Given the growing federal deficits in the United States, reducing tax expenditures—tax exemption for the ESHI premium being one of the

[86] Of course, as a result of disallowing ESHI, we have to drop the employer mandate of the ACA.

major tax expenditure categories—has been mentioned in several prominent reports.[87] In this section, we describe the results from counterfactual experiments where the tax exemption status of the ESHI premium is eliminated, both under the benchmark model and under the ACA. We implement this counterfactual as follows. Suppose that a worker works for a firm that pays wage w and incurs an actuarially fair health insurance premium R; we let the after-tax income of the worker be $T(w + R) - R$ when R is not exempted from personal income tax. In contrast, with tax exemption of the ESHI premium, the worker's after-tax income would have been $T(w)$, where $T(\cdot)$ is as specified in (3). In addition, firms' payroll tax τ_p in (13) will also be applied to the health insurance premium $m^1_{\chi\mathbf{h}}$.[88]

Columns 1 and 3 of table 20 report the same simulation results for the benchmark and the ACA as reported in columns 1 and 2, respectively, of table 16 under the current tax exemption status for the ESHI premium. In column 2, we remove the tax exemption for ESHI under the benchmark economy. We find that removing the tax exemption increases the uninsured rate from 21.3% to 31.8%. The removal of ESHI premium exemption does significantly reduce the fraction of firms that offer ESHI; this effect is particularly strong for firms with 50 or more workers, whose ESHI offering rate decreases from 93.5% under the benchmark with tax exemption to 61.7% under no exemption. This, of course, is a result of the fact that workers in large firms are in higher income tax brackets.

In column 4, we remove the tax exemption for ESHI under the ACA. We find that removing the tax exemption increases the uninsured rate from 6.6% to 12.4%. Eliminating tax exemption for ESHI again has a strong negative effect on the ESHI offering rates for both small and large firms. Notice that as firms decrease ESHI offering, more workers purchase insurance from the exchange.[89]

Overall, our findings show that eliminating the tax exemption status for the ESHI premium will increase the uninsured rate, both under the benchmark and under the ACA, but the elimination of the tax exemption of the ESHI premium does not lead to the collapse of the ESHI. In fact, in table 20, we report that even without the tax exemption for the ESHI premium, a substantial fraction of the firms will choose to offer health insurance to their workers, both in the benchmark economy and under the ACA. In the benchmark economy, we find that 32.6% of the firms will still

[87] See, e.g., National Commission on Fiscal Responsibility and Reform (2010).

[88] The analogous expression for (13) in this counterfactual is now

$$\Pi_1(p) = \max_{\{w^1_H, w^1_U\}} \Pi\left(w^1_H, w^1_U, E = 1\right) \equiv \sum_{\chi} \sum_{h^0_1 \in \mathcal{H}_1} \sum_{\mathbf{h} \in \mathcal{H}} \left[p d_{\chi\mathbf{h}} - \left(1 + t_p\right)\left(w^1_{h^0_1} + m^1_{\chi\mathbf{h}}\right)\right] n_{\chi\mathbf{h}}\left(\mathbf{w}^1_{h^0_1}, 1\right) - C.$$

[89] Note that the model predicts that the fraction of individuals with their own ESHI decreases, while the fraction with spousal ESHI coverage increases. As firms' ESHI offering rate is reduced, the supply for spousal ESHI is lowered, but the take-up rate of spousal ESHI increases. The latter effect dominates the former in the counterfactual experiment.

TABLE 20
COUNTERFACTUAL POLICY EXPERIMENTS: EVALUATING THE EFFECTS OF ELIMINATING THE TAX EXEMPTION FOR EHI PREMIUM UNDER THE BENCHMARK AND THE ACA

	BENCHMARK		ACA	
	Exempt (1)	No Exempt (2)	Exempt (3)	No Exempt (4)
A. Labor market statistics:				
Fraction of firms offering ESHI	.525	.326	.459	.342
(If firm size is at least 50)	.935	.617	.989	.842
(If firm size is fewer than 50)	.480	.290	.400	.278
Unemployment rate	.079	.081	.079	.080
Average wages of the employed	.989	1.013	.992	1.014
(Among firms offering ESHI)	1.070	1.130	1.110	1.186
(Among firms not offering ESHI)	.798	.919	.766	.839
B. Distribution of health insurance status:				
Uninsured	.213	.318	.066	.124
ESHI	.595	.383	.580	.429
Individual insurance	.034	.072	.112	.182
Medicaid	.050	.057	.099	.115
Spousal insurance	.108	.169	.143	.150
C. Worker's utility, firm profit, and government expenditure and revenues ($10,000):				
Average worker utility (consumption equivalent)	.597	.598	.611	.603
Average firm profit	.572	.570	.579	.574
Average tax subsidies to ESHI	.021	.000	.020	.000
Average exchange/Medicaid subsidies	.005	.006	.021	.029
Revenue from penalties	.000	.000	.001	.003

NOTE.—Panel C values are per capita and expressed at the 4-month level.

offer health insurance to their workers when the ESHI premium is no longer exempt from income taxation. Similarly, 34.2% of the firms will offer health insurance to their workers under the ACA when the ESHI premium is not exempt from income taxation. There are several reasons that firms have strong incentives to offer health insurance to their workers in our economy. First, workers are risk averse and firms are risk neutral; thus, firms can enjoy the risk premium by offering health insurance to their workers. Second, health insurance improves health and healthy workers are more productive. Thus, firms, particularly those with higher productivity, will have incentives to offer health insurance to their workers so that their workforce will be healthier and thus more productive. This mechanism is illustrated in table 15.

6. Welfare Implications

Finally, we briefly discuss the welfare implications of health care reforms in our model. Panel C of tables 16, 19, and 20 reports a worker's welfare, a firm's profits, and government expenditures and revenues in each counterfactual experiment. We find that the full implementation of the ACA increases both workers' and firms' welfare with additional government expenditure. The sum of per capita worker utility and firm profit per 4 months increases by about \$220 ($[(0.611 - 0.597) + (0.579 - 0.572)] \times$ \$10,000), and the per capita net government expenditure increases by about \$140 ($[(0.020 + 0.021 - 0.001) - (0.021 + 0.005)] \times$ \$10,000). Thus, our experiments indicate that the ACA can lead to a modest welfare gain overall.

In panel C of table 19, we report the welfare effects of eliminating ESHI. We find that the sum of a worker's welfare and a firm's profit decreases by about \$70 from that under the full ACA. In addition, the total government expenditure increases by about \$40 from that under the full ACA. Most of welfare loss is due to the decrease in a firm's profit. Without ESHI, firms can no longer benefit from tax deductibility of ESHI. However, such a tax saving through the elimination of ESHI generates significant increases in subsidies in the health insurance exchange. As a result, the total government expenditure actually increases.

In panel C of table 20, we also report the implications of removing tax exemption on government expenditures. Under the ACA with tax exemption, we find that the net per capita government expenditure, which includes the tax expenditure due to the exemption, the premium subsidy, and individual/employer mandate penalties, is about \$400; under the ACA without tax exemption, it is reduced to about \$270. This is a decline of \$130 per capita per 4 months, which translates to about \$390 per capita per year. Also, note that average worker utility under the ACA without tax exemption is actually higher than that under the benchmark economy with tax exemption. Removing tax exemption does have a negative effect on firms' average profit: the reduction in firm profits is at about 0.35% ($[0.572 - 0.570]/0.570 \approx 0.35\%$) in the benchmark and about 0.87% ($[0.579 - 0.574]/0.574 \approx 0.87\%$) under the ACA.

IX. Conclusion

We present and empirically implement an equilibrium labor market search model where risk-averse workers facing medical expenditure shocks are matched with employers making health insurance coverage decisions. The distributions of wages, health insurance provisions, employer size, employment, and worker's health are all endogenously determined in equilibrium. We estimate our model using various micro data sources, including the panel of SIPP, MEPS, and Kaiser. The equilibrium of our estimated model is largely consistent with the dynamics of the workers' labor market experience, health, health insurance, and medical expenditure, as well as the distributions of employer sizes in the data. We use our estimated model to examine the impact of the key components of the 2010 ACA, as well as various alternative designs that are central to the current policy debates. We also demonstrate that our model is able to quantitatively account for an early impact of the ACA seen in the data.

We find that the implementation of the full version of the ACA would significantly reduce the uninsured rate from about 21.3% in the pre-ACA benchmark economy to 6.6% under the ACA. This large reduction of the uninsured rate is driven mainly by low-wage workers participating in Medicaid or in the insurance exchange with their premium supported by the income-based subsidies. We find that income-based premium subsidies for health insurance purchases from the exchange and Medicaid expansion play an important role for the sustainability of the ACA; if the subsidies were removed from the ACA, the insurance exchange would suffer from severe adverse selection problems such that it would not be active at all and the uninsured rate would be around 15.8%.

We find that the ACA would also have achieved significant reduction in the uninsured rate if its individual mandate component were removed. We find in our simulation that under the ACA without the individual mandate," the uninsured rate would be 11.4%, significantly lower than the 21.3% under the benchmark. The Medicaid expansion and the exchange premium subsidy component of the ACA would cover all the unemployed (healthy or unhealthy) and the low-wage employed (again, both healthy and unhealthy). Interestingly, we find that the employer mandate does not seem to be an essential feature of the ACA; under the ACA without the employer mandate, the uninsured rate would be about 7.5%, just slightly higher than that under the full ACA. If both individual and employer mandates were removed from the ACA, the uninsured rate would be around 12.9% as long as the ACA components of Medicaid expansion, premium subsidies, and health insurance exchanges with community rating stayed intact.

We also simulate the effects of removing the tax exemption for the ESHI premium both under the benchmark and under the ACA. We find that—while the removal of the tax exemption for the ESHI premium would reduce but not eliminate the incentives of firms, especially the larger ones, offering health insurance to their workers—the overall effect on the uninsured rate is modest: we find that the uninsured rate would increase from 21.3% to 31.8% when the ESHI tax exemption is removed in the benchmark economy, and it will increase from 6.6% to 12.4% under the ACA. Finally, we find that prohibiting firms from offering ESHI in the post-ACA environment would lead to a large increase in the uninsured rate. It also decreases the total welfare and increases the overall government expenditure. Thus, ESHI complements—instead of hinders—the smooth operations of the health insurance exchange.

We should emphasize that our paper is only a first step toward understanding the mechanism through which the ACA, and more generally any health insurance reform, may influence labor market equilibrium.

We estimated our model using a selected sample of individuals with relatively homogeneous skills (with no more than high school education between ages 26 and 46), and thus our quantitative findings may be valid only for this population. Thus, the quantitative results we present in this paper should be understood with these qualifications in mind.

Nevertheless, the framework developed in this paper incorporates all the relevant features of the US health insurance system for the working-age population, including ESHI, individual markets, Medicaid, spousal insurance, and uncompensated care modeled as consumption floor; as such, it can serve as a useful starting point for future research on the interaction between the labor market and the health insurance market. Of course, for specific policy questions it may not be necessary to include all of these features. For example, Aizawa (2019) studies the optimal design of health insurance exchanges in the labor market sorting equilibrium. Fang and Shephard (2019) examine how the ACA-like policies affect firms' incentives to offer an employee-only insurance option in an equilibrium household search model. In both studies, they model only a subset of the health insurance system to focus on their key mechanisms.

Finally, there are a number of interesting questions not addressed in this paper. First, there are many additional channels through which firms and workers might have responded to individual mandates and employer mandates that we abstracted in this paper; for example, firms may change their choices of production technology in response to the ACA, which could be interpreted as a form of labor market regulations. Similarly, firms may change the composition of part- and full-time workers as well as the number of job openings in response to the ACA. Incorporating these additional channels will allow us a more complete understanding of the general equilibrium impacts of health care reforms on aggregate productivity and employment. Moreover, in this paper we partially incorporated Medicaid by modeling its availability probabilistically, but we did not model the endogenous asset accumulation. Incorporating endogenous asset accumulation to model Medicaid eligibility more realistically will be an important but challenging area of research. Finally, it is important to explore the optimal design of the health insurance system.

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