Equilibrium Labor Market Search and Health Insurance Reform*

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Abstract

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 1996 panel of the Survey of Income and Program Participation (SIPP), the Medical Expenditure Panel Survey (MEPS, 1997-1999) and the 1997 Robert Wood Johnson Foundation Employer Health Insurance Survey. 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 evaluate the impact of the key components of the 2010 Affordable Care Act (ACA), including the individual mandate, the employer mandate, the insurance exchange and the income-based insurance premium subsidy. We evaluate the impact of the ACA as a whole, as well as a variety of combinations of the components of the ACA.

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1 Introduction

The Affordable Care Act (hereafter, ACA), signed into law by President Barack Obama in March 2010, represents the most significant reforms to the U.S. health insurance and health care market since the establishment of Medicare in 1965.[1] The health care reform in the U.S. was partly driven by two factors, first, a large fraction of the U.S. population does not have health insurance (close to 18% for 2009); second, the U.S. spends a much larger share of the national income on health care than the other OECD countries (health care accounts for about one sixth of the U.S. GDP in 2009). There are many provisions in the ACA whose implementation will be phased in over several years, and some of the most significant changes will take effect from 2014. In particular, we focus on four of the important components of the ACA:

- **(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 percent of income or $695, whichever is higher.[2, 3]

- **(Employer Mandate)** Employers with more than 50 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.[4]

- **(Insurance Exchanges)** State-based health insurance exchanges will be established where the unemployed, as well as workers whose employers do not offer health insurance and the self-employed, can purchase insurance. Importantly, the premiums for individuals who purchase their insurance from the insurance exchanges will be based on the average health expenditure risks of those in the exchange pool.[5] Insurance companies that want to participate in an exchange need to meet a series of statutory requirements in order to be designated as "qualified health plan."

[1] The Affordable Care Act 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 in the Health Care and Education Reconciliation Act of 2010.

[2] These penalties would be implemented fully from 2016. In 2014, the penalty is 1 percent of income or $95 and in 2015, it is 2 percent or $325, whichever is higher. Cost-of-livign adjustments will be made annually after 2016. If the least inexpensive policy available would cost more than 8 percent of one's monthly income, no penalties apply and hardship exemptions will be permitted for those who cannot afford the cost.

[3] This component of the ACA is the subject of the U.S. Supreme Course case 567 U.S. 2012 where twenty-six States, several individuals, and the National Federation of Independent Business challenged the constitutionality of the individual mandate and the Medicaid expansion. The U.S. Supreme Court ruled on June 28, 2012 to uphold the constitutioniality of the individual mandate on a 5-to-4 decision.

[4] Employers also need to pay a fine if they offer health insurance but any worker receives federal subsidies to purchase health insurance. The fine is set to equal to $\min\{\$2000 \times (\text{employees}-30), \$3000 \times (\text{employees receiving health insurance})\}$.

[5] Separate exchanges would also be created for small businesses to purchase coverage.

- **(Premium Subsidies)** All adults in households with income under 133% of Federal poverty line (FPL) will be eligible for receiving Medicaid coverage with no cost sharing.[6] For individuals and families whose income is between the 133 percent and 400 percent of the federal poverty level, subsidies will be provided toward the purchase of health insurance from the exchanges.[7]

The goal of this paper is to understand how the health care reform as it is will change the health insurance and labor markets. Would the ACA with individual mandate significantly reduce the uninsured rate? Would more employers be offering health insurance to their employees? How would the reform affect wage, employment, and employer size distributions? How would it impact worker's health and average labor productivity? What is the impact on total health expenditures? What is the impact of the reform on government budget? We are also interested in several counterfactual policies. For example, how would the remainder of the ACA perform if had the individual mandate been struck down by the Supreme Court? What would happen if the current tax exemption status of employer-provided insurance premium is eliminated? Is the premium subsidies necessary for the insurance exchanges to overcome the adverse selection problem? Can we identify alternative reforms that can improve welfare relative to the ACA?

In order to address these questions, it is crucial to have an equilibrium framework for us to have a better understanding of the interactions between the labor market and health insurance market. There are plenty reasons. First, the United States is unique among industrialized nations in that it lacks a national health insurance system and most of the working age populations obtain health insurance coverage through their employers. According to Kaiser Family Foundation and Health Research and Educational Trust (2009), more than 60 percent of the non-elderly population received their health insurance sponsored by their employers, and about 10 percent of workers' total compensation was in the form of employer-sponsored health insurance premiums.[8] 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 wage, and to experience high rate of worker turnover. In the 1997 Robert Wood Johnson Foundation Employer Health Insurance Survey which we use later in our analysis, we found that the average employee size of employers was about 8.8 if

[6] This is a significant expansion of the current Medicaid system because many States currently cover adults with children only if their income is considerably lower, and do not cover childless adults at all.

The U.S. Supreme Court's 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.

[7] The detailed formula for the permium subsidies under the ACA will be discussed in Section 8.2.

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

they did not offering health insurance, in contrast to an average size of 33.9 for employers offering health insurance; the average annual wage was $20,560 for workers at firms that did not offer health insurance, in contrast to average wage of $29,077 at firms that did; moreover, annual separation rate of workers at firms not offering health insurance was 17.3%, while it was 15.8% at firms that did.

In this paper we first construct and estimate an equilibrium labor market search model, where both the wages and health insurance provisions are endogenously determined, that can match the most salient features of the labor market and health care in the data. Our model is based on Burdett and Mortensen (1998) and Bontemps, Robin, and Van den Berg (1999, 2000), but we depart from these standard models by incorporating health and health insurance.

In our model, workers observe their own health status which evolves stochastically. Health status affects both their medical expenditures and their labor productivity. Health insurance insures their medical expenditure risks and affects the dynamics of health status. In the benchmark model, we assume that workers can obtain health insurance only through employers. Both unemployed and employed workers randomly meet firms and decide whether to accept their job offer, compensation package of which consists of wage and employer-sponsored health insurance.

Firms, which are heterogenous in their productivity, post compensation packages to attract workers. The cost of providing health insurance, i.e., premiums for employer-sponsored health insurance, is determined by both the health composition of employees of the firm and a fixed administrative cost. When deciding the compensation packages, they anticipate that their choice of compensation packages will affect the composition of workers in terms of their health status, and will also affect their size in the steady state. Moreover, they take into account two institutional features. First, the premiums for employer-sponsored health insurance are exempt from income taxes. Second, the offer of compensation package cannot depend on workers' individual health status due to anti-discrimination laws.

We characterize the steady state equilibrium of the model in the spirit of Burdett and Mortensen (1998).[9] We show that our baseline model can qualitatively and quantitatively explain the observed relationship between firms' health insurance coverage decisions and their other characteristics such as size, wages, turnover rates etc. In particular, we argue that the effect of health insurance on the dynamics of health status is critical to generating the relationship. If firms offer health insurance, they can benefit from the tax exemption of the insurance premium; on the other hand, by offering insurance they may attract unhealthy workers who both increase their health insurance costs and decrease their labor productivity.

[9] Their model theoretically explains both wage dispersion among ex ante homogenous workers and the positive correlation between firm size and wage. Moscarini and Postel-Vinay (2011) demonstrate that the extended version of this model, which allows firm productivity heterogeneity and aggregate uncertainty, has very interesting but also empirically relevant properties about firm size and wage adjustment over the business cycles.

Because firms cannot design a compensation package based on worker's health, this creates an *adverse selection* problem, creating a potential disincentives for firms to offer health insurance. In Section 4.2, we show that in the presence of the positive effect of health insurance on health, the degree of the adverse selection problem faced by high-productivity firms offering health insurance is *less severe* than that for low-productivity firms. The reason is that, a high-productivity firm offering health insurance can poach workers from a much wider range of firms, including a larger fraction of workers who worked in firms that already offer insurance and thus are healthier; in contrast, a low-productivity firm offering health insurance can only poach workers from firms with even lower productivity, most of which do not offer health insurance and thus have less healthy workers.

The adverse selection problem that firms offering health insurance suffer is quickly reduced by the *positive effect of health insurance on health*. Importantly, however, this effect from the improvement of health status of the workforce is captured more by high productivity firms due to what we term as "*retention effect*," which simply refers to the fact that high-productivity firms tend to offer higher wages and retain workers longer (see Fang and Gavazza (2011) for evidence for this mechanism). These effects jointly allow our model to generate a positive correlation between wage, health insurance, and firm size. Moreover, it also helps explain why health status of employees covered by employer-sponsored health insurance is better than that of uninsured employees in the data.

We estimate the model by using 1996 Panel of Survey of Income and Program Participation (SIPP), Medical Expenditure panel Survey (MEPS) 1996-1999, and 1997 Robert Wood Johnson Foundation Employer Health Insurance Survey (RWJ-EHIS). The first two data sets are panel data on worker side labor market status and health and health insurance and the last one is cross sectional establishment level micro data which contains information such as establishment size and health insurance coverage. Because the data on the supply side (i.e., workers) and demand side (i.e. employers) of labor markets come from different sources, we estimate the model using method of moments, for the case of combinations of data sets, as suggested by Imbens and Lancaster (1994) and Petrin (2002).[10] As in the most of structural estimation of

[10] An alternative approach is to rely on multi-step estimation such as Bontemps, Robin, and Van den Berg (1999, 2000) and Shephard (2011). In these estimations, worker side parameters are firstly estimated by the likelihood function of individual labor market transitions. Then, firm productivity distribution is estimated to perfectly fit wage distribution observed from the worker side. The advantage of this approach is that one can recover firm productivity distribution nonparametrically. The main difference from them is that we incorporate employer side data moments, which are from separate data sources. The model's prediction on these moments depend on all the parameters in the model. This leads us to choose a different estimation strategy.

Note that one can still apply multi-step estimation to fit both worker and employer side moments if they have access to employee-employer matched panel data. See Postel-Vinay and Robin (2002) and Cahuc, Postel-Vinay, and Robin (2006). They nonparametrically estimate worker's sampling distribution of job offer from each firm to match observed wage distribution.

labor market search models, we construct worker side moments from likelihood function of individual labor market transition. We then construct employer side moments such as firm size distribution and health insurance coverage rate. Our estimates show that the model reasonably fits well in terms of coverage rate, health, labor market dynamics, and wage distribution.

We use the model estimates to evaluate the equilibrium effects of four of the important features of the ACA mentioned above. We find that the implementation of the full version of the ACA would significantly reduced the uninsured rate from 25.43% in the benchmark economy to 9.39%. This large reduction of the uninsured rate is mainly driven by low-wage workers participating in the insurance exchange with their premium supported by the income-based subsidies. We find that, if the subsidies were removed from the ACA, the insurance exchange will suffer from adverse selection problem so that only unhealthy workers participate in the market, resulting in a much more modest reduction in the uninsured rate, from 25.43% in the benchmark to 18.50% under "ACA without the subsidies."

We also 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 "ACA without individual mandate", the uninsured rate would be 13.64%, significantly lower than the 25.43% under the benchmark. The premium subsidy component of the ACA would have in itself drawn all the unemployed (healthy or unhealthy) and the low-wage employed (again both healthy and unhealthy) in the insurance exchange.

We also evaluate the efficacy of the ACA by comparing with alternative health reforms. We find that the current version of ACA without employer mandate may be more efficient than the one with employer mandate. The latter achieves higher average productivity, higher worker's average utility, higher average wage, and lower government spending.

Finally, we simulate the effects of eliminating the tax exemption for employer-sponsored health insurance (ESHI) premium both under the benchmark and under the ACA. We find that, while the elimination of the tax exemption for ESHI premium would reduce the probability of all firms, especially the larger ones, offering health insurance to their workers, the overall effect on the uninsured rate is rather modest. We find that in the benchmark economy the uninsured rate would increase from 25.43% to 25.65% when the ESHI tax exemption is removed; and it will increase from 9.38% to 10.17% under the ACA.

The remainder of the paper is structured as follows. In Section 2, we review the related literature; in Section 3, we present the model of the labor market with endogenous determinations of wages and health insurance provisions; in Section 4, we describe the numerical algorithm to solve for the steady state

Given the estimated sampling distribution, they then estimate productivity distribution of firms to perfectly fit with employer size distribution. Allowing nonparametric estimations of these distribution requires employee-employer matched data, which is unfortunately unavailable for our purpose.

equilibrium of the model, and present a qualitative assessment of the workings of the model; in Section 5, we describe the data sets used in our empirical analysis; in Section 6, we explain our estimation strategy; in Section 7, we present our estimation results and the goodness-of-fit; in Section 8, we describe the results from several counterfactual experiments; and finally in Section 9, we conclude.

2 Related Literature

This paper is related to three strands of the literature. First and mostly, it is related to a small literature that examines the relationship between health insurance and labor market. 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 examine the question of whether the employer-provided health insurance system leads to inefficiencies in workers' mobility decisions (which are often referred to as "job lock" or "job push" effects). Their model has the following important features. Workers are heterogenous in their preference for health insurance; firms are heterogeneous in their costs of offering health insurance which are exogenously given; and health insurance is productive in the sense that it reduces the probability of separation between workers and firms. However, because a worker/vacancy match is the unit of analysis of Dey and Flinn (2005), their model is not designed to address the relationship between firm size and wage/health insurance provisions. More importantly, we explicitly incorporate worker's health and link it with health insurance costs/premium. This feature is necessary in order to assess general equilibrium effects of the ACA, because it requires us to model how the premium in insurance exchange and employer sponsored health insurance will be determined, which affect both individuals' insurance purchase and employers' insurance coverage decisions.

Bruegemann and Manovskii (2010) develop a search and matching model with large firms to study employer's coverage decision. In their model employer sizes are discrete in order to highlight the effect of health composition of employees on the dynamics of firm's coverage decision, and they argue that the insurance market for small firms suffers from adverse selection problem because those firms try to purchase health insurance when most of their employees are unhealthy. In contrast, our study provides an alternative but complementary channel which has received little attention in the literature: small firms cannot overcome adverse selection problems because they cannot retain their workers long enough to capture the benefits from the advantageous dynamic effects of health insurance on health. This channel arises in our environment because we allow for on-the-job searches and explicitly model the dynamic effect of health insurance on health, both of which are absent in their model. Moreover, our model both qualitatively and quantitatively captures the relationships not only between health insurance and employer size, but also between wage and health insurance, the latter of which is not the focus of their study.

The channel that worker turnover discourages employer's health insurance provision is related to the one emphasized in 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 under-investment in health during working years and increasing medical expenditures during retirement. We argue in this paper that such a channel also helps explain why small firms cannot overcome the adverse selection problem. Moreover, our primary focus is about labor market outcomes and health insurance coverage provision, while theirs is on the life-cycle medical expenditure.

Second, there are a growing number of empirical analyses examining the likely impact of the ACA by focusing the Massachusetts Health Reform, implemented in 2006, which has similar features with the ACA. Kolstad and Kowalski (2010, 2012a,b) study the effect on medical expenditure, selection in insurance markets, and labor markets. Courtemanche and Zapata (2012) found that Massachusetts reform improves the health status of individuals. They study these issues based on the difference in difference approach. These approaches are very informative to understand the overall and likely impact of reform. By developing a quantitative 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 the removal of tax exclusion of employer sponsored health insurance, which have not been implemented but are the policy agenda which may be addressed in the future health care reforms.

Third, this paper is related to a large literature estimating equilibrium labor market search models.[11] Van den Berg and Ridder (1998) and Bontemps, Robin, and Van den Berg (1999, 2000) empirically implement Burdett and Mortensen (1998)'s model. Their empirical frameworks have been widely applied in the subsequent studies investigating the impact of various labor market policies on labor market outcomes. Among this literature, our studies are mostly related to Shephard (2011) and Meghir, Narita, and Robin (2011). Both allow for multi-dimensional job characteristics as in our paper: wage and part-time/full-time in Shephard (2011), wage and formal/informal sector in Meghir, Narita, and Robin (2011), and wage and health insurance offering in our paper. However, in Shephard (2011) a firm's job characteristics is assumed to be exogenous, while in our paper employers endogenously choose job characteristics. In Meghir, Narita, and Robin (2011) firms choose whether to enter the formal or informal sectors so in some sense their job characteristics is also endogenously determined; however, in Meghir, Narita, and Robin (2011), 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 heterogenous in their health,

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

thus employers endogenously choose job characteristics – namely wage and health insurance offering – by taking into account its influence on the initial composition of its workforce as well as the subsequent worker turnover. Therefore, although our primary focus is on the health insurance reform, our empirical framework is also useful to study other labor market issues such as how firms' decision of whether to offer training affects the type of workers they attract and subsequent human capital accumulation.

3 An Equilibrium of Model of Wage Determination and Health Insurance Provision

3.1 The Environment

Consider a labor market with a continuum of firms with measure normalized to 1 and a continuum of workers with measure $M > 0$.[12] They are randomly matched in a frictional labor market. Time is discrete, and indexed by $t = 0, 1, ...$, and we use $\beta \in (0, 1)$ to denote the discount factor for the workers.[13]

Workers have constant absolute risk aversion (CARA) preferences:

$$u(c) = -\exp(-\gamma c) \tag{1}$$

where $\gamma > 0$ is the absolute risk aversion parameter.

Workers' Health. Workers differ in their health status, denoted by h, and they can either be **H**ealthy (H) or **U**nhealthy (U) . In our model, a worker's health status has two effects. First, it affects the distribution of health expenditures. Specifically, we assume that the probability that a healthy worker experiences a bad health shock is given by q_B^H, and with the complementary probability $1 - q_B^H$ a healthy worker experiences a good health shock. For an unhealthy worker, the probability of experiencing a bad health shock is q_B^U, where $q_B^U > q_B^H$.[14] In order to capture the idea that an individual's health expenditure may be affected by whether he has health insurance, we assume that the medical expenditure for an individual with health insurance status $x \in \{0, 1\}$ upon experiencing a bad health shock is m_B^x where $m_B^1 > m_B^0$; similarly, the medical expenditure for an individual with health insurance status $x \in \{0, 1\}$ upon experiencing a good health shock is m_G^x where $m_G^1 > m_G^0$. Moreover, we assume that $m_G^1 < m_B^0$. We will use m_h to denote the

[12]Throughout the paper, we use "workers" interchangeably with "individuals", and "firms" interchangeably with "employers."

[13]In our empirical analysis, a "period" correponds to four months.

[14]The assumption that there are only two health shocks, namely good or bad health shocks, is for simplicity only. Allowing for the medical expenditure distributions conditional on health status to be continuous will not cause any complications for our analysis.

expected medical expenditure of worker with health status h, i.e.,

$$m_h = q_B^h m_B^1 + (1 - q_B^h) m_G^1. \tag{2}$$

Second, a worker's health status affects his productivity. Specifically, if an individual works for a firm with productivity p, he can produce p units of output if he is healthy, but he can produce only $d \times p$ units of output if he is unhealthy where $1 - d$ represents the productivity loss from being unhealthy.[15]

In each period, worker's health status changes stochastically according to a Markov Process. The period-to-period transition of an individual's health status depends on his health insurance status. We use $\pi_{h'h}^x \in (0, 1)$ to denote the probability that a worker's health status changes from $h \in \{H, U\}$ to $h' \in \{H, U\}$ conditional on coverage status $x \in \{0, 1\}$, where $x = 1$ means that the worker owns insurance. The transition matrix is thus, for $x = 0, 1$,

$$\boldsymbol{\pi}^x = \begin{pmatrix} \pi_{HH}^x & \pi_{UH}^x \\ \pi_{HU}^x & \pi_{UU}^x \end{pmatrix}, \tag{3}$$

where $\pi_{UH}^x = 1 - \pi_{HH}^x$ and $\pi_{HU}^x = 1 - \pi_{UU}^x$.

Firms. Firms are heterogeneous in their productivity. In the population of firms the distribution of productivity is denoted by $\Gamma(\cdot)$. We assume that Γ has an everywhere continuous and positive density function. In our empirical application, we assume that Γ is lognormal distribution with mean μ_p and variance σ_p^2, i.e., $p \sim \ln N(\mu_p, \sigma_p^2)$.

Firms, after observing their productivity, decide a package of wage and health insurance provision, denoted by (w, x) where $w \in R_+$ and $x \in \{0, 1\}$. If a firm offers health insurance to its workers, we assume that it has to pay a fixed administrative cost $C > 0$. We assume that any firm that offers health insurance to its workers is self-insured, and will charge an insurance premium from its workers each period to cover the necessary reimbursement of all the realized health expenditures in addition to the administrative cost C.[16]

Importantly, we assume, following the regulations in Health Insurance Portability and Accountability Act (HIPAA) which prohibits discrimination against employees and dependents based on their health

[15] One can alternatively assume that the productivity loss only occurs 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 the paper.

[16] In principle, firms should also be able to decide on the premium conditional on offering health insurance. However, as we show below, we will be requiring firms to be self-insured in our model. Thus, the insurance premium will be determined in equilibrium by the health distribution of workers for the firm in steady state.

status, that all the workers in a given firm will be assessed the *same* insurance premium *regardless of* their health status.[17]

Health Insurance Market. In the baseline model intended to capture the pre-ACA U.S. health insurance market, we assume that workers can obtain health insurance only if their employers offer them. This is a simplifying assumption meant to capture the fact that the individual private insurance market is tiny in the U.S. In our counterfactual experiment, we will consider the case of competitive private insurance market to mimic the State-based health insurance exchanges that would be established under the ACA.

Labor Market. Firms and workers are randomly matched in the labor market. In each period, an unemployed randomly meets a firm with probability $\lambda_u \in (0,1)$. He then decides whether to accept the offer, or to remain unemployed and search for jobs in next period. We assume that all new-born workers are unemployed.

If an individual is employed, he meets randomly with another firm with probability $\lambda_e \in (0,1)$ where $\lambda_e < \lambda_u$. If a currently employed worker receives an offer from another firm, he needs to decide whether to accept the outside offer or to stay with the current firm. An employed worker can also decide to return to the unemployment pool.[18] Moreover, each match is destructed exogenously with probability $\delta \in (0,1)$. If a match is destroyed exogenously, the worker will return to unemployment. We assume that individual may experience both the exogenous job destruction and the arrival of the new job offer within in the same period.[19]

To generate a steady state for the labor market, we assume that in each period any individual, regardless of health and employment status, will leave the labor market with probability $\rho \in (0,1)$. An equal measure of newborns will enter the labor market unemployed and their initial health status with be healthy with probability $\mu_H \in (0,1)$.

Income Taxes and Unemployment Benefit. Workers' wages and unemployment benefits are subject to tax schedule but the premium for employer-provided health insurance is assumed to be tax exempt in

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

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

[19]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.

the baseline model. We follow We specify the specification used by Kaplan (2011) for the *after-tax income* $T(y)$, which approximates the U.S. tax code:[20]

$$T(y) = \tau_0 + \tau_1 \frac{y^{(1+\tau_2)}}{1+\tau_2} \tag{4}$$

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

3.2 Timing in a Period

Now we describe the 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 assumption we use in the derivation of the value functions in Section 3.3. We believe that our particular timing assumption simplifies our derivation but it is not crucial.

1. Any individual, whether employed or unemployed, and regardless of his health status, may leave the labor market with probability $\rho \in (0,1)$;
2. If an employed worker stays in the labor market with a firm with productivity p, then:
   (a) he produces output p if healthy and pd if unhealthy;
   (b) the firm pays wage and collects insurance premium if health insurance is offered;
   (c) medical expenditure shock, the distribution of which depends on his beginning-of-the-period health status, is realized;
   (d) he then observes the realization of the health status that will be applicable next period;
   (e) he randomly meets with new employers with probability λ_e;
   (f) the current job will be terminated with probability $\delta \in (0,1)$, in which case the worker must decide whether to accept the outside offer, if any, or to enter unemployment pool;
   (g) if the current job is not terminated, then he decides whether to accept the outside offer if any, to stay with the current firm, or to quit into unemployment.
3. Any unemployed worker receives unemployment benefit b, and then will randomly meet with employers with probability λ_u, and decides whether to accept the offer if any, or to stay unemployed.
4. Time moves to the next period.

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

3.3 Analysis of the Model

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, for a postulated distribution of wage and insurance packages by the firms, denoted by $F(w,x)$, 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 (w,x). We then provide the conditions for the postulated $F(w,x)$ to be consistent with equilibrium.

3.3.1 Value Functions

We first introduce the notation for several valuation functions. We use $v_h(y,x)$ to denote the expected flow utility of workers with health status h from per period income y and insurance status $x \in \{0,1\}$; and it is give by:

$$v_h(y,x) = \begin{cases} u\left(T\left(y\right)\right) & \text{if } x = 1 \\ q_B^h u\left(T(y) - m_B^0\right) + \left(1 - q_B^h\right) u\left(T(y) - m_G^0\right) & \text{if } x = 0, \end{cases} \tag{5}$$

where we recall that q_B^h is the probability of experiencing a bad health shock for an individual with health status h, m_B^0 (respectively, m_G^0) is the medical expenditures for an uninsured individual when there is a bad (respectively, good) health shock and $T(y)$ is after-tax income. Note that when an individual is insured, i.e., $x = 1$, his medical expenditures are fully covered by the insurance. The fact that m_B^0 and m_G^0 are positive, together with risk aversion, implies that $v_h(y,1) > v_h(y,0)$; i.e., regardless of workers' health, if wages are fixed, then all workers desire health insurance. Moreover, because $q_B^U > q_B^H$ and $m_B^0 > m_G^0$, it can be easily shown that $v_U(y,1) - v_U(y,0) > v_H(y,1) - v_H(y,0)$.

Now let U_h denote the value function for an unemployed worker with health status h at the beginning of a period; and let $V_h(w,x)$ denote the value function for an employed worker with health status h working for a job characterized by wage-insurance package (w,x) at the beginning of a period. U_h and $V_h(\cdot,\cdot)$ are of course related recursively. U_h is given by:

$$\frac{U_h}{1-\rho} = v_h(b,0) + \beta \mathrm{E}_{h'|(h,0)} \left[\lambda_u \int \max\{V_{h'}(w,x), U_{h'}\} dF(w,x) + (1-\lambda_u) U_{h'} | (h,0) \right], \tag{6}$$

where the expectation $\mathrm{E}_{h'}$ is taken with respect of the distribution of h' conditional on the current health status h and insurance status $x = 0$ because unemployed workers are uninsured in the baseline model. (6) states that the value of being unemployed, normalized by the survival rate $1-\rho$, consists of the flow payoff $v_h(b,0)$, and the discounted expected continuation value where the expectation is taken with respect to the health status h' next period, whose transition is given by $\pi^0_{h'h}$ as described in (3). The unemployed worker may be matched with a firm with probability λ_u and the firm's offer (w,x) is drawn from the distribution

$F(w,x)$. If an offer is received, the worker will choose to whether to accept the offer by comparing the value of being employed at that firm $V_{h'}(w,x)$, and the value of remaining unemployed $U_{h'}$; if no offer is received, which occurs with probability $1-\lambda_u$, the worker's continuation value is $U_{h'}$.

Similarly, $V_h(w,x)$ is given by

$$\begin{aligned}\frac{V_h(w,x)}{1-\rho} &= v_h(w,x)+\beta\lambda_e\left\{\begin{array}{c}(1-\delta)\mathrm{E}_{h'}\left[\int\max\{V_{h'}(\tilde{w},\tilde{x}),V_{h'}(w,x),U_{h'}\}dF(\tilde{w},\tilde{x})|(h,x)\right]\\+\delta\mathrm{E}_{h'}\left[\int\max\left\{U_{h'},V_{h'}(\tilde{w},\tilde{x})\right\}dF(\tilde{w},\tilde{x})|(h,x)\right]\end{array}\right\}\\&+\beta(1-\lambda_e)\left\{(1-\delta)\mathrm{E}_{h'}\left[\max\left\{U_{h'},V_{h'}(w,x)\right\}|(h,x)\right]+\delta\mathrm{E}_{h'}[U_{h'}|(h,x)]\right\}.\end{aligned}\tag{7}$$

Note that in both (6) and (7), we used our timing assumption that a worker's health status next period depends on his insurance status this period even if he is separated from his job at the end of this period (see Section 3.2).

3.3.2 Workers' Optimal Strategies

Standard arguments can be used to show that worker's decision about whether to accept a job offer is characterized by reservation wage policies. Note that in our model, both unemployed and employed workers make decisions about whether to accept or reject an offer, and their reservation wages will depend on their state variables, i.e., their employment status including the terms of their current offer (w,x) if they are employed, and their health status.

Optimal Strategies for Unemployed Workers. First, consider an unemployed worker. As the right hand side of (5) is increasing in w, $V_h(w,x)$ is increasing in w. On the other hand, U_h is independent of w. Therefore, the reservation wage for unemployed worker with health status h is defined as

$$U_h=V_h(\underline{w}_h^x,x),\tag{8}$$

so that if an unemployed worker meets a job with offer (w,x), he will accept the offer if $w\geq\underline{w}_h^x$ and reject otherwise. Because a worker's expected flow utility $v_h(w,x)$ as described in (5) and the law of motion for health as described in (3) both depend on his current health and health insurance status, the reservation wages of the unemployed also differ across these status.

Optimal Strategies for Currently-Employed Workers: Job-to-Job Transitions. Now we consider the reservation wages for a currently-employed worker. Let (w,x) be the wage-insurance package offered by his current employer; and let (w',x') be the one offered by his potential employer. Then, the reservation wage for the employed worker with health status h to switch, denoted by $\underline{s}_h^{x'}(w,x)$, must satisfy

$$V_h(w,x)=V_h\left(\underline{s}_h^{x'}(w,x),x'\right).\tag{9}$$

A worker with health status h on a current job (w, x) will switch to a job (w', x') if and only if $w' > \underline{s}_h^{x'}(w, x)$. It is straightforward from (7) that

$$\underline{s}_h^{x'}(w, x) = w \text{ if } x = x'.$$

However, when $x \neq x'$, the exact value of $\underline{s}_h^{x'}(w, x)$ must be solved from (9); in particular, it will differ by worker's health and health insurance status. It can be easily shown that

$$\underline{s}_h^{x'}(w, x) > w \text{ if } x = 1, x' = 0; \; \underline{s}_h^{x'}(w, x) < w \text{ if } x = 0, x' = 1.$$

Once we solve $\underline{s}_h^{x}(\cdot, \cdot)$, we can use its definition as in (9) to obtain, for any new offer (w', x'),

$$V_h\left(w', x'\right) = V_h\left(\underline{s}_h^{x}(w', x'), x\right),$$

thus a worker with a current offer (w, x) will accept the new offer (w', x') if and only if

$$w < \underline{s}_h^{x}(w', x'). \tag{10}$$

We will use this characterization in the expressions for steady steady conditions in Section 3.3.3.

Optimal Strategies for Currently-Employed Workers: Quitting-to-Unemployment. Finally, a worker with health status h who is currently on a job (w, x) may choose to quit into unemployment. This may happen because of the changes in workers' health condition since he last accepted the current job offer and the assumption that the offer arrival probability is higher for unemployed worker than for an employed worker ($\lambda_e < \lambda_u$). Clearly a worker with health status h and health insurance status x will quit into unemployment only if the current wage w is below a threshold. Let us denote the threshold wages for quitting into unemployment by $\underline{q}_h^x$. Clearly, $\underline{q}_h^x$ must satisfy

$$V_h\left(\underline{q}_h^x, x\right) = U_h. \tag{11}$$

Comparing (11) with (8), it is clear that $\underline{q}_h^x = \underline{w}_h^x$. Thus we can conclude that employed workers will quit to unemployment only if his health status changed from when he first started on the job. Moreover, if $\underline{w}_H^x < \underline{w}_U^x$, then a currently unhealthy worker who accepted a job (w, x) with wage $w \in (\underline{w}_H^x, \underline{w}_U^x)$ when his health status was H may now quit into unemployment; if $\underline{w}_H^x > \underline{w}_U^x$ instead, then a currently healthy worker who accepted a job (w, x) with wage $w \in (\underline{w}_U^x, \underline{w}_H^x)$ when his health status was U may now quit into unemployment.

3.3.3 Steady State Condition

We will focus on the steady state of the dynamic equilibrium of the labor market described above. We first describe the steady state equilibrium objects that we need to characterize and then provide the steady state conditions.

In the steady state, we need to describe how the workers are allocated in their employment (w, x) and their health status h. Let u_h denote the measure of unemployed workers with health status $h \in \{U, H\}$; and let e_h^x denote the measure of employed workers with health insurance status $x \in \{0, 1\}$ and health status is $h \in \{U, H\}$. Of course, we have

$$\sum_{h\in\{U,H\}} (u_h + e_h^0 + e_h^1) = M. \tag{12}$$

Let $G_h^x(w)$ the *fraction* of employed workers with health status h working on jobs with insurance status x and wage below w, and let $g_h^x(w)$ be the corresponding density of $G_h^x(w)$. Thus, $e_h^x g_h^x(w)$ is the density of employed workers with health status h in sector x whose compensation package is (w, x).

These objects would have to satisfy the steady state conditions for unemployment as well as the allocations of workers across firms with different productivity. First, let us consider the steady state condition for unemployment. The inflow into unemployment with health status h is given by

$$\begin{aligned}
[u_h]^+ \quad \equiv \quad & (1-\rho)\left[\delta(1-\lambda_e) + \delta\lambda_e(F(\underline{w}_h^1, 1) + F(\underline{w}_h^0, 0))\right]\left[e_h^0\pi_{hh}^0 + e_h^1\pi_{hh}^1 + e_{h'}^0\pi_{hh'}^0 + e_{h'}^1\pi_{hh'}^1\right] && \text{(13a)}\\
& +(1-\rho)u_{h'}\pi_{hh'}^0[1-\lambda_u(1-F(\underline{w}_h^1, 1) - F(\underline{w}_h^0, 0))] + M\rho\mu_h && \text{(13b)}\\
& +(1-\rho)(1-\delta)\int^{\underline{w}_h^1} \pi_{hh'}^1 e_{h'}^1 g_{h'}^1(w)\left[1-\lambda_e(1-F(\underline{w}_h^1, 1) - F(\underline{w}_h^0, 0))\right] dw && \text{(13c)}\\
& +(1-\rho)(1-\delta)\int^{\underline{w}_h^0} \pi_{hh'}^0 e_{h'}^0 g_{h'}^0(w)\left[1-\lambda_e(1-F(\underline{w}_h^1, 1) - F(\underline{w}_h^0, 0))\right] dw. && \text{(13d)}
\end{aligned}$$

In the above expression, the term on line (13a) is the measure of employed workers who has health status h this period who did not leave the labor market but whose job is terminated and cannot find a job which is better than being unemployed; the first term on line (13b) is the measure of workers whose health status was h' last period but transitioned to h this period and who did not leave for employment; the second term on line (13b) is the measure of new workers born into health status h; and finally the terms on lines (13c) and (13d) are respectively the measures of workers currently working on jobs with and and without health insurance respectively quitting into unemployment. To understand these expressions, consider the term on line (13c). First, quitting into unemployment only applies to workers who did not die and whose job did not get terminated (i.e., $(1-\rho)(1-\delta)$ measure of them); second, note that quitting into unemployment at health status h this period is possible only if the worker's health status is h' in the previous period, because otherwise the worker would have quit already in the previous period; thus quitting into unemployment with health status h this period only comes from workers with health status h' last period and then transitioned to h this period, given by the term $\pi^1_{hh'}e^1_{h'}$; the rest of the term in the integrand is the accepted wage distribution of such workers.

The outflow from unemployment is given by:

$$[u_h]^- \equiv u_h \left\{\rho + (1-\rho)\left[\pi^0_{h'h} + \pi^0_{hh}\lambda_u(1 - F(\underline{w}^1_h, 1) - F(\underline{w}^0_h, 0))\right]\right\}. \tag{14}$$

It states that a ρ fraction of the unemployed with health status h will die and the remainder $(1-\rho)$ will either change to health status h' (with probability $\pi^0_{h'h}$), or if their health does not change (with probability π^0_{hh}) they may become employed with probability $\lambda_u(1 - F(\underline{w}^1_h, 1) - F(\underline{w}^0_h, 0))$. Then, in a steady-state we must have

$$[u_h]^+ = [u_h]^-, h \in \{U, H\}. \tag{15}$$

Now we provide the steady state equation for workers employed on jobs (w, x) with health status h. Note that the inflow of workers with health status h on jobs $(w, 1)$, denoted by $\left[e^1_h(w)\right]^+$, is given by:

$$\begin{aligned}\left[e^1_h(w)\right]^+ \quad \equiv \quad & (1-\rho)f(w,1)\left\{\begin{array}{c}\lambda_u\left(u_h\pi^0_{hh} + u_{h'}\pi^0_{hh'}\right) + (1-\delta)\lambda_e\left[\begin{array}{c}\pi^0_{hh}e^0_hG^0_h\left(\underline{s}^0_h(w,1)\right) + \pi^0_{hh'}e^0_{h'}G^0_{h'}\left(\underline{s}^0_{h'}(w,1)\right)\\ +\pi^1_{hh}e^1_hG^1_h(w) + \pi^1_{hh'}e^1_{h'}G^1_{h'}(w)\end{array}\right]\\ +\delta\lambda_e\left(\pi^0_{hh}e^0_h + \pi^0_{hh'}e^0_{h'} + \pi^1_{hh}e^1_h + \pi^1_{hh'}e^1_{h'}\right)\end{array}\right\}\\ & +(1-\rho)(1-\delta)\pi^1_{hh'}e^1_{h'}g^1_{h'}(w)\left[1 - \lambda_e\left(1 - \tilde{F}_h(w,1)\right)\right],\end{aligned} \tag{16}$$

where $h' \neq h$ and $\tilde{F}_h(w,1)$ is defined by

$$\tilde{F}_h(w,1) = F(w,1) + F(\underline{s}^0_h(w,1), 0). \tag{17}$$

In expression (16), the first term presents the inflows from unemployed workers with health status h; the second term presents inflows from workers who were employed on other jobs to job $(w, 1)$; and finally the third term is the inflow from workers who were employed on the same job but has experienced a health transition from h' to h and yet did not transition to other better jobs, which occurs with probability $\lambda_e\left[1 - \tilde{F}_h(w,1)\right]$.

Denote the outflow of workers with health status h from jobs $(w, 1)$ by $\left[e^1_h(w)\right]^-$, and it is given by

$$\left[e^1_h(w)\right]^- \equiv e^1_hg^1_h(w)\left\{\rho + (1-\rho)\left[\pi^1_{h'h} + \pi^1_{hh}\left(\delta + \lambda_e(1-\delta)\left(1 - \tilde{F}_h(w,1)\right)\right)\right]\right\}. \tag{18}$$

The outflows consists of job losses due to death and exogenous termination represented by the term $e^1_hg^1_h(w)\left(\rho + (1-\rho)\pi^1_{hh}\delta\right)$; changes in current workers' health status represented by the term $e^1_hg^1_h(w)(1-\rho)\pi^1_{h'h}$; and transitions to other jobs represented by the term $e^1_hg^1_h(w)\left(1-\rho\right)\pi^1_{hh}\lambda_e(1-\delta)\left(1 - \tilde{F}_h(w,1)\right)$.

The steady state condition requires that

$$\left[e_h^1(w)\right]^+ = \left[e_h^1(w)\right]^- \text{ for } h \in \{U, H\} \text{ and for all } w \text{ in the support of } F(w, 1). \tag{19}$$

Similarly, the inflows of workers with health status h into jobs $(w, 0)$, denoted by $\left[e_h^0(w)\right]^+$, are given by

$$\begin{aligned}\left[e_h^0(w)\right]^+ \quad = \quad & f(w,0)(1-\rho)\left\{\begin{array}{c}\lambda_u\left[u_h\pi_{hh}^0 + u_{h'}\pi_{hh'}^0\right] + \lambda_e(1-\delta)\left[\begin{array}{c}\pi_{hh}^1 e_h^1 G_h^1\left(\underline{s}_h^1(w,0)\right) + \pi_{hh'}^1 e_{h'}^1 G_{h'}^1(\underline{s}_{h'}^1(w,0)) \\ +\pi_{hh}^0 e_h^0 G_h^0(w) + \pi_{hh'}^0 e_{h'}^0 G_{h'}^0(w)\end{array}\right] \\ +\delta\lambda_e\left(\pi_{hh}^1 e_h^1 + \pi_{hh'}^1 e_{h'}^1 + \pi_{hh}^0 e_h^0 + \pi_{hh'}^0 e_{h'}^0\right)\end{array}\right\} \\ & +(1-\rho)(1-\delta)\pi_{hh'}^0 e_{h'}^0 g_{h'}^0(w)\left[1-\lambda_e\left(1-\tilde{F}_h(w,0)\right)\right],\end{aligned} \tag{20}$$

where $h \neq h'$ and $\tilde{F}_h(w, 0)$ is defined by

$$\tilde{F}_h(w,0) = F(w,0) + F(\underline{s}_h^1(w,0), 1). \tag{21}$$

The outflows of workers with health status h from jobs $(w, 0)$, denoted by $\left[e_h^0(w)\right]^-$, are given by:

$$\left[e_h^0(w)\right]^- = e_h^0 g_h^0(w)\left\{\rho + (1-\rho)\left[\pi_{h'h}^0 + \pi_{hh}^0(\delta + (1-\delta)\lambda_e(1-\tilde{F}_h(w,0))\right]\right\}. \tag{22}$$

The steady state condition thus requires that

$$\left[e_h^0(w)\right]^+ = \left[e_h^0(w)\right]^- \text{ for } h \in \{H, U\} \text{ and for all } w \text{ in the support of } F(w, 0). \tag{23}$$

From the four employment densities, $\langle e_h^x g_h^x(w) : h \in \{U, H\}, x \in \{0, 1\}\rangle$, we can define a few important terms related to firm size. First, given $\langle e_h^x g_h^x(w) : h \in \{U, H\}, x \in \{0, 1\}\rangle$, the number of employees with health status h if a firm offers (w, x) is simply given by

$$n_h(w,x) = \frac{e_h^x g_h^x(w)}{f(w,x)}, \tag{24}$$

where the numerator is the total density of workers with health status h on the job (w, x) and the denominator is the total density of firms offering compensation package (w, x). Of course, the total employee size if a firm offers compensation package (w, x) is

$$n(w,x) = \sum_{h\in\{U,H\}} n_h(w,x) = \sum_{h\in\{U,H\}} \frac{e_h^x g_h^x(w)}{f(w,x)}. \tag{25}$$

Expressions (24) and (25) allow us to connect the firm sizes in steady state as a function of the entire distribution of employed workers $\langle e_h^x g_h^x(w) : h \in \{U, H\}, x \in \{0, 1\}\rangle$.

3.3.4 Firm's Optimization Problem

Firms with a given productivity p decides what compensation package (w, x) to offer, taken as given the aggregate distribution of compensation packages $F(w, x)$. We assume that, before the firms make this decision, they each receive an i.i.d draw of ϵ from a Type-I extreme value distribution, which we interpret as an employer's specific preference of offering health insurance. We assume that the ϵ shock a firm receives is persistent over time and it is separable from firm profits.[21]

Given the realization of ϵ, each firm chooses (w, x) to maximize the steady-state flow profit *inclusive* of the shocks. It is useful to think of the firm's problem as a two-stage problem. First, it decides the wages that maximizes the deterministic part of the profits for a given insurance provision 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 as follows:

$$\max\{\Pi_0(p), \Pi_1(p) + \epsilon\}, \tag{26}$$

where

$$\Pi_0(p) = \max_{\{w_0\}} \Pi(w_0, 0) \equiv (p - w_0)\, n_H(w_0, 0) + (pd - w_0)\, n_U(w_0, 0); \tag{27}$$

$$\Pi_1(p) = \max_{\{w_1\}} \Pi(w_1, 1) \equiv [(p - w_1 - m_H)\, n_H(w_1, 1) + (pd - w_1 - m_U)\, n_U(w_1, 1)] - C. \tag{28}$$

To understand the expressions (27), note that $n_H(w_0, 0)$ and $n_U(w_0, 0)$ are respectively the measure of healthy and unhealthy workers the firm will have in the steady state as described by (24) if it offers compensation package $(w_0, 0)$. Thus, $(p - w_0)\, n_H(w_0, 0)$ is the firm's steady-state flow profit from the healthy workers and $(pd - w_0)\, n_U(w_0, 0)$ is the flow profit from the unhealthy workers. The expressions (28) can be similarly understood after recalling that m_h is the expected medical expenditure of worker with health status h as defined in (2). For future reference, we will denote the solutions to problems (27) and (28) respectively as $w_0(p)$ and $w_1(p)$.

Due to the assumption that ϵ is drawn from i.i.d. Type-I extreme value distribution, firms' optimization problem (26) thus implies that the fraction of firms offering health insurance among those with productivity p is

$$\Delta(p) = \frac{\exp(\Pi_1(p))}{\exp(\Pi_1(p)) + \exp(\Pi_0(p))}, \tag{29}$$

where $\Pi_0(p)$ and $\Pi_1(p)$ are respectively defined in (27) and (28).

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

3.4 Steady State Equilibrium

A *steady state equilibrium* is a list $\left\langle \left(\underline{w}_h^x, \underline{s}_h^x(\cdot,\cdot), \underline{q}_h^x\right), (u_h, e_h^x, G_h^x(w)), (w_x(p), \Delta(p)), F(w,x) \right\rangle$ such that the following conditions hold:

- **(Worker Optimization)** Given $F(w,x)$, for each $(h,x) \in \{U,H\} \times \{0,1\}$,
  - $\underline{w}_h^x$ solves the unemployed workers' problem as described by (8);
  - $\underline{s}_h^x(\cdot,\cdot)$ solves the job-to-job switching problem for currently employed workers as described by (9);
  - $\underline{q}_h^x$ describes the optimal strategy for currently employed workers regarding whether to quit into unemployment as described by (11);
- **(Steady State Worker Distribution)** Given workers' optimizing behavior described by $\left(\underline{w}_h^x, \underline{s}_h^x(\cdot,\cdot), \underline{q}_h^x\right)$ and $F(w,x)$, $(u_h, e_h^x, G_h^x(w))$ satisfy the steady state conditions described by (12), (15), (19) and (23);
- **(Firm Optimization)** Given $F(w,x)$ and the steady state employee sizes implied by $(u_h, e_h^x, G_h^x(w))$, a firm with productivity p chooses to offer health insurance with probability $\Delta(p)$ where $\Delta(p)$ is given by (29). Moreover, conditional on insurance choice x, the firm offers a wage $w_x(p)$ that solves (27) and (28) respectively for $x = 0$ and 1.
- **(Equilibrium Consistency)** The postulated distributions of offered compensation packages are consistent with the firms' optimizing behavior $(w_x(p), \Delta(p))$. Specifically, $F(w,x)$ must satisfy:

$$F(w,1) = \int_{\underline{p}}^{\overline{p}} \mathbf{1}(w_1(p) < w)\Delta(p)d\Gamma(p), \tag{30}$$

$$F(w,0) = \int_{\underline{p}}^{\overline{p}} \mathbf{1}(w_0(p) < w)\left[1-\Delta(p)\right]d\Gamma(p), \tag{31}$$

  where $\Gamma(\cdot)$ is the CDF of the firms' productivity.

4 Numerical Algorithm and Qualitative Assessment of the Model

Due to the complexity of the model, we cannot solve the equilibrium analytically. We instead solve the equilibrium numerically using the algorithm we describe below. The complexity of our model also prevents us from obtaining a proof the existence and uniqueness of the equilibrium, but, throughout extensive numerical simulations, we always find a unique equilibrium based on our algorithm. We then present numerical simulation results using parameter estimates that we will report in Section 7 to illustrate how our model can generate the positive correlation among wage, health insurance and firm size we discussed in the introduction. We also use the numerical simulations to provide an informal argument about how some of key parameters of model are identified.

4.1 Numerical Algorithm

1. **(Discretization of Productivity).** Discretize the support of productivity $[\underline{p}, \overline{p}]$ into N finite points $\{p_1, ..., p_N\}$, and calculate the probability weight of each $p \in \{p_1, ..., p_N\}$ using $\Gamma(p)$.[22]

2. **(Initialization).** Provide an initial guess of the wage policy function and the health insurance offer probability $(w_0^0(p), w_1^0(p), \Delta^0(p))$ for all $p \in \{p_1, ..., p_N\}$.

3. **(Iterations).** At iteration $\iota = 0, 1, ...$, do the following sequentially, where we index the objects in iteration ι by superscript ι :

   (a) Given the current guess of the wage policy function and the health insurance offer probability $(w_0^\iota(p), w_1^\iota(p), \Delta^\iota(p))$, construct the offer distribution $F^\iota(w, x)$ by using (31) and (30).

   (b) By using $F^\iota(w, x)$, numerically solve worker's optimal strategy $\left(\underline{w}_h^x, \underline{s}_h^x(\cdot, \cdot), \underline{q}_h^x\right)$ and calculate U_h and $V_h(w_x^\iota(p), x)$ for $h \in \{U, H\}$, $x \in \{0, 1\}$, and p on on support $[\underline{p}, \overline{p}]$. Moreover, calculate $V_h(w, x)$ for $w \in \mathcal{W}$, where $\mathcal{W}$ is the discrete set of potential wage choices.[23]

   (c) Calculate unemployment u_h^ι and employment distribution $e_h^{x,\iota} G_h^{x,\iota}(w_x^\iota(p))$ for all $p \in \{p_1, ..., p_N\}$ by solving functional fixed point equations (12), (15), (19) and (23);[24]

   (d) Calculate $n_h^\iota(w^\iota(p), x)$ and $n^\iota(w^\iota(p), x)$ for all p by respectively using (24) and (25). Moreover, calculate $n^\iota(w, x)$ for $w \in \mathcal{W}$;

   (e) Update the firm's optimal policy $(w_0^{*\iota}(p), w_1^{*\iota}(p), \Delta^{*\iota}(p))$ for all p using (27) and (28);[25]

   (f) Given $(w_0^{*\iota}(p), w_1^{*\iota}(p))$, calculate $\pi_0^{*\iota}(p)$ and $\pi_1^{*\iota}(p)$ from (27) and (28) and obtain $\Delta^{*\iota}(p)$ by using (29).

4. **(Convergence Criterion)**

[22] See Kennan (2006) for a discussion about the discrete approximation of the continuous distributions. In our empirical application, we set $N = 200$; and set $p_1 = 0.1$ and $p_N = 6$. We also experimented with $N = 800$. The results are similar.

[23] The number discrete values of potential wage choices is set to 400 in our empirical application.

[24] Although we do not have a proof that the unique fixed point exists, we always find the unique solution regardless of initial guess of u_h and $e_h^x G_h^x(w(p))$.

[25] See Lemma 2 for a numerical shortcut in the updating of $w_0^{\iota+1}(p)$ and $w_1^{\iota+1}(p)$.

(a) If $(w_0^{*\iota}(p), w_1^{*\iota}(p), \Delta^{*\iota}(p))$ satisfies $d(w_0^{*\iota}(p), w_0^{\iota}(p)) < \epsilon_{tol}$, $d(w_1^{*\iota}(p), w_1^{\iota}(p)) < \epsilon_{tol}$ and $d(\Delta^{*\iota}(p), \Delta^{\iota}(p)) < \epsilon_{tol}$ where ϵ_{tol} is a pre-specified tolerance level of convergence and $d(\cdot,\cdot)$ is a distance metric, then firm's optimal policy converges and we have an equilibrium.[26]

(b) Otherwise, update $(w_0^{\iota+1}(p), w_1^{\iota+1}(p), \Delta^{\iota+1}(p))$ as follows:

$$\begin{aligned} w_0^{\iota+1}(p) &= \omega w_0^{\iota}(p) + (1-\omega) w_0^{*\iota}(p), \\ w_1^{\iota+1}(p) &= \omega w_1^{\iota}(p) + (1-\omega) w_1^{*\iota}(p), \\ \Delta^{\iota+1}(p) &= \omega \Delta^{\iota}(p) + (1-\omega) \Delta^{*\iota}(p), \end{aligned}$$

for $\omega \in (0,1)$ and continue Step 3 at iteration $\iota' = \iota + 1$.

Given our convergence criterion, it is clear that the convergence point of our numerical algorithm will correspond to steady state equilibrium of our model.

4.2 Numerical Simulations

In Column (1) of Table 1, we report the main implication obtained from our benchmark model using parameter estimates that we report in Section 7. It shows that our baseline model is able to replicate the positive correlation among coverage rate, average wage, and employer size. Moreover, it also generates the empirically consistent prediction that the average health status of employees at firms offering health insurance is relatively better compared with employers not offering health insurance.

In Table 2, we use the estimates from Section 7 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 productivity levels in our discretized productivity distribution. Table 2 shows that, in steady state, the fraction of unhealthy workers in low and high productivity firms that offer health insurance are respectively 4.582% and 3.645%; in contrast, the fraction of unhealthy workers in low and high productivity firms that do not offer health insurance are respectively 9.969% and 10.889%. Offering health insurance seems to improve the health composition of workers over not offering health insurance for high-productivity firms, more so than for the low productivity firms.

In Panel A, we show that among the new hires, including those hired directly from unemployment pool and those poached from other firms, for low-productivity firms the fraction of unhealthy is 7.575% if they offer health insurance and 7.444% if they do not; in contrast, for high-productivity firms the fraction of unhealthy is 5.467% if they offer health insurance and 5.463% if they do not. Indeed the new hires

[26] In solving for the equilibrium we set ϵ_{tol} to 1.0e-6.

Statistics	Benchmark	$\widehat{C}=0$	$\widehat{\pi^0_{hh'}=\pi^1_{hh'}}$	$\widehat{\gamma}=0.5$	$\widehat{d}=1.00$
	(1)	(2)	(3)	(4)	(5)
Fraction of Firms Offering Health Insurance	0.52	0.53	0.50	0.51	0.50
... if firm size is less than 50	0.49	0.50	0.49	0.49	0.49
...if firm size is at least 50	0.81	0.81	0.53	0.76	0.55
Fraction of Firms with Less than 50 Workers	0.91	0.91	0.91	0.90	0.91
Average (4-month) Wages of Employed Workers	0.89	0.89	0.92	0.90	0.95
... for insured employees	0.94	0.94	0.92	0.95	0.95
... for uninsured employees	0.73	0.73	0.92	0.75	0.95
Fraction of Healthy Workers	0.95	0.95	0.9643	0.94	0.93
... among the uninsured workers	0.90	0.90	0.9644	0.90	0.89
... among the insured workers	0.96	0.96	0.9642	0.96	0.96

Table 1: Predictions of the Baseline Model: Benchmark and Comparative Statistics.

Notes: (1). The benchmark predictions are based on the parameter estimates reported in Section 7. (2). The average wages are in units of $10,000.

attracted to firms that offer health insurance is somewhat unhealthier, which is 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 fact that, a high-productivity firm offering health insurance can poach workers from a much wider range of firms, including a larger fraction of workers who worked in firms that already offer insurance and thus are healthier; in contrast, a low-productivity firm offering health insurance can only poach workers from firms with even lower productivity, most of which do not offer health insurance and thus have less healthy workers.

In Panel B, we show that any adverse selection effect that a firm offering health insurance suffers in terms of the health composition of their new hires is quickly remedied by the positive effect of health insurance on health. We show that, just one-period later, the new hires' health composition is already in favor of firms that offer health insurance. For low-productivity firms, the fraction of unhealthy workers among those hired a period (4-months) ago is 6.454% and 8.434% respectively in those offering health insurance and those not offering health insurance. Similarly, for high-productivity firms, the fraction of unhealthy workers among those hired a period ago is 4.937% and 6.989% respectively in those offering health insurance and those not offering health insurance. The effects is even stronger after nine-periods (3 years).

Finally, in Panel C, 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. It shows that the job-to-job transition rates for workers in high-productivity firms, regardless of their health status, is significantly

Statistics	Low-Productivity Firms HI	Low-Productivity Firms No HI	High-Productivity Firms HI	High-Productivity Firms No HI
Fraction of Unhealthy Workers in Steady State	0.04582	0.09969	0.03645	0.10889
	Panel A: Adverse Selection Effect			
Fraction of Unhealthy Among New Hires	0.07575	0.07444	0.05467	0.05463
	Panel B: Health Insurance Effect on Health			
One-Period Ahead Fraction of Unhealthy Among New Hires	0.06454	0.08434	0.04937	0.06989
Nine-Period Ahead Fraction of Unhealthy Among New Hires	0.03785	0.10877	0.03673	0.10751
	Panel C: Retention Effect			
Job-to-Job Transition Rate for Healthy Workers	0.08484	0.09903	4.9066E-9	3.6084E-7
Job-to-Job Transition Rate for Unhealthy Workers	0.08484	0.09903	4.9066E-9	1.3347E-5

Table 2: Understanding Why High-Productivity Firms Are More Likely to Offer Health Insurance than Low Productivity Firms.

Notes: For the simulations reported in this table, the low-productivity and high productivity firms are the firms with the bottom 20 and top 20 values of productivity in our discretized productivity support. See Footnote 22.

lower than that in low-productivity firms.

4.3 Comparative Statics

In Columns (2)-(5) of Table 1 we also present some comparative statics result to shed light on the effects of different parameters on the equilibrium features. This sheds light on how different parameters may be identified in our empirical estimation.

Fixed Administrative Cost of Offering Health Insurance. In Column (2), we investigate the effect of the fixed administrative cost C on coverage rate, by setting it to 0, as supposed to the estimated value of $C = 0.0585$. Comparing the results in Column (2) with the benchmark results in Column (1), we find that lowering the fixed administrative cost of offering health insurance affects mainly the coverage rate for small firms. Its effect for large firms is virtually zero. Moreover, it does not affect other outcomes. Although we still have a positive correlation between coverage and firm size, the coverage rate for small firms is around 50% if $C = 0$.

Health Insurance Effect on Health. In Column (3), we shut down the effect that health insurance affects the dynamics of health status by assuming that health transition process for the uninsured is the same as that of the insured, $\widehat{\pi^0_{h'h}} = \pi^1_{h'h}$, implying that health composition of the economy must be better.[27] Column (3) of Table 1 shows that the fraction of large firms offering health insurance decrease significantly when $\widehat{\pi^0_{h'h}}$ is set to be equal to $\pi^1_{h'h}$. Moreover, this change significantly reduces the positive correlation between wage and health insurance. Therefore, the health insurance effect on health substantially affects the relationship among coverage, wage, and employer size in our model.

The reason why large employers decide not to offer health insurance when $\widehat{\pi^0_{h'h}} = \pi^1_{h'h}$ can be understood as follows. When $\widehat{\pi^0_{h'h}} = \pi^1_{h'h}$, i.e., when health insurance provision does not influence the dynamics of worker's health status, the health composition of a firm's workforce is fully determined by initial health selections of the workers when they accept the offer. The bottom two cells in Column (3) show that health composition of employers offering health insurance is worse than that of employers who do not, because health insurance provision attract more unhealthy workers. This creates an adverse selection problem, thus leading to some firms not to provide coverage.

Risk Aversion. In Column (4) of Table 1 we simulate the effect on the equilibrium when we decrease the CARA coefficient from the estimated value of 1.4221 in Table 8 to 0.5. A reduction in CARA risk aversion leads to a significant reduction in the health insurance offering rate for the large firms. It also increases the average wages in firms without health insurance.

Productivity Effect of Health In Column (5) of Table 1 we investigate the productivity effect of health by increasing d from 0.1506 in Table 8 to 1.00, which eliminates the negative productivity effect of bad health. Column (5) shows that the absence of the negative productivity effect of bad health leads to a substantial reduction of the coverage rate for the large employers relative to the benchmark. The reason is that, in the benchmark when bad health reduces productivity, the large firms tend to retain workers longer, so they have stronger incentive than smaller firms to improve the health of their workforce in order to raise the expected flow profit.

4.4 Identification of γ, d and C

As shown in Columns (2) and (4)-(5) in Table 1, the absolute risk aversion parameter γ, the productivity effect of health d, and the fixed administrative cost of offering health insurance C, all have important effects on the firms' incentives to provide health insurance. How are they separately identified? Here we provide some "heuristic" discussion. As we detail in Section 6, we will be using in our estimation both worker-side

[27] We can obtain the same qualitative result in the opposite scenario, where health transition of the insured is set to be equal to that estimated for the uninsured, i.e., $\widehat{\pi^1_{h'h}} = \pi^0_{h'h}$. This would imply that the health composition of the economy will be worse.

data which has information about workers' labor market dynamics and firm-side data that has information about firm size, wages and health insurance offering.

While it is true that the absolute risk aversion parameter γ affects the firms' incentives to provide insurance as shown in Column (4) of Table 1, it also affects the workers' job-to-job transitions. In particular, if γ is larger (i.e. when workers are more risk averse), we would expect to observe *more frequent* transitions of workers from jobs *without* health insurance to a job *with* health insurance, especially after a deterioration of health status, and even if the transition involves a reduction in wages. Moreover, the magnitude of the wage cut a worker is willing to tolerate in order to switch from a job without health insurance to a job with health insurance increases with the risk aversion parameter γ.These effects are not shown in Table 1, but will be incorporated in our estimation via the likelihood function of the workers' job market transition dynamics.

As shown in Columns (4) and (5) in Table 1, both the productivity effect of health d and risk aversion γ affect the relationship between the probability of offering health insurance and firm size. However, since the risk aversion parameter γ is disciplined by the worker-side job-to-job transition information as we described above, the parameter d is then pinned down to fit the observed *slope* between the firm size and insurance offering probability from the firm-side data. Finally, the administrative cost C is identified from the the probability (in *level*) of small firms offering health insurance.

5 Data Set

In this section, we describe our data set and its sample selection. In order to estimate the model, it is ideal to use single employee-employer matched data which contains information about worker's labor market outcome and its dynamics, health, medical expenditure, and health insurance, and employer's insurance coverage rate and size. Unfortunately, such a data set does not exist in the U.S. Instead, we combine three separate data sets for our estimation: (1) Survey of Income and Program participation; (2) Medical Expenditure Panel Survey; and (3) Robert Wood Johnson Employer Health Insurance Survey.

5.1 Survey of Income and Program Participation

Our main dataset for individual labor market outcome, health, and health insurance is 1996 Panel of Survey of Income Program Participation (hereafter, SIPP 1996).[28] SIPP 1996 interviews individuals *every four months* up to twelve times, so that an individual may be interviewed over a four-year period. It consists of two parts: (1) core module, and (2) topical module. The core module, which is based on interviews

[28]SIPP 1996 Panel is available at: `http://www.census.gov/sipp/core_content/1996/1996.html`

in each wave, contains detailed *monthly* information regarding individuals' demographic characteristics and labor force activity, including earnings, number of weeks worked, average hours worked, employment status, as well as whether the individual changed jobs during each month included in the survey period. In addition, information for health insurance status is recorded in each wave; it also specifies the source of insurance so 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 name or the spouse's name. The topical module, which is based on *annual* interviews (i.e. at interview waves 3, 6, 9 and 12), contains yearly information about the worker and his/her family member's self reported health status and *out-of-pocket* medical expenditure.[29] For our estimation, we match the core module with the topical module.

Sample Selection Criterion. The total sample size after matching the topical module and the core module is 115,981. In order to have an estimation sample that is somewhat homogeneous in skills, we restrict our sample to men (dropping 59,846 female individuals) whose age is between 26-46 (dropping an additional 38,016 individuals). In addition, we only keep an individual who is not in school, does not work as a self-employment, does not work in a public sector, dose not engage in military service, and does not participate in any government welfare program (dropping an additional 6,995 individuals). We also require that our sample is covered either by an employer-based health insurance in his own name or is uninsured (dropping an additional 1,948 individuals). We restrict our samples to individuals who are at most high school graduates (dropping 3,060 individuals). Finally we drop top and bottom 3% of salaried workers (dropping an additional 817 individuals). Our final sample that meets our above sample selection criterion has a total of 5,309 individuals.

5.2 Medical Expenditure Panel Survey (MEPS)

The weakness of using SIPP data for our research is the lack of information for total medical expenditure. To obtain the information, we use Medical Expenditure Panel Survey (hereafter, MEPS) 1997-1999. 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-year and a half period.[30] Medical expenditure is recorded at annual frequency. Several health status related variables are recorded in each wave. Moreover, health insurance status is recorded at monthly level. We use the same sample selection criteria as SIPP 1996.

[29] In both SIPP and MEPS, we use the self-reported health status to construct whether the individual is healthy or unhealthy. The self-reported health status has five categorie. We categorize "Excellent", "Very Good" and "Good" as *Healthy* and "Fair" and "Poor" as *Unhealthy*.

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

The sample size is 4,815.

5.3 Robert Wood Johnson Foundation Employer Health Insurance Survey

In addition, we also need information for employer size and associated health insurance offering rate, which is not available from worker side data like SIPP. The data source we use is 1997 Robert Wood Johnson Foundation Employer Health Insurance Survey (hereafter, RWJ-EHI).[31] It is a nationally representative survey of public and private establishments conducted in 1996 and 1997. It contains information about employer's characteristics such as industry, firm size, and employees' demographics, as well as information about health insurance such as whether their workers purchase health insurance from the employer, health insurance plans, employees' eligibility and enrollment in health plans, and the plan type.

We restrict the sample to establishments which belongs to private sectors and has at least 3 employees. The final sample size is 19,089.

5.4 Summary Statistics

Table 3 reports the summary statistics of key variables in SIPP 1996. About 76% of the employed workers receive health insurance from their employers; the average 4-month wage for employed workers with health insurance is about $9,240, higher than that for those without health insurance which is about $6,187. The unemployment rate for our selected sample is about 3.18%, lower than the overall unemployment rate in the U.S. in 1996 (which was about 5.4%).[32] About 95.11% of our sample reported their health to be healthy (i.e. either "Good", "Very Good", or "Excellent"). Moreover,it is important to note that 95.36% of the workers with insurance reported healthy, in contrast, 93.89% of those without insurance reported healthy. We will discuss later in the paper how we can account for such differences in the health compositions of workers in firms offering health insurance vs. those in firms not offering health insurance.

In Table 4 we report the comparison of summary statistics for the individuals in MEPS 1997-1999 and those in SIPP 1996. Overall, MEPS under-estimates both the fraction of healthy workers and the fraction of employed workers who own health insurance. By using the mean expenditure given health and health insurance, we also report the annual average medical expenditure implied from SIPP's health and health insurance composition. It shows that annual medical expenditure is not so much different.

Finally, in Table 5 we provide the summary statistics for our firm side data based on RWJ-EHI 1997. In general, firms that tend to offer health insurance have large size in employment and provide higher wage. Moreover, the magnitude of wage both unconditional and conditional on insurance status is very close

[31] It is publicly available at `http://www.icpsr.umich.edu/icpsrweb/HMCA/studies/2935`

[32] See U.S. Department of Labor, Bureau of Labor Statistics at website: `http://stats.bls.gov`.

Variable	Mean	Std. Dev.
Fraction of Insured Among Employed Workers	0.7619	0.4260
Average (4-Month) Wages for Employed Workers	0.8538	0.3532
... for insured employees	0.9240	0.3462
... for uninsured employees	0.6187	0.2750
Fraction of Unemployed Workers	0.0318	0.1758
Fraction of Healthy Workers	0.9511	0.2177
... among insured workers	0.9536	0.2103
... among uninsured workers	0.9389	0.2398

Table 3: Summary Statistics: SIPP 1996. Notes: The average wages are in units of $10,000.

to one reported in SIPP 1996. Therefore, although we restrict samples to relatively unskilled workers in SIPP, we do not lose a lot of consistency between worker side and employer side at least for compensation pattern.

6 Estimation Strategy

In this section we present our strategy to structurally estimated our baseline model using the dataset we described above. We estimate parameters regarding health transitions and medical expenditure distribution without using the model. The remaining parameter is estimated via a minimum-distance estimator which follows Imbens and Lancaster (1994) and Petrin (2002). They consider the situation where moments come from different data sources. In this study we construct worker-side moments from the likelihood of individuals' labor market transition, as in Bontemps, Robin, and Van den Berg (1999, 2000) and Shephard (2011). Then, we construct employer-side moments such as firm size distribution and firm's coverage rate conditional on their size from employer side micro data. We choose the parameters to fit the data in *both* sides of labor markets. This is the main difference from the existing estimation procedure used in Bontemps, Robin, and Van den Berg (1999, 2000) and Shephard (2011), where model parameters are chosen to fit worker side data and consequently they can estimate productivity distribution nonparametrically so that the model's wage distribution of workers perfectly fits with the data. On the other hand, by incorporating employer side moments, our model is overidentified. As a result, instead of following their approach, we assume that productivity distribution follows parametric distribution and it is estimated, jointly with other parameters, to fit both the wage distribution and the firm size distribution. As we mentioned in Section 3.1, we specify that the productivity distribution is given by a lognormal distribution with mean μ_p and variance σ_p^2.

Variable	MEPS (1)	SIPP (2)
Fraction of Healthy Workers	0.91 (0.28)	0.95 (0.22)
Fraction of Insured Among Employed Workers	0.65 (0.47)	0.76 (0.43)
Annual Medical Expenditure	0.08 (0.34)	0.079*
... for those with health insurance and who are healthy	0.078 (0.27)	-
... for those without health insurance and who are healthy	0.043 (0.37)	-
... for those with health insurance and who are unhealthy	0.293 (0.60)	-
... for those without health insurance and who are unhealthy	0.133 (0.45)	-

Table 4: Summary Statistics: Comparison between MEPS 1996-1999 and SIPP 1996.

Notes: (1). The average wages are in units of $10,000. (2). Standard deviations are in parentheses. (Note *). The annual medical expenditure for SIPP is imputed based on the average annual medical expenditures for workers of different health insurance and health status combinations computed from MEPS (reported in Column (1)), using the factions of the workers of the four health insurance and health status combinations that can be calculated from Table 3.

In our empirical application, we set the model period as four month, which is motivated by the fact that we can only observe the transition of health insurance status at four-month frequency in the SIPP data. In this paper, we do not try to estimate β but set $\beta = 0.99$ so that annual interest rate is 4%. It is known from Flinn and Heckman (1982) that separately identifying the discount factor β from flow unemployed income b is difficult in the standard search model. Moreover, we set the exogenous death rate is set so that $\rho = 0.001$.[33] Finally, we adopt the after-tax income schedule in (4) from that estimated by Kaplan (2011): $\tau_0 = 0.0056$, $\tau_1 = 0.6377$, and $\tau_2 = -0.1362$.

6.1 First Step

In Step 1 we estimate parameters of the medical expenditures $\left\langle m_B^0, m_G^0, m_B^1, m_G^1 \right\rangle$ and the probability of bad health shocks conditional on health $\left\langle q_B^H, q_B^U \right\rangle$, as well as the health transitions $\boldsymbol{\pi}$ as in (3) without explicitly using the model.

We estimate the parameters in medical expenditure distributions (q_B^H, q_B^U, m_B^0, m_G^0, m_B^1, m_G^1) by GMM using the MEPS. The sample target moments are mean, variance, skewness, and kurtosis of medical expenditure conditional on health and health insurance status. For simplicity, we estimate these parameters using a subsample of individuals whose health and health insurance status are *unchanged* throughout the year. The *annual* theoretical moments conditional on health insurance and health status are constructed

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

Variable Name	Mean	Std. Dev.
Average Establishment Size	19.92	133.40
... for those that offer health insurance	30.08	177.24
... for those that do not offer health insurance	6.95	11.03
Health Insurance Coverage Rate	0.56	0.50
... for those with less than 50 workers	0.53	0.50
... for those with 50 or more workers	0.95	0.23
Average Annual Wage Compensation, in $10,000	2.53	2.44
... for those that offer health insurance	2.92	2.50
... for those that do not offer health insurance	2.03	2.27

Table 5: Summary Statistics: RWJ-EHI 1997. Note: Standard deviations are in parentheses.

from parameters which are defined for a 4-month period model. We have 16 moments and 6 parameters. We use weighting matrix as the diagonal matrix where each diagonal element is the inverse of variance of each sample moment.

Because we are assuming that the effect of health insurance and health status on medical shocks and medical expenditures are exogenous, our restriction to the subsample of individuals whose health and health insurance status are *unchanged* throughout the year does not create a biased sample for our estimation purpose. However, it is useful to recognize that this subsample differs from the overall MEPS sample. Table 6 provides the analogous summary statistics of the MEPS subsample we used in our estimation.[34] The comparison of Table 6 and 4 shows that the magnitudes of medical expenditure are substantially lower in this subsample than those the overall sample.

We estimate the parameters in health transition matrix $\langle \pi^1_{HH}, \pi^1_{UU}, \pi^0_{HH}, \pi^0_{UU} \rangle$ using SIPP 1996 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 for each period (every four months), we observe health status only every *three* periods (a year). We deal with this issues as follows. Let $x_t \in \{0, 1\}$ be worker's insurance status at period t, and let $h_t \in \{H, U\}$ and $h_{t+3} \in \{H, U\}$ denote respectively the worker's health status in period t and $t + 3$ (when it is next measured), the likelihood of observing $h_{t+3} \in \{H, U\}$ conditional on

[34]The sample size is 2,892.

Variable	Mean	Std. Dev.
Fraction of Healthy Workers	0.97	0.16
Fraction of Insured Among Employed Workers	0.64	0.48
Annual Medical Expenditure, in \$10,000	0.06	0.34
... for those with health insurance and who are healthy *throughout the year*	0.067	0.20
... for those without health insurance and who are healthy *throughout the year*	0.036	0.40
... for those with health insurance and who are unhealthy *throughout the year*	0.480	0.93
... for those without health Insurance and who are unhealthy *throughout the year*	0.125	0.30

Table 6: Summary Statistics of the Subsample of the MEPS 1996-1999 Used in the Estimation of Medical Expenditure Distributions in the First Step.

x_t, x_{t+1}, x_{t+2} and $h_t \in \{H, U\}$ are as:

$$\begin{aligned}
\Pr(h_{t+3} &= H|x_t, x_{t+1}, x_{t+2}, h_t = H) = \pi_{HH}^{x_t}\pi_{HH}^{x_{t+1}}\pi_{HH}^{x_{t+2}} + \pi_{HH}^{x_t}(1-\pi_{HH}^{x_{t+1}})(1-\pi_{UU}^{x_{t+2}}) \\
&\quad +(1-\pi_{HH}^{x_t})(1-\pi_{UU}^{x_{t+1}})\pi + (1-\pi_{HH}^{x_t})\pi_{UU}^{x_{t+1}}(1-\pi_{UU}^{x_{t+2}}); \\
\Pr(h_{t+3} &= U|x_t, x_{t+1}, x_{t+2}, h_t = H) = \pi_{HH}^{x_t}\pi_{HH}^{x_{t+1}}(1-\pi_{HH}^{x_{t+2}}) + \pi_{HH}^{x_t}(1-\pi_{HH}^{x_{t+1}})\pi_{UU}^{x_{t+2}} \\
&\quad +(1-\pi_{HH}^{x_t})(1-\pi_{UU}^{x_{t+1}})(1-\pi_{HH}^{x_{t+2}}) + (1-\pi_{HH}^{x_t})\pi_{UU}^{x_{t+1}}\pi_{UU}^{x_{t+2}}; \\
\Pr(h_{t+3} &= H|x_t, x_{t+1}, x_{t+2}, h_t = U) = (1-\pi_{UU}^{x_t})\pi_{HH}^{x_{t+1}}\pi_{HH}^{x_{t+2}} + (1-\pi_{UU}^{x_t})(1-\pi_{HH}^{x_{t+1}})(1-\pi_{UU}^{x_{t+2}}) \\
&\quad +\pi_{UU}^{x_t}(1-\pi_{UU}^{x_{t+1}})\pi_{HH}^{x_{t+2}} + \pi_{UU}^{x_t}\pi_{UU}^{x_{t+1}}(1-\pi_{UU}^{x_{t+2}}); \\
\Pr(h_{t+3} &= U|x_t, x_{t+1}, x_{t+2}, h_t = U) = (1-\pi_{UU}^{x_t})\pi_{HH}^{x_{t+1}}(1-\pi_{HH}^{x_{t+2}}) + (1-\pi_{UU}^{x_t})(1-\pi_{HH}^{x_{t+1}})\pi_{UU}^{x_{t+2}} \\
&\quad +\pi_{UU}^{x_t}(1-\pi_{UU}^{x_{t+1}})(1-\pi_{HH}^{x_{t+2}}) + \pi_{UU}^{x_t}\pi_{UU}^{x_{t+1}}\pi_{UU}^{x_{t+2}}.
\end{aligned}$$

We use these 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 $\boldsymbol{\pi}^x$, for $x \in \{0, 1\}$, as in (3) in our model.

6.2 Second Step

In the second step, we estimate the remaining parameters $\theta = (\theta_1, \theta_2)$ where $\theta_1 = (\lambda_u, \lambda_e, \delta, \gamma, \mu, b)$ are parameters that affect worker-side dynamics, and $\theta_2 = (C, d, M, \mu_p, \sigma_p)$ are the additional parameters that are relevant to the firm-side equilibrium. Our objective function is based on the optimal GMM which consists of two types of moments. The first set of moments are derived from the worker-side data in SIPP in the form of the log-likelihood of the observed labor market dynamics of the workers, which we aim to maximize by requiring that the first derivatives should be equal to zero, following Imbens and Lancaster (1994). The second set of moments come from the firm-side data RWJ-EHI.

Specifically, let the targeted moments be

$$g(\theta) = \begin{bmatrix} \frac{\sum_i \partial \log(L_i(\theta_1))}{\partial \theta_1} \\ \mathbf{s} - \mathrm{E}[\mathbf{s};\theta] \end{bmatrix}, \tag{32}$$

where $L_i(\theta_1)$ is individual i's contribution to the labor market dynamics likelihood, which we discuss in details in Section 6.2.1; and $\mathbf{s}$ is a vector of firm-side moments we describe in Section 6.2.2. Then, we construct an objective function as

$$\min_{\{\theta\}} g(\theta)'\Omega g(\theta), \tag{33}$$

where the weighting matrix Ω is chosen as a consistent estimator of $\mathrm{E}[g(\theta)g(\theta)']^{-1}$, which is obtained using $\tilde{\theta}$, a preliminary consistent estimate of θ. As in Petrin (2002), we first assume that $\mathrm{E}[g(\theta)g(\theta)']$ takes block diagonal matrix because different moments come from different sampling processes. Let $G(\theta) = \mathrm{E}[\frac{\partial g(\theta)}{\partial \theta'}]$, the gradient of the moments with respect to the parameters evaluated at the true parameter values. The asymptotic variance of $\sqrt{n}\left(\hat{\theta} - \theta\right)$ is then given by

$$\left[G(\theta)'G(\theta)\right]^{-1}\left[G(\theta)'\Omega G(\theta)\right]\left[G(\theta)'G(\theta)\right]^{-1},$$

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

6.2.1 Deriving the Likelihood Functions of Workers' Labor Market Dynamics

Here we derive the likelihood functions of workers' labor market dynamics similar to those in Bontemps, Robin, and Van den Berg (1999, 2000). Let $F(w, x)$ denote the distribution of (w, x) in the labor market.

We will first derive the likelihood contribution of the labor market transitions of *unemployed workers.* Consider an unemployed worker at period 1 with health status is h_1, who experiences an unemployment spells l and in period $l+1$ transitions to a job $(\tilde{w}, x)$. Moreover, suppose that the observed health history between $j = 1$ to $l+1$ being $(h_1, h_2, ..., h_{l+1})$. The likelihood contribution of observing such a transition is:

$$\frac{u_{h_1}}{M} \times \Pi_{j=2}^{l}\left\{\Pr(h_j|h_{j-1}) \times \left[(1-\lambda_u) + \lambda_u\left(F\left(\underline{w}_{h_j}^1, 1\right) + F\left(\underline{w}_{h_j}^0, 0\right)\right)\right]\right\} \tag{34a}$$

$$\times \Pr(h_{l+1}|h_l) \times [\lambda_u f(\tilde{w}, 1)]^{\mathbf{1}(x=1)} \times [\lambda_u f(\tilde{w}, 0)]^{\mathbf{1}(x=0)} \tag{34b}$$

where $\mathbf{1}(x = 1)$ is an indicator function such that it takes one if we observe a transition to employment with $(\tilde{w}, 1)$ at period $l+1$, and similarly $\mathbf{1}(x = 0)$ is an indicator function such that it takes one if we observe a transition to employment with $(\tilde{w}, 0)$ at period $l+1$. To understand (34), note that the first term in line (34a), u_h/M, reflects the assumption that the initial condition of individuals is drawn from steady state worker distribution because u_h/M the probability that an unemployed worker with health status h is sampled. The second term in line (34a) is the probability that individual experiences l periods of unemployment with health status transitions $(h_2, ..., h_l)$ during the process; note that the term $\left[(1-\lambda_u)+\lambda_u(F(\underline{w}^1_{h_j},1)+F(\underline{w}^0_{h_j},0)\right]$ is the probability that the individual does not receive an offer or receives an offer that is lower than the relevant reservation wages $\underline{w}^1_{h_j}$ or $\underline{w}^0_{h_j}$. The term on line (34b) is the probability that his health transitions from h_l to h_{l+1} in period $l+1$ and receive an acceptable offer $(\tilde{w}, x)$ from the relevant density function $f(\tilde{w}, x)$.

We can similarly derive the likelihood contribution of the job dynamics of *employed workers.* Consider an employed worker in period 1 with health status h_1 working on a job with compensation package (w, x). Suppose that the worker experiences a job status changes in period $l+1$, and suppose that the Suppose that observed health history between $j = 1$ to $l+1$ being $(h_1, h_2, ..., h_{l+1})$. For an employed worker, there are four possible changes in job status:

- [Event *"Job Loss"*] the individual experienced a job loss at period $l+1$;
- [Event *"Switch 1"*] the individual transitioned to a job $(\tilde{w}, x')$ such that $x' = x$ and the accepted wage is $\tilde{w} > w$;
- [Event *"Switch 2"*] the individual transitioned to a job $(\tilde{w}, x')$ such that $x' = x$ and the accepted wage is $\tilde{w} < w$;
- [Event *"Switch 3"*] the individual transitioned to a job $(\tilde{w}, x')$ such that $x' \neq x$ and the accepted wage is $\tilde{w}$.

The likelihood contribution is given by:

$$\frac{e^x_h g^x_h(w)}{M} \times \Pi^l_{j=2}\left\{\Pr(h_{j+1}|h_{j-1})(1-\delta)\left[(1-\lambda_e)+\lambda_e\left(F(w,x)+F\left(\underline{s}^{x'}_{h_j}(w,x),x'\right)\right)\right]\right\} \tag{35a}$$

$$\times \Pr(h_{l+1}|h_l) \times \begin{cases} \delta\left[(1-\lambda_e)+\lambda_e\sum_{\tilde{x}}F(\underline{w}^{\tilde{x}}_{h_{l+1}},\tilde{x})\right] & \text{if Event is "Job Loss"} \\ \lambda_e f(\tilde{w},x) & \text{if Event is "Switch 1"} \\ \delta\lambda_e f(\tilde{w},x) & \text{if Event is "Switch 2"} \\ (1-\delta)\lambda_e f(\tilde{w},x')+\delta\lambda_e f(\tilde{w},x') & \text{if Event is "Switch 3",} \end{cases} \tag{35b}$$

where $x' \neq x$. To understand (35), note that similar to that in (34), the first term in line (35a), $e^x_h g^x_h(w)/M$, is the probability of sampling an employed worker with health status h working on a job (w, x); the second term in line (35a) is the probability that individual stays with the job (w, x) for l periods of unemployment with health status transitions $(h_2, ..., h_l)$ during the process. Line (35b) expresses the likelihood of observing health transition from h_l to h_{l+1} in period $l+1$ and one of the four job status change events. For example, the event "Job Loss" is observed in period $l+1$ with probability $\delta\left[(1-\lambda_e)+\lambda_e\sum_{\tilde{x}}F(\underline{w}^{\tilde{x}}_{h_{l+1}},\tilde{x})\right]$ because in order for a job loss to occur, the worker has to experience an exogenous shock that destroys the current match (which occurs with probability δ), and then does not get matched to another accepted job (which occurs with probability $(1-\lambda_e)+\lambda_e\sum_{\tilde{x}}F(\underline{w}^{\tilde{x}}_{h_{l+1}},\tilde{x})$). To understand the probability of event "Switch 2", we note that in order for a worker to switch to a job $(\tilde{w},x')$ with $x'=x$ but $\tilde{w}<w$, the worker must have experienced a job separation (which occurs with probability δ), but is then lucky enough to find an acceptable job immediately, which happens with probability $\lambda_e f(\tilde{w},x)$. The probability of the other job switch events are derived similarly.

6.2.2 Employer-Side Moments

In our estimation, we also require that our model's predictions match the following employer-side moments calculated from the RWJ-EHI (1997) data. These moments correspond to the vector $\mathbf{s}$ in expression (32).

- Mean establishment size;
- Fraction of firms less than 50 workers;
- Mean size of establishments that offer health insurance;
- Mean size of establishment that do not offer health insurance;
- Health insurance coverage rate;
- Health insurance coverage rate among employers with more than 50 workers;
- Health insurance coverage rate among employers with less than 50 workers;
- Average wages of firms with less than 50 workers;
- Average wages of firms with more than 50 workers.

6.2.3 Estimation Procedure

Having The following is the procedure we use to obtain the moments.

1. **(Initialization)** Initialize a guess of the parameter values θ;
2. **(Solving for Equilibrium Offer Distribution)** Given the guess, solve equilibrium numerically using the algorithm we provided in Section 4.1. Obtain the offer distribution $\hat{F}(w,x)$ from the equilibrium;
3. **(Calculating the Worker-Side Moments)** Use $\hat{F}(w,x)$ in place of $F(w,x)$ in the likelihood functions of the observed worker-side data based on (34) and (35), and obtain the numerical derivative of likelihood with respect to parameters $\theta_1\equiv(\lambda_u,\lambda_e,\delta,\gamma,\mu_h,b)$ and use them as a subset of the moments in (32);[35]
4. **(Calculating the Employer-Side Moments)** Use $\hat{F}(w,x)$ and other equilibrium elements obtained in (2) to calculate the employer-side moments listed in Section 6.2.2;
5. **(Iteration)** Evaluate the GMM objective (33) and iterate until it converges.

[35] Note from (34) and (35), the likelihood function of the worker labor market transitions depends only on θ_1, given $F(w,x)$.

Parameter	Estimate	Std. Err.
Panel A: Medical Expenditure Parameters in Eq. (2)		
q_B^H	0.0021	(0.002)
q_B^U	0.0295	(0.005)
m_B^1	3.3029	(0.0365)
m_B^0	1.0556	(0.019)
m_G^1	0.0171	(0.002)
m_G^0	0.0091	(0.003)
Panel B: Health Transition Parameters in Eq. (3)		
π_{HH}^1	0.99	(0.0015)
π_{HH}^0	0.97	(0.0052)
π_{UU}^1	0.73	(0.03)
π_{UU}^0	0.76	(0.03)

Table 7: Parameter Estimate from Step 1.

Note: Standard errors are in parentheses. The unit of medical expenditure is $10,000.

7 Estimation Results

7.1 Parameter Estimates

Parameters Estimated in the First Step. Table 7 reports the parameter estimates from step 1. We find that, conditional on realized health shock, the realization of medical expenditure is much larger if individuals have health insurance, which captures the moral hazard effect of health insurance. Specifically, we find that the medical expenditure for an insured when facing a bad health shock is, m_B^1, is about $33,029, while that for an uninsured, m_B^0, is about $10,556. Similarly, the estimated medical expenditure when an insured does not suffer from a bad health shock, m_G^1, is $171, while that for an uninsured, m_G^0, is $91. All of these are measured in terms of four-month expenditures. Thus, a bad health shock should be interpreted as a rather catastrophic health shock, as also shown in the estimates of q_B^U and q_B^H respectively: we estimate that q_B^U is about 2.95%, while q_B^H is about 0.21%. Note that our estimates confirm that unhealthy individuals are more likely to experience bad health shocks.

In Panel B of Table 7, we find that there is a significant health insurance effect on the dynamics of health since $\pi_{HH}^1 > \pi_{HH}^0$ and $\pi_{UU}^1 < \pi_{UU}^0$, implying that the lack of health insurance increases the probability that the next period health status is unhealthy. It is also interesting to note that our estimates indicate that health insurance has a higher marginal effect on health for a currently unhealthy worker than for a currently healthy worker, that is, $\pi_{HU}^1 - \pi_{HU}^0 > \pi_{HH}^1 - \pi_{HH}^0$.

Parameters Estimated in the Second Step. Table 8 reports the parameter estimates from step 2. Panel A shows that our estimate of CARA coefficient is about 1.4221E-4 (recalling that our unit is in $10,000). Using the four-month average wages for employed workers reported in Table 3, which is about $9,608, our estimated CARA coefficient implies a relative risk aversion of about 1.367. These are squarely in the range of estimates of CARA and RRA coefficients in the literature (see Cohen and Einav (2007) for a summary of such estimates).

We find that the offer arrival rate for an employed worker, λ_e, is about 0.22, which implies that on average it takes about 19 months for a currently employed worker to receive an outside offer; we also find that the offer arrival rate for an unemployed worker, λ_u, is 0.414, implying that on average it takes about 9 months for an unemployed to receive an offer.[36] Our estimate of the unemployment income b is small, about \$24.7, probably reflecting that a large fraction of the UI benefits are probably expensed for job search costs. In Panel A, we also report that our estimate of the probability of exogenous job destruction, δ, is about 1.05%, in a four-month period; and the fraction of newly arrived workers who are healthy is about 99.23%.

Panel B reports our estimates of parameters $\theta_2 \equiv (C, d, M, \mu_p, \sigma_p)$. We find that the productivity of a worker in bad health, d, is only 0.1506, implying that there is a significant amount of productivity loss from bad health. This seems plausible because we categorize only those whose self-reported health is "Poor" or "Fair" as unhealthy. Moreover, we find that the fixed administration cost of offering health insurance is about \$585 per four month, (equivalent to about \$1,755 per year).

In order to fit the average firm size, our estimate of M, the ratio between workers and firms, is about 19.106. This estimate is smaller than the average establishment size reported in Table 5 because in our model some low-productivity firms do not attract any workers in equilibrium. We also estimated that the scale and shape parameters of the lognormal productivity distribution are respectively -0.5863 and 0.4037, which implies that the mean (4-month) productivity of firms is about 0.6105 (i.e. \$6105). Considering that the mean accepted four-month wage in our sample is 0.8538 (see Table 3), our model actually implies that a substantial fraction of the low-productivity firms are not able to attract any workers.[37]

7.2 Within-Sample Goodness of Fit

In this section, we examine the within-sample goodness of fit of our estimates by simulating the equilibrium of our estimated model and compare with the model predictions to their data counterparts.

[36]Dey and Flinn (2005) estimated that the mean wait between contacts for the unemployed is about 3.25 months, while the 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 due to the fact that a period is four months in our paper while it is a 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 firm inbetween. 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 graduate degree, while Dey and Flinn (2005)'s sample is at least a high school graduate.

[37]One advantage of postulating a parametric productivity distribution is that it allows us to potentially capture how counterfactual policies might have affected the set of active firms. If we estimated firms' productivity non-parametrically from workers' productivity, we would not have been able to examine this margin.

Parameter	Estimates	Std. Err.
Panel A: Parameters in $\theta_1 \equiv (\lambda_u, \lambda_e, \delta, \gamma, \mu, b)$		
CARA Coefficient (γ)	1.4221	(0.0015)
Unemployment Income (b)	0.00247	(0.000008)
Offer Arrival Rate for the Unemployed (λ_u)	0.4140	(0.0005)
Offer Arrival Rate for the Employed (λ_e)	0.2203	(0.0001)
Probability of Exogenous Match Destruction (δ)	0.0105	(0.000008)
Fraction of New Born Workers that are Healthy (μ_H)	0.9923	(0.00001)
Panel B: Parameters in $\theta_2 \equiv (C, d, M, \mu_p, \sigma_p)$		
Productivity of a Worker in Bad Health (d)	0.1506	(0.00071)
Fixed Administrative Cost of Insurance in \$10,000 (C)	0.0585	(0.00005)
Total Measure of Workers Relative to Firms (M)	19.106	(0.025)
Scale Parameter of Firms' Lognormal Productivity Distribution $\left(\mu_p\right)$	-0.5863	(0.0003)
Shape Parameter of Firms' Lognormal Productivity Distribution (σ_p)	0.4037	(0.0001)

Table 8: Parameter Estimate from Step 2

	Data	Model
Mean Annual Medical Expenditure	0.080	0.0774
... for Healthy Workers with Insurance	0.0672	0.0719
... for Healthy Workers without Insurance	0.0365	0.0338
... for Unhealthy Workers with Insurance	0.4791	0.3422
... for Unhealthy Workers without Insurance	0.1249	0.1199

Table 9: Mean Medical Expenditure for Different Health and Health Insurance Compositions: Model vs. Data.

Moments	Data	Model
Fraction of individuals who are unemployed and healthy	0.0314	0.0250
Fraction of individuals who are unemployed and unhealthy	0.004	0.0017
Fraction of individuals who are employed, healthy and have health insurance and	0.7001	0.7168
Fraction of individuals who are employed, unhealthy and have health insurance and	0.034	0.0288
Fraction of individuals who are employed, healthy and do not have health insurance	0.2156	0.2091
Fraction of individuals who are employed, unhealthy and do not have health insurance	0.014	0.0243
Mean wage ($10,000)	0.8538	0.8952
Mean wage with health insurance ($10,000)	0.9240	0.9449
Mean wage without health insurance ($10,000)	0.6187	0.7362
Mean medical expenditure ($10,000)	0.0220	0.0210

Table 10: Worker-Side Moments in the Labor Market: Model vs. Data.

Worker-Side Goodness of Fit. Table 9 reports the model fits for medical expenditure in the first step. It shows that our parameter estimates fit the data on the mean medical expenditure conditional on health and health insurance status reasonably well.

Table 10 reports the model fit for the worker-side moments. It shows that the model fit really well for cross section worker distribution in terms of health, health status, health insurance, wage, and employment distribution.

Employer-Side Goodness of Fit. Next, we demonstrate the model fit for employer side moments. As shown from table 11, the model fits is reasonably well for firm size distribution and coverage rate conditional on firm size.

Figure 1 plots the size distribution of the firms both in the data and that implied by our model estimates. Figure 2 shows the size distributions of firms by health insurance offering status. Both figures show that our model is able to capture the size distribution of firms overall and by health insurance status reasonably well.

8 Counterfactual Experiments

In this section, we use our estimated model to conduct counterfactual policy experiments and evaluate the impact of the Affordable Care Act and its various components. For the ACA, we consider a stylized version which incorporates its main components as mentioned in the introduction: first, all individuals are required to have health insurance or have to pay a penalty; second, all employers with more than 50 workers are required to offer health insurance, or have to pay a penalty; third, we introduce a health insurance exchange where individuals can purchase health insurance at community rated premium; fourth, the participants in health insurance exchange can obtain income-based subsidies.

The introduction of health insurance exchange where individuals can purchase health insurance if they are unemployed or if their employers do not offer them represents a substantial departure from our benchmark model

Moments	Data	Model
Mean establishment size	19.92	18.7273
Fraction of firms less than 50 workers	0.93	0.9092
Mean size of establishments that offer health insurance	30.08	27.4695
Mean size of establishment that do not offer health insurance	6.95	9.2854
Health insurance coverage rate	0.56	0.5192
Health insurance coverage rate among employers with less than 50 workers	0.53	0.4908
Health insurance coverage rate among employers with more than 50 workers	0.95	0.8096
Average wages of firms with less than 50 workers	0.84	0.4163
Average wages of firms with more than 50 workers	0.92	0.9634

Table 11: Employer-Side Moments: Model vs. Data.

because premium in exchange will be endogenously determined. As a result, we will first describe how we extend and analyze our benchmark model to incorporate the health insurance exchange.

8.1 Model for the Counterfactual Experiments

We provide a brief explanation of the main changes in the economic environment, as well as the definition of equilibrium, for the model used in our counterfactual experiments.

The Main Change in Individuals' Environment. We now assume individuals who are not offered health insurance by their employers and those who are unemployed can purchase individual insurance from the health insurance exchange. We assume that the insurance purchased from the exchange is similar to those offered by the employers in that it also fully insures medical expenditure risk. Thus in the extended model, an individual's insurance status x is defined as

$$x = \begin{cases} 0 & \text{if uninsured} \\ 1 & \text{if insured through employer} \\ 2 & \text{if insured through exchange.} \end{cases}$$

We assume that the effect on health for health insurance purchased from the exchange, denoted by $\boldsymbol{\pi}^2$ analogously defined as (3), is identical to that for employer-sponsored health insurance, i.e., $\boldsymbol{\pi}^2 = \boldsymbol{\pi}^1$.

We also incorporate the premium subsidies to the individuals and penalties if uninsured into the model. Let $S\left(y, R^{EX}\right)$ denote income based subsidies to an individual with income y who purchase health insurance from the exchange; note that the amount of subsidies also depends on the premium in exchange, R^{EX}, which is to be determined in equilibrium. Similarly, let $P_W(y)$ denote the penalty to individuals who remain uninsured, which also depends on income level.

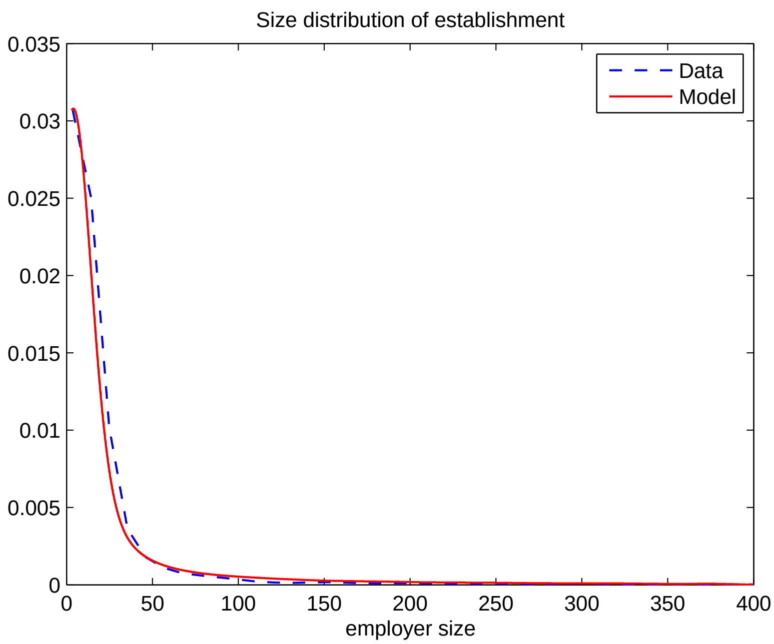


Figure 1: Size Distribution of Firms: Model vs. Data.

Worker's problem. Under this extension, the expected flow utility $v_h(y,x)$ in the counterfactual is defined as:

$$v_h(y,x) = \begin{cases} q_B^h u\left(T(y) - m_B^0 - P_W(y)\right) + \left(1-q_B^h\right) u\left(T(y) - m_G^0 - P_W(y)\right) & \text{if } x = 0 \\ u\left(T\left(y\right)\right) & \text{if } x = 1 \\ u\left(T\left(y\right) + S\left(y, R^{EX}\right) - R^{EX}\right) & \text{if } x = 2 \end{cases} \tag{36}$$

The value function of an unemployed individual with health insurance status $x \in \{0,2\}$ becomes

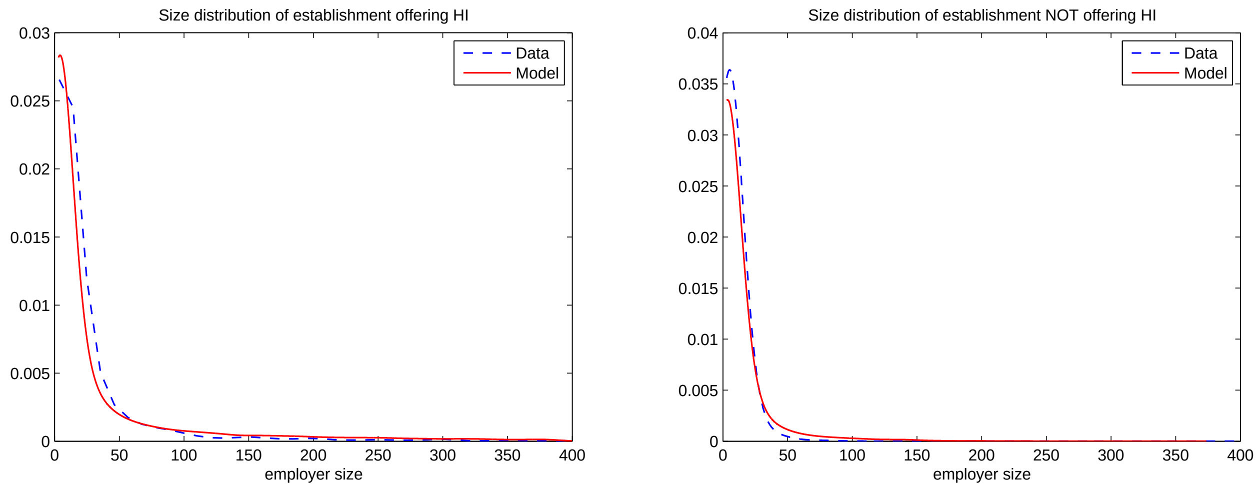
$$\frac{U_h(x)}{1-\rho} = v_h(b,x) + \beta \mathrm{E}_{h'|(h,x)} \left[\begin{array}{c} \lambda_u \int \max\left\{V_{h'}(w,1), U_{h'}(x^*_{h'})\right\} dF(w,1) \\ +\lambda_u \int \max_{x' \in \{0,2\}} \left\{V_{h'}(w,x'), U_{h'}(x^*)\right\} dF(w,0) \\ +(1-\lambda_u) U_{h'}(x^*), \end{array} \right] \tag{37}$$

where

$$x^*_{h'} = \arg\max_{x' \in \{0,2\}} U_{h'}(x'). \tag{38}$$

and the expectation $\mathrm{E}_{h'}$ is taken with respect of the distribution of h' conditional on the current health status h and insurance status $x \in \{0,2\}$.

Similarly, the value function of an employed worker with health status h working on a job with insurance status



(a) With Health Insurance

(b) Without Health Insurance

Figure 2: Size Distribution of Firms by Insurance Offering Status: Model vs. Data.

(w,x), $V_h\left(w,x\right)$, is as follows. If $x=1$,

$$\begin{aligned}\frac{V_h(w,1)}{1-\rho} &= v_h(w,1)+\beta\lambda_e\left\{(1-\delta)\,\mathrm{E}_{h'|(h,1)}\left[\begin{array}{c}\int\max\{V_{h'}(\tilde{w},1),V_{h'}(w,1),U_{h'}(x^*)\}dF(\tilde{w},1)\\+\int\max\{V^0_{h'}(\tilde{w},x^*),V_{h'}(w,1),U_{h'}(x^*)\}dF(\tilde{w},0)\end{array}\right]\right.\\ &\quad\left.+\ \delta\mathrm{E}_{h'|(h,1)}\left[\begin{array}{c}\int\max\left\{U_{h'}(x^*),V_{h'}(\tilde{w},1)\right\}dF(\tilde{w},1)\\+\int\max\left\{U_{h'}(x^*),V_{h'}(\tilde{w},x^*)\right\}dF(\tilde{w},0)\end{array}\right]\right\}\\ &\quad+\beta(1-\lambda_e)\left\{(1-\delta)\mathrm{E}_{h'|(h,1)}\max\left\{U_{h'}(x^*),V_{h'}(w,1)\right\}+\delta\mathrm{E}_{h'|(h,1)}U_{h'}(x^*)\right\},\end{aligned}\tag{39}$$

and if $x\in\{0,2\}$,

$$\begin{aligned}&\frac{V_h(w,x)}{1-\rho}=v_h(w,x)+\beta\lambda_e\left\{(1-\delta)\mathrm{E}_{h'|(h,1)}\left[\begin{array}{c}\int\max\{V_{h'}(\tilde{w},1),V_{h'}(w,x^*),U_{h'}(x^*)\}dF(\tilde{w},1)\\+\int\max\{V_{h'}(\tilde{w},x^*),V_{h'}(w,x^*),U_{h'}(x^*)\}dF(\tilde{w},0)\end{array}\right]\right.\\ &\left.+\ \delta\mathrm{E}_{h'|(h,1)}\left[\begin{array}{c}\int\max\left\{U_{h'}(x^*),V_{h'}(\tilde{w},1)\right\}dF(\tilde{w},1)\\+\int\max\left\{U_{h'}(x^*),V_{h'}(\tilde{w},x^*)\right\}dF(\tilde{w},0)\end{array}\right]\right\}\\ &+\beta(1-\lambda_e)\left\{(1-\delta)\mathrm{E}_{h'|(h,1)}\max\left\{U_{h'}(x^*),V^0_{h'}(w,x^*)\right\}+\delta\mathrm{E}_{h'|(h,1)}U_{h'}(x^*)\right\},\end{aligned}\tag{40}$$

where in both (39) and (40),

$$x^*_{h'}\left(\tilde{w}\right)=\arg\max_{x\in\{0,2\}}V_{h'}(\tilde{w},x).\tag{41}$$

We characterize the individuals' optimal job acceptance strategies, and their optimal decision regarding whether to purchase insurance from the exchanges when they are unemployed or when their employers do not offer health insurance similar to those for the benchmark model. We also characterize the steady state worker distribution among firms $\langle e_h^x, G_h^x(w)\rangle$ for $x \in \{0,1,2\}$ when the two additional terms, e_h^2 and $G_h^2(w)$, are now respectively the measure of employed workers with health status h who purchase insurance from the exchange, and the distribution of wages among them.

Employer's Problem. Employers with more than 50 workers now face a penalty if they do not offer health insurance. Let $P_E(n)$ denote the the amount of the penalty, which depends on the employer size n.

There are two important changes to the employer's problem. The first one is how employer size is determined. Because of insurance exchange, some of their workforce may be insured even if they do not offer health insurance. Specifically, $n(w,0)$, the size of employers not offering health insurance, becomes

$$n(w,0) = \sum_{h\in\{U,H\}} n_h(w,0) = \sum_{h\in\{U,H\}} \frac{\sum_{x,x'\in\{0,2\}} e_h^x g_h^x(w)}{f(w,0)},$$

and the expression for $n(w,1)$ remains the same as before.

Second, because of employer mandate, firm's profit maximization problem will change. It now becomes

$$\max\{\Pi_0(p), \Pi_1(p)+\epsilon\},$$

where:

$$\Pi_0(p) = \max_{w_0} \Pi(w_0,0) \equiv (p-w_0)\, n_H(w_0,0) + (pd-w_0)\, n_U(w_0,0) - P_E(n(w,0)), \tag{42}$$

$$\Pi_1(p) = \max_{w_1} \Pi(w_1,1) \equiv ((p-w_1-m_H)\, n_H(w_1,1) + (pd-w_1-m_U)\, n_U(w_1,1)) - C \tag{43}$$

where the expression for $\Pi_0(p)$ reflects the possible penalty to employers for not offering employer-sponsored health insurance to their workers.

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

$$R^{EX} = (1+\xi)\frac{\sum_{h\in\{H,U\}} m_h \left[u_h^2 + \int e_h^2(w)dw\right]}{\sum_{h\in\{H,U\}} \left[u_h^2 + \int e_h^2(w)dw\right]} \tag{44}$$

where, m_h is expected medical expenditure of individual with health status h as described by (2), u_h^2 is the measure of unemployed workers participating insurance exchange with health status h, and $e_h^2(w)$ is the density for employed workers not being offered health insurance from employers but participating insurance exchange with health status h.

Steady State Equilibrium for the Post-Reform Economy. A *steady state equilibrium for the post-reform economy* is a list $\left\langle \left(\underline{w}_h^x, \underline{s}_h^x(\cdot,\cdot), \underline{q}_h^x, x_h^*, x_h^*(\cdot)\right), \left(u_h^x, e_h^x, G_h^x(w)\right), \left(w_x(p), \Delta(p), F(w,x)\right), R^{EX} \right\rangle$ such that the following conditions hold:

- **(Worker Optimization)** Given $F(w,x)$ and R^{EX},
  - $\underline{w}_h^x$ solves the unemployed workers' job acceptance decision problem for each $(h,x) \in \{U,H\} \times \{0,1\}$;
  - $\underline{s}_h^x(\cdot,\cdot)$ solves the job-to-job switching problem for currently employed workers for each $(h,x) \in \{U,H\} \times \{0,1\}$
  - $\underline{q}_h^x$ describes the optimal strategy for currently employed workers regarding whether to quit into unemployment for each $(h,x) \in \{U,H\} \times \{0,1\}$;
  - x_h^* and $x_h^*(\cdot)$ respectively solve (38) and (41) for $h \in \{H,U\}$.
- **(Steady State Worker Distribution)** Given workers' optimizing behavior described by $\left(\underline{w}_h^x, \underline{s}_h^x(\cdot,\cdot), \underline{q}_h^x, x_h^*, x_h^*(\cdot)\right)$ and $F(w,x)$ and R^{EX}, $\left(u_h^x, e_h^x, G_h^x(w)\right)$ satisfy the steady state conditions for worker distribution.
- **(Firm Optimization)** Given $F(w,x)$, R^{EX} and the steady state employee sizes implied by $\left(u_h^x, e_h^x, G_h^x(w)\right)$, a firm with productivity p chooses to offer health insurance, i.e., $x = 1$, with probability $\Delta(p)$ and chooses not to offer health insurance with probability $1 - \Delta(p)$, where $\Delta(p)$ is given by (29). Moreover, conditional on insurance choice x, the firm offers a wage $w_x(p)$ that solves (42) and (43) respectively for $x = 0$ and 1.
- **(Equilibrium Consistency)** The postulated distributions of offered compensation packages are consistent with the firms' optimizing behavior $\left(w_x(p), \Delta(p)\right)$. Specifically, $F(w,x)$ must satisfy:

$$
\begin{aligned}
F(w,1) &= \int_{\underline{p}}^{\overline{p}} \mathbf{1}(w_1(p) < w)\Delta(p)d\Gamma(p), \\
F(w,0) &= \int_{\underline{p}}^{\overline{p}} \mathbf{1}(w_0(p) < w)\left[1 - \Delta(p)\right]d\Gamma(p).
\end{aligned}
$$

- **(Equilibrium Condition in Insurance Exchange)** The premium in exchange is determined by (44).

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 that described in Section 4.1, but there are two important changes. First, we need to find the fixed point of not only $(w_0(p), w_1(p), \Delta(p))$ but also R^{EX}, the premium in insurance exchange. Second, because the penalty associated with employer mandate depends on size of the firm, for example, the threshold under the ACA for firms to pay penalty if they do not offer health insurance is 50; as a result we need to modify the algorithm to allow for a potential mass point of employers just to the left of 50 (say, 49 workers) when we derive optimal wage policy $w_0(p)$. The details of the modified numerical algorithm are provided in the Appendix.

Finally, the establishment of the health insurance exchange with community rating may result in multiple equilibria under some counterfactual policy experiments. In our numerical simulations, we indeed sometimes find multiple equilibria and we will discuss their implication.

8.2 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 ACA provisions, such as penalty associated with individual mandate, employer mandate and the premium subsidies, into our model. First, we estimated our model using data sets in 1996, while the ACA policy parameters are chosen to suit the economy in 2011. However, the U.S. health care sector has very different growth rate than that of the overall GDP; in particular, there are substantial increases in medical care costs relative to GDP in the last 15 years. Thus we need to appropriately adjust the policy parameters in the ACA to make them more in line with the U.S. economy in 1996. Second, the amount of penalties and subsidies are defined as annual level, while our model assumes 4 month as a model period. We simply divide all monetary unit by 3 to obtain the applicable number for a four-month period. Third, we need to decide on the magnitude of the loading factor ξ that appeared in (44) that is applicable in the insurance exchange. We calibrate ξ based on the ACA requirement that all insurance sold in the exchange must satisfy the newly-imposed regulation by ACA that the medical loss ratio must be at least 80%.[38] This implies that $\xi = 0.25$.[39]

We now describe how we translate the ACA provisions for 2011 into applicable formulas for our 1996 economy.

[38] The medical loss ratio is the ratio of the total claim costs the insurance company incurs to total insurance premium collected from participants.

[39] The medical loss ratio implied by (44) is simply $1/(1+\xi)$, thus an 80% medical loss ratio corresponds to $\xi = 0.25$. ACA requires that $\xi \leq 0.25$.

Penalties Associated with Individual Mandate. The exact stipulation of the penalty in ACA if an individual does not show proof of insurance (from 2016 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:

$$P_W^{ACA}(y) = \max\{0.025 \times (y - \text{TFT\_2011}), \$695\}, \tag{45}$$

where y is annual income.

We adjust the above formula in several dimensions. First, the \$695 amount is adjusted by the ratio of the 1996 Medical_CPI relative to the 2011 Medical_CPI; this is appropriate if we believe that the amount \$695 is chosen to be proportional to the 2011 medical expenditures. We then multiply it by 1/3 to reflect our period-length of fourth months instead of a year. Second, we need to adjust the TFT_2011 by the ratio of 1996 GDP_CPI relative to the 2011 GDP_CPI and also multiply it by 1/3 to reflect that our income is four-month income. Finally, we need to adjust the percentage 2.5% by the differential growth rate of medical care and GDP, i.e., multiply it by the relative ratio of Medical_CPI/GDP_CPI for 1996 and 2011. With these adjustments, we specify the adjusted penalty associated with individual mandate appropriate for the 1996 economy as:

$$\begin{aligned} P_W(y) &= \max\left\{ \begin{array}{c} 0.025 \times \left(\frac{\text{Medical\_CPI\_1996}}{\text{GDP\_CPI\_1996}}\right) / \left(\frac{\text{Medical\_CPI\_2011}}{\text{GDP\_CPI\_2011}}\right) \times \left(y - \frac{1}{3}\text{TFT\_2011} \times \frac{\text{GDP\_CPI\_1996}}{\text{GDP\_CPI\_2011}}\right), \\ \frac{1}{3} \times \$695 \times \frac{\text{Medical\_CPI\_1996}}{\text{Medical\_CPI\_2011}} \end{array} \right\} \\ &\approx \max\left\{\frac{0.025}{1.42} \times (y - 2,323),\ \$119\right\}. \end{aligned} \tag{46}$$

where y is four-month income in dollars.

Penalties Associated with Employer Mandate. ACA stipulates that employers with 50 or more full-time employees that do not offer 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,

$$P_E^{ACA}(n) = (n - 30) \times \$2,000. \tag{47}$$

We adjust the above formula by first scaling the \$2,000 per-worker penalty using the ratio of the 1996 Medical_CPI relative to the 2011 Medical_CPI, and then multiply it by 1/3 to reflect our period-length of four months instead of a year, i.e.,

$$\begin{aligned} P_E(n) &= \frac{1}{3}\left[(n-30) \times \$2,000 \times \frac{\text{Medical\_CPI\_1996}}{\text{Medical\_CPI\_2011}}\right] \\ &= 342.45\,(n-30). \end{aligned} \tag{48}$$

Income-Based Premium Subsidies. ACA stipulates that premium subsidies for purchasing health insurance from the exchange are available if an individual's income is less than 400 % of Federal Poverty Level (FPL), denoted by FPL400.[40] The premium subsidies will be set on a sliding scale such that the premium contributions are limited to a certain percentages of income for specified income levels. If an individual's income is at 133% of the FPL, denoted by FPL133, premium subsidies will be provided so that the individual's contribution to the premium is equal to 3.5% of his income; when an individual's income is at FPL400, his premium contribution is set to be 9.5% of the income. when his income is below FPL133, he will receive insurance with zero premium contribution. If his income is above FPL400, he is no longer eligible for premium subsidies. We summarize the rules by the following formula:

$$S\left(y, R^{EX}\right) = \begin{cases} \max\left\{R^{EX} - \left[0.0350 + 0.060\frac{(3y-\text{FPL133})}{\text{FPL400}-\text{FPL133}}\right] y \times \frac{\text{Medical\_CPI\_1996}}{\text{Medical\_CPI\_2011}},\ 0\right\} \text{ if } \frac{\text{FPL133}}{3} < y < \frac{\text{FPL400}}{3} \\ R^{EX} \text{ if } y \leq \frac{\text{FPL133}}{3} \\ 0, \text{ otherwise,} \end{cases} \tag{49}$$

when y is four-month income.

8.3 Main Result

In Table 12, we report results from several counterfactual policy experiments and contrast the outcomes under these counterfactual policies with the benchmark. Column (1) reports the predictions from our baseline model using our parameter estimates reported in Tables 7 and 8. It shows that our benchmark model predicts that about 51.97% of the *active* firms offer health insurance to their workers, but the health insurance offering rate is 80.96% if the firm size is more than 50 and only 49.08% if it has fewer than 50 workers.[41] In our benchmark environment, 90.92% of the firms have fewer than 50 workers. Importantly, our benchmark model predicts that 25.43% of the population would have no health insurance; and the overall fraction of healthy workers in the economy is 94.54%.

ACA. In Column (2), we report the simulation results when we introduce the ACA, including insurance exchange (EX), Individual Mandate (IM), Employer Mandate (EM) and Premium Subsidies (Sub), as parameterized in Section 8.2. The important finding from Column (2) is that, under the ACA, our model predicts that there would be significant reduction in the uninsured rate relative to the benchmark: the uninsured rate under ACA is predicted to be about 9.39% in contrast to 25.43% under the benchmark. Our model also predicts that the reduction in the uninsured rate under the ACA is because 19.32% of the

[40] We assume that FPL is defined as single person. In 1996, it is $7,730 annually.

[41] Recall that in our model, some low-productivity firms would not be able to attract any workers and they are considered *non-active* firms. The set of non-active firms is affected by the counterfactual policies. Thus our model allows for an extensive margin on the firm side.

	Benchmark	ACA	EX+Sub+EM	EX+Sub+IM
	(1)	(2)	(3)	(4)
	Panel A: Effects on the Firm Side			
Frac. of firms offering HI	0.5197	0.5215	0.5149	0.5068
...if firm size is less than 50	0.4908	0.4760	0.4700	0.4895
...if firm size is 50 or more	0.8096	0.9612	0.9591	0.6802
Frac. of firms with less than 50 workers	0.9092	0.9062	0.9082	0.9092
Average labor productivity	1.1569	1.1557	1.1533	1.1684
Firm's profit/ouput ratio	0.3709	0.3923	0.3960	0.3620
	Panel B: Effects on the Worker Side			
Uninsured rate	0.2543	0.0939	0.1364	0.0800
Frac. of employed workers with insurance from EX	-	0.1932	0.0857	0.3303
Average wage	0.8952	0.8955	0.8859	0.9135
... with health insurance	0.9449	0.9270	0.9379	0.9172
... without health insurance	0.7362	0.8244	0.6914	0.9076
Unemployment rate	0.0208	0.0210	0.0208	0.0208
Fraction of healthy workers	0.9454	0.9573	0.9547	0.9599
... among uninsured	0.8956	1.0000	1.0000	1.0000
... among insured through EHI	0.9613	0.9638	0.9632	0.9638
... among insured through EX	-	0.9224	0.7744	0.9438
Average worker utility	-40.9129	-39.9958	-40.0369	-39.7140
	Panel C: Effects on Expenditures			
Tax expenditure to ESHI	0.0174	0.0166	0.0178	0.0149
Subsidies to exchange purchases	-	0.0023	0.0021	0.0022
Revenue from penalties	-	0.0031	0.0010	0.0019
Average health expenditure	0.0279	0.0307	0.0300	0.0307
Average premium in EHI	0.0329	0.0326	0.0327	0.0330
Premium in exchange	-	0.0463	0.0550	0.0414

Table 12: Counterfactual Policy Experiments: Evaluation of the ACA and its Two Variations.

employed workers purchase insurance from the exchange. (In our counterfactual model, all unemployed workers will purchase from the exchange as well because they will receive the insurance for free due to their low income at unemployment.) Interestingly, we find in Panel A that the ACA would slightly increase the fraction of active firms that offer health insurance. Not surprisingly, as a result of employer mandate penalty for firms with more than 50 workers, such firms significantly increase the probability they offer health insurance to their workers.

We also find that the ACA somewhat increases the unemployment rate. This effect arises because the presence of insurance exchange and the premium subsidy available to all unemployed workers increases their reservation wages. The increase in reservation wages on unemployment is partially offset by aggressive wage offers from firms that do not offer health insurance. The average wage in firms without health insurance increased significantly from the benchmark of \$7,362 to \$8,244.

In Panel C, we report the effect of ACA on expenditures. First, because a smaller fraction of firms offer health insurance under the ACA, and since health insurance premium is not subject to income taxation, the tax expenditure due to EHI premium exemption is reduced somewhat. The government also incurs on average \$23 subsidies to health insurance purchases from the exchange; however, the revenue from penalties from individuals who decide to go without insurance or firms with 50 or more workers which do not offer health insurance is also about \$23 per capita. Because of the reduction in the uninsured rate, there is about a 10% increase in the average medical expenditure.

ACA without the Individual Mandate. In Column (3), we report simulation results from a hypothetical environment of ACA without the individual mandate, i.e. only EX, Sub and EM components of ACA are implemented. This would correspond to the case if the Supreme Court had ruled against the individual mandate.

We find that ACA without the individual mandate would also have achieved significant reduction in the uninsured rate. In Panel B, we show that the uninsured rate under "EX+Sub+EM" would be about 13.64%, which is 4.25 percentage points higher than under the ACA, but still represent close to 50% reduction from the 25.43% uninsured rate in the benchmark. The reason for the sizeable reduction in the uninsured rate despite the absence of individual mandate is the premium subsides. Individuals are risk averse so they would like to purchase insurance if the amount of premium they need to pay out of pocket is sufficiently small, which is true for many workers in low-wage firms that do not offer health insurance. Those workers who work in firms with medium-wages but do not offer health insurance turn out to be those workers who decide to pay the penalty and go without health insurance, if they are healthy.

ACA without Employer Mandate. In Column (4), we report the result from a hypothetical environment of ACA *without* the employer mandate. This would roughly correspond to a health care system in the spirit of what is implemented in 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 subsides health care for the poor on a graduated basis.

Somewhat surprisingly, we find that such a system without employer mandate would actually lead to somewhat lower uninsured rate than the full version of ACA. We find that the uninsured rate under this "EX+Sub+IM" system would be about 8%, lower than the 9.39% uninsured rate predicted under the full ACA. The main reason is that the ACA without employer mandate actually improves the overall health of the pool in the exchange, reducing the premium in the exchange. Indeed we find that the premium in the exchange decreases from $463 under ACA to $414 under "ACA without employer mandate."

8.4 Assessing the Effects of Components of the ACA

In Table **??**, we report the results from several counterfactual experiments that are aimed to understand the effects of several components of the ACA. In Column (1), we report the results when we introduce only the insurance exchange to the benchmark economy. It shows that having an exchange alone does little to the uninsured rate in equilibrium: the equilibrium uninsured rate under this counterfactual, if anything, slightly increases over the benchmark economy. In fact, the exchange will not have any participants at all due to the adverse selection problem. However, the presence of the exchange does cause small changes to the labor market, both on the firm side and on the worker side.

In Column (2), 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 20.15%. The exchange is quite active with all the unemployed and 6% of the employed workers purchasing insurance from the exchange. However, without employer mandate, the introduction of exchange and premium subsides also lead to a reduction in the probabilities of firms offering health insurance to their workers.

In Column (3) and (4), we report the results when we introduce health insurance exchange and individual mandate. In this counterfactual experiment, we find multiple equilibrium that differ substantially in the equilibrium premium in the exchange. Column (3) reports the outcomes in the "good" equilibrium in that a large fraction (30.95%) of employed workers, healthy or unhealthy, participate in the exchange. Thus the adverse selection problem is moderate in the exchange and the premium is low. In this equilibrium, the uninsured rate is about 14.43%. Column (4) reports the outcomes in the "bad" equilibrium in that a much smaller fraction (2.48%) of employed workers, and those who are unhealthy, participate in the exchange. Thus the adverse selection problem is severe in the exchange and the premium is very high (about $1425 per four months). In this equilibrium, the uninsured rate is about 20.76%.

In Column (5), we report the results when we introduce the health insurance exchange and employer mandate (as in the ACA) into the benchmark economy. We find that the exchange is not active. There is a reduction of the uninsured rate, from 25.43% in the benchmark to about 21.17%, but this decline is purely from the increased probability of offering health insurance by firms larger than 50 workers.

In Column (6), we report the results when we introduce the ACA except that the income-based premium subsidies are removed. Relative the full ACA results reported in Column 2 of Table 12, the uninsured rate is about twice as large, 18.50%. This shows the importance of the premium subsidies in the large effect of reducing uninsured rate we found for the full ACA.

8.5 Effect of Eliminating Tax Exemption of Employer-Sponsored Health Insurance Premium

In this section, we describe the results from the counterfactual experiments where the tax exemption status of employer-sponsored health insurance premium is eliminated, both under the benchmark model and under the ACA. We are interested in these counterfactual experiments because, given the growing federal deficits the United States is facing, reducing tax expenditures, tax exemption for EHI premium being one of the major tax expenditure categories, has been mentioned in several prominent reports.

Columns (1) and (3) of Table 8.5 report the same simulation results for the benchmark and the ACA as reported in Table 12 under the current tax exemption status for ESHI premium. In Column (2), we remove the tax exemption for ESHI under the benchmark economy. We find that removing the tax exemption increase the uninsured rate from 25.43% to 26.65%. It leads to an increase in average wage for workers, and a deterioration of workers' health.

In Column (4), we remove the tax exemption for ESHI under ACA. We find that removing the tax exemption increase the uninsured rate from 9.39% to 10.17%. However, its effect on average wages is rather different from that for the benchmark economy, and also it actually improves the fraction of workers who are healthy. These differences are driven by the fact that under the ACA, workers who do not receive health insurance from their employers would have to purchase health insurance from the exchange or pay a penalty. When firms reduce the probability of health insurance to their workers, the adverse selection problem in the exchange is reduced, resulting in lower premium.

	EX	EX+Sub	EX+IM		EX+EM	EX+IM+EM
	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A: Effects on the Firm Side					
Frac. of firms offering HI	0.5188	0.5140	0.5139	0.5236	0.5199	0.5214
...if firm size is less than 50	0.4901	0.4881	0.5007	0.4926	0.4748	0.4750
...if firm size is 50 or more	0.8075	0.7635	0.6400	0.8324	0.9587	0.9769
Frac. of firms with less than 50 workers	0.9095	0.9059	0.9051	0.9088	0.9067	0.9075
Average labor productivity	1.1568	1.1605	1.1666	1.1598	1.1503	1.1493
Firm's profit/output ratio	0.3707	0.3699	0.3605	0.3743	0.3929	0.4029
	Panel B: Effects on the Worker Side					
Uninsured rate	0.2582	0.2015	0.1443	0.2076	0.2117	0.1850
Frac. of employed workers with HI from EX	0.0000	0.0640	0.3095	0.0248	0.0000	0.0212
Average wage	0.8953	0.8986	0.9135	0.8949	0.8806	0.8828
... with health insurance	0.9467	0.9489	0.9146	0.9409	0.9307	0.9334
... without health insurance	0.7342	0.7531	0.9119	0.7245	0.6959	0.6766
Unemployment rate	0.0208	0.0210	0.0210	0.0210	0.0208	0.0211
Fraction of healthy workers	0.9450	0.9501	0.9542	0.9496	0.9486	0.9508
... among uninsured	0.8955	1.0000	1.0000	1.0000	0.8969	1.0000
... among insured through EHI	0.9613	0.9630	0.9617	0.9619	0.9615	0.9620
... among insured through exchange	-	0.5974	0.9057	0.0000	-	0.0000
Average worker utility	-39.98	-39.7688	-39.93	-40.11	-40.0612	-40.38
	Panel C: Effects on Expenditures					
Tax expenditure to ESHI	0.0173	0.0170	0.0147	0.0177	0.0177	0.0180
Subsidies to exchange purchases	-	0.0017	-	-	-	-
Tax revenue from penalties	-	-	0.0027	0.0048	0.0010	0.0040
Average health expenditure	0.0275	0.0295	0.0299	0.0294	0.0286	0.0296
Average premium in EHI	0.0329	0.0328	0.0331	0.0328	0.0328	0.0328
Premium in Exchange	0.1425	0.0673	0.0459	0.1425	0.1425	0.1425

Table 13: Counterfactual Policy Experiments: Evaluation of Various Components of the ACA.

	Benchmark		ACA	
	Exemption	No Exemption	Exemption	No Exemption
	(1)	(2)	(3)	(4)
	Panel A: Effects on the Firm Side			
Frac. of firms offering HI	0.5197	0.5154	0.5215	0.5123
...if firm size is less than 50	0.4908	0.4909	0.4760	0.4716
...if firm size is 50 or more	0.8096	0.7514	0.9612	0.9170
Frac. of firms with less than 50 workers	0.9092	0.9058	0.9062	0.9086
Average labor productivity	1.1569	1.1555	1.1557	1.1493
Firm's profit/output ratio	0.3709	0.4103	0.3923	0.4071
	Panel B: Effects on the Worker Side			
Uninsured rate	0.2543	0.2665	0.0939	0.1017
Frac. of employed workers with HI from EX	-	-	0.1932	0.2699
Average wage	0.8952	0.8965	0.8955	0.8864
... with health insurance	0.9449	0.9497	0.9270	0.9086
... without health insurance	0.7362	0.7496	0.8244	0.8451
Unemployment rate	0.0208	0.0208	0.0210	0.0229
Fraction of healthy workers	0.9454	0.9433	0.9573	0.9571
... among uninsured	0.8956	0.8953	1.0000	1.0000
... among insured through EHI	0.9613	0.9610	0.9638	0.9638
... among insured through exchange	-	-	0.9224	0.8980
Average worker utility	-40.9129	-41.2007	-39.9958	-39.2906
	Panel C: Effects on Expenditures			
Tax expenditure to ESHI	0.0174	-	0.0166	-
Subsidies to exchange purchases	-	-	0.0023	0.0026
Tax revenue from penalties	-	-	0.0031	0.0032
Average health expenditure	0.0279	0.0274	0.0307	0.0306
Average premium in EHI	0.0329	0.0330	0.0326	0.0327
Premium in Exchange	-	-	0.0463	0.0448

Table 14: Counterfactual Policy Experiments: Evaluating the Effects of Eliminating the Tax Exemption for EHI Premium under the Benchmark and the ACA.

9 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 1996 panel of the Survey of Income and Program Participation (SIPP), the Medical Expenditure Panel Survey (MEPS, 1997-1999) and the 1997 Robert Wood Johnson Foundation Employer Health Insurance Survey. 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 evaluate the impact of the key components of the 2010 Affordable Care Act (ACA), including the individual mandate, the employer mandate, the insurance exchange and the income-based insurance premium subsidy. We evaluate the impact of the ACA as a whole, as well as a variety of combinations of the components of the ACA.

We find that the implementation of the full version of the ACA would significantly reduced the uninsured rate from 25.43% in the benchmark economy to 9.39%. This large reduction of the uninsured rate is mainly driven by low-wage workers participating in the insurance exchange with their premium supported by the income-based subsidies. We find that, if the subsidies were removed from the ACA, the insurance exchange will suffer from adverse selection problem so that only unhealthy workers participate in the market, resulting in a much more modest reduction in the uninsured rate, from 25.43% in the benchmark to 18.50% under "ACA without the subsidies."

We also 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 "ACA without individual mandate", the uninsured rate would be 13.64%, significantly lower than the 25.43% under the benchmark. The premium subsidy component of the ACA would have in itself drawn all the unemployed (healthy or unhealthy) and the low-wage employed (again both healthy and unhealthy) in the insurance exchange.

Interestingly, we find that the current version of ACA without employer mandate may be more efficient than the one with employer mandate. The latter achieves higher average productivity, higher worker's average utility, higher average wage, and lower government spending.

Finally, we simulate the effects of eliminating the tax exemption for employer-sponsored health insurance (ESHI) premium both under the benchmark and under the ACA. We find that, while the elimination of the tax exemption for ESHI premium would reduce the probability of all firms, especially the larger ones, offering health insurance to their workers, the overall effect on the uninsured rate is rather modest. We find that in the benchmark economy the uninsured rate would increase from 25.43% to 25.65% when the ESHI tax exemption is removed; and it will increase from 9.38% to 10.17% under the ACA.

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 markets equilibrium. 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. We plan to address those issues in our future research.

A Appendix: Lemma

Lemma 1. *For any wage distribution $F(w,x)$, $w_x(p)$ is increasing in p for each x.*

Proof. The proof is based on revealed preference argument. Choose any p and p' in $[\underline{p}, \overline{p}]$ such that $p > p'$ and fix $x \in \{0,1\}$. Notice that

$$\begin{aligned}
\pi_x(p) &= ((p - w_x(p) - xm_H)\, n_H(w_x(p),x) + (pd - w_x(p) - xm_U)\, n_U(w_x(p),x)) - xC \\
&\geq \big((p - w_x(p') - xm_H\big)\, n_H(w_x(p'),x) + \big(pd - w_x(p') - xm_U\big)\, n_U(w_x(p'),x)\big) - xC \\
&\geq \big((p' - w_x(p') - xm_H\big)\, n_H(w_x(p'),x) + \big(p'd - w_x(p') - xm_U\big)\, n_U(w_x(p'),x)\big) - xC \\
&= \pi_x\left(p', k\right) \\
&\geq \big((p' - w_x(p) - xm_H\big)\, n_H(w_x(p),x) + \big(p'd - w_x(p) - xm_U\big)\, n_U(w_x(p),x)\big) - xC,
\end{aligned}$$

where the second line comes from the fact that $w_x(p)$ is the optimal wage policy for a firm with productivity p and third line is implied by the assumption that $p > p'$. The fifth line is implied by the fact that $w_x(p)$ is the optimal policy for a firm with productivity p, not p'. Therefore, we have

$$(p-p')(n_H(w_x(p),x) + n_U(w_x(p),x)) \geq (p-p')(n_H(w_x(p'),x) + n_U(w_x(p'),x)).$$

Since $n_h(w,x)$ is increasing in w, this inequality holds if and only if $w_x(p) \geq w_x(p')$. $\square$

Lemma 2. *For each p, optimal wage policy must satisfy*

$$w_1(p) = \frac{\left\{ \begin{array}{c} [p - cm_H]\, n_H(w_1(p),1) + [pd - cm_U]\, n_U(w_1(p),1) \\ -\int_{p_1^*}^{p} \left(n_H(w_1(\tilde{p}),1) + dn_U(w_1(\tilde{p}),1)\right) d\tilde{p} - \pi_1(p_1^*) \end{array} \right\}}{n_H(w_1(p),1) + n_U(w_1(p),1)}$$

$$w_0(p) = \frac{\left\{ \begin{array}{c} pn_H(w_0(p),0) + pdn_U(w_0(p),0) \\ -\int_{p_0^*}^{p} \left(n_H(w_0(\tilde{p}),0) + dn_U(w_0(\tilde{p}),0)\right) d\tilde{p} - \pi_0(p_0^*) \end{array} \right\}}{n_H(w_0(p),0) + n_U(w_0(p),0)}$$

where p_x^* =inf$\{p \in [\underline{p}, \overline{p}] : n_H(w_x(p), x) > 0$ *and* $n_U(w_x(p), x) > 0\}$ *and*

$$\pi_1(p_1^*) = [p_1^* - w_1^*(p_1^*) - m_H] \, n_H(w_1^t(p_1^*), 1) + [p_1^* d - w_1(p_1^*) - m_U] \, n_U(w_1^t(p_1^*), 1)$$

$$\pi_0(p_0^*) = [p_0^* - w_0(p_0^*)] \, n_H(w_0(p_0^*), 0) + [p_0^* d - w_0\,(p_0^*)] \, n_U(w_0(p_0^*), 0).$$

Proof. Define p_x^* =inf$\{p \in [\underline{p}, \overline{p}] : n_H(w_x(p), x) > 0$ and $n_U(w_x(p), x) > 0\}$ for $x = 0, 1$. Because $w_x(p)$ is increasing in p and $n_h(w, x)$ is increasing in w, we have $n_H(w_x(p), x) > 0$ and $n_U(w_x(p), x) > 0$ for $p > p_x^*$. Define

$$\tilde{\pi}\,(w_x, x) \equiv \max_x \left((p - w_x - m_H)\, n_H(w_x, x) + (pd - w_x - m_U)\, n_U(w_x, x)\right).$$

Notice that the solution $w_x(p)$ is equal to the one defined in (27) and (28) and be independent of $h_p(k)$ and C. By applying envelope condition, we have

$$\tilde{\pi}_x'(p) = (n_H(w_x(p), x) + dn_U(w_x(p), x))$$

for $p > p_x^*$. By taking integral over $[p_x^*, p]$, we then obtain

$$\tilde{\pi}_x(p) = \int_{p_x^*}^{p} (n_H(w_x(\tilde{p}), x) + dn_U(w_x(\tilde{p}), x))\, d\tilde{p} + \tilde{\pi}_x(p_x^*).$$

By equating it with (27) and (28), we obtain

$$\begin{aligned} w_1(p) &= \frac{(p - m_H)\, n_H(w_1(p), 1) + (pd - m_U)\, n_U(w_1(p), 1) - \int_{p_1^*}^{p} (n_H(w_1(\tilde{p}), 1) + dn_U(w_1(\tilde{p}), 1))\, d\tilde{p} - \pi_1(p_1^*)}{n_H(w_1(p), 1) + n_U(w_1(p), 1)} \\ w_0(p) &= \frac{pn_H(w_0(p), 0) + pdn_U(w_0(p), 0) - \int_{p_0^*}^{p} (n_H(w_0(\tilde{p}), 0) + dn_U(w_0(\tilde{p}), 0))\, d\tilde{p} - \pi_0(p_0^*)}{n_H(w_0(p), 0) + n_U(w_0(p), 0)} \end{aligned}$$

This is a form of wage policy which we utilize in our numerical algorithm. □

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