HEALTH INSURANCE AS A PRODUCTIVE FACTOR*

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Abstract

In this paper, we present a less explored channel through which health insurance impacts productivity: by offering health insurance, employers reduce the expected time workers spend out of work in sick days. Using data from the Medical Expenditure Panel Survey (MEPS), we show that a worker with health coverage misses on average 4.7 workday less than workers without coverage. We develop a model that embodies this impact of health coverage in productivity. In our model, offering health insurance has an impact on the probability that a worker gets sick, missing workdays, as well as the probability that he recovers and gets back to work. Through this framework, we match several features empirically observed about the connection between labor market and health insurance coverage: Companies that offer health insurance will be larger in equilibrium, as well as they will offer a higher wage. We calibrated the model using US data for 2004 and show that an increase of 10% in health insurance premium generates a reduction of 11.65% in the proportion of worker with health coverage, as well as an increase in the measure of sick workers in steady state by 6.14%. We also showed that investments in preventive medicine have a larger impact on health coverage and the fraction of sick workers in equilibrium than investments in curative medicine. Finally, we show that a government mandate that forces firms to offer health insurance increases average salaries, while reducing profits, having ultimately a negative impact on social welfare.

Keywords: Health, Health Insurance, Labor Market, Labor Mobility.

JEL Codes: E20, E24, E25, H10, J32, J63, J78

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1 Introduction

The main characteristic of the US health system is the presence of employers as the main source of insurance for the population at work age (18 to 64 years old). This generates a peculiar interaction between health care and labor markets. As health insurance costs outside the workplace are prohibitive to most workers, employers can distinguish themselves by offering health coverage to their employees and obtain a hiring edge over firms that do not offer insurance. On the other hand, as health costs increased, labor force’s health coverage became a main source of variable costs for employers. As evident in the last decade, increasing health care costs was followed by a decrease in the fraction of workers covered by their employers, increasing the number of uninsured from 36.5 million in 1994 to 45.7 million in 2008, representing now 17.4% of the non-elderly population. The interaction between labor market and health insurance in a scenario of rising health care costs also seemed to be harmful to labor productivity: In order to save in health care costs, several employers hire workers as part-time or contract employees. Similarly, many workers decide not to move to a job that seems a better match in terms of total productivity but does not offer health insurance. Therefore, a better understanding of the impact of employer-based health insurance on labor market outcomes seems fundamental to estimate the real cost of the US health insurance system.

In this paper, we present a second channel through which health insurance impacts productivity. By offering health insurance, employers reduce the expected time out of work in two ways: by reducing the probability a worker gets sick (preventive medicine) and/or increasing the probability a worker recovers from illness (curative medicine). Our empirical results using data from the Medical Expenditure Panel Survey (MEPS) show that a worker with health coverage misses on average \(\frac{4}{7}\) workdays per year less than workers without health coverage. This reduction in workdays lost implies that workers become a more valuable asset for the firm.

We develop an on-the-job search model that embodies this impact of health coverage in productivity. In our model, employers decide not only which wages to offer, but also if they offer a health care option to their employees. Offering health insurance has an impact on the probability that a worker gets sick, misses workdays, recovers, and returns to work. Through this framework, we match several features empirically observed about the connection between labor market and health insurance coverage. For example, in our model, companies that offer health insurance will be larger in equilibrium, as well as they will offer a higher wage. The reason for higher wage is derived from the productivity boost of health insurance; once employees are working more in expected terms, losing a worker becomes more costly for a firm, and therefore firms offer higher wages to avoid workers accepting outside offers. These results are also corroborated by our empirical findings with the MEPS. More specifically, increases in firm size and wages augment the probability of a worker having health insurance coverage, being these variables are more important than other worker specific characteristics, such as previous general health condition, health habits, or addictions.

Once we calibrate the model using US data for 2004, we evaluate a series of policy changes in the sector.

\footnote{As usual, we controlled for observables and endogeneity.}
We evaluate how different levels of tax deductibility of employer-provided coverage affect labor market results. We find a negligible effect of taxes on unemployment rate, while there is a significant wage reduction, and an increment in the share of firms providing health insurance. We also show that an increase in 10% on health insurance premium reduces the proportion of workers with health coverage by 11.65%, as well as an increase in the number of workers sick in steady state by 6.14%. In addition, we assume a scenario in which the government mandates that all firms provide health insurance. Using the parameters obtained for the US economy in 2004, we show that such policy reduces firms’ profit but increases workers’ welfare, and the total welfare effect is negative. Finally, we also study the difference in impact of improvements on preventive versus curative care. We consider the case of an governmental investment on medical research that make preventive methods 10% more efficient and compare that to the case in which such investment was made to improve curative methods (again, method becomes 10% more efficient). Our results show that, although both medical advances have positive impacts, choosing to invest on preventive instead of curative approaches represents a gain of 13.4% in labor force’s health coverage and a reduction of 5.53% in the number of sick workers in steady state.

In the next section, we discuss the related literature. Section 3 describes the data, while Section 4 describes our econometric specification. Empirical results are presented in Section 5 to motivate the model’s main hypothesis, which is the positive effect of holding health insurance on worker productivity. The model is described in Section 6 while comparative statistics and policy experiments are presented in Section 7. Finally, Section 8 concludes the paper.

## 2 Related Literature

Several scholars attempted to explain the predominance of employer provided health insurance in the United States. There are two current leading explanations for this phenomenon. One explanation has to do with the U.S. tax system, where firms receive a tax benefit when they provide nondiscriminatory health insurance to their employees. Gruber and Poterba (1996) estimated that the tax-induced reduction in the "price" of employer-provided health insurance is about 27% on average. Woodbury and Huang (1991), Gruber and Poterba (1994), and Gentry and Peress (1994) concluded that taxes are an important factor in the provision of fringe benefits, although, not surprisingly, there is a wide range in the magnitude of the estimates on how important taxes are in the determination of fringe benefits. A second possible explanation is the cost advantage that employers have to reduce adverse selection and lower administrative expenses through pooling. Together these two factors reduce the cost of providing insurance in large firms relative to small groups. Brown et al. (1990) and Manovskii and Brugemann (2009) mentioned these factors as the reasons why large firms are much more likely than smaller firms to offer health insurance.

Regarding to the effect of health insurance provision on wages, the empirical literature is inconclusive. The conflicting evidence highlights the difficulty associated with isolating the impact of health insurance, as separate from other factors, on labor market outcomes. In principle, we should expect that employees pay for the cost of employer-provided health insurance through lower wages, since health, similar to general human capital, can be kept by the worker as she moves from one job to another. However, surprisingly Monheit et al. (1985) estimated
a positive relationship between the two. This result does not seem to be robust since Gruber (1994), Gruber and Krueger (1990), and Eberts and Stone (1985), using different datasets and methods\(^2\), found that most cost of the benefit is reflected in lower wages. Subsequent research in this area addressed possible endogenous relationship between health provision and wages. One possible explanation for the endogenous relationship among these variables is that healthy individuals are more productive and obtain a higher wage, but a possible reason why they are healthy is the fact that they have health insurance. Several scholars attempted to handle this problem by looking for instrumental variables to obtain a more accurate measure of the health-wage relationship. Leibowitz (1983) used health insurance expenditures as an instrumental variable; he used the RAND Health Insurance Study 17 to estimate the wage/fringe benefit trade-off. For the Health Insurance Study RAND contacted employers to obtain information on employer health insurance expenditures before survey respondents were enrolled in the study. Using this "ideal" dataset, Leibowitz estimated employer health insurance expenditures had a positive effect on wages.

In spite of the vast empirical literature on this subject, few theoretical models explain the empirical findings. In the last few years some papers attempted to address this literature gap. Brugemann and Manovskii (2009) developed a quantitative equilibrium model that features tax deductibility of employer-provided coverage, non-discriminatory restrictions, and fixed cost of coverage to understand labor market flows and explain why the smaller firms are less likely to provide coverage than large firms. Dey and Flinn (2005) presented an equilibrium model of health insurance provision by firms and wage determination. They investigated the effect of employer-provided health insurance on job mobility rates and economic welfare using an on-the-job search model with Nash-bargaining. They found an equilibrium in which not all employment matches are covered by health insurance, wages at jobs providing health insurance are larger (in a stochastic sense) than those at jobs without health insurance. Moreover, workers at jobs with health insurance are less likely to leave those jobs, even after conditioning the wage rate. They also found that the employer-provided health insurance system does not lead to any serious inefficiency in mobility decisions. Finally, Fang and Gavazza's (2011) developed a frictional labor-market model, in which they show that an employment-based health system fails to internalize the entire surplus generated by health investment, which leads to dynamic inefficiencies.

Our paper is different from the previous papers in several ways. Unlike Brugemann and Manovskii (2009), we have homogeneous firms, while the difference in productivity is generated endogenously through the health insurance decision. Therefore, we obtain the result even if firms do not have different firm costs. Our model also delivers the results without the presence of adverse selection, which is fundamental for Brugermann and Manovskii’s model, even though they didn’t find empirical evidence to support it. Our model differs from Dey and Flinn’s in two ways. First, we do not assume that firms that do not offer health coverage have necessarily a larger exogenous job destruction rate. Therefore, our model takes into account not only the productivity impact of large negative health shocks, but also the impact of milder ones, which do not necessarily induce job destruction\(^3\). This approach is not only more general, but also allows us to evaluate the impact of changes and/or advances

\(^2\)Gruber (1994) uses statewide variation in mandated maternity benefits, Gruber and Krueger (1990) employs industry and state variation in the cost of worker’s compensation insurance, and Eberts and Stone (1985) rely on school district variation in health insurance costs to estimate the manner in which wages are negatively affected by health insurance provision.

\(^3\)In their model, even though diseases imply job destruction, they do not impact workers’ future productivity and/or employability. These assumptions seem contradictory, once job destructing diseases or injuries are usually related to chronic or permanent states.
in medical treatment - more specifically, investments in curative versus preventive medicine. Second, unlike Dey and Flinn, we take into account the impact of taxes on health insurance provision.

3 Data and Summary Statistic

The data used for this paper come from the Household Component of the Medical Expenditure Panel Survey (MEPS). The MEPS HC is a nationally representative survey of the U.S. civilian noninstitutionalized population. The MEPS-HC collects data from a sample of households through an overlapping panel design. Every year a new sample of households is selected to compose a new panel. Five rounds of interviews take place over a two and a half year period to collect the panel data. The purpose of this design is to provide continuous and current estimates of health care expenditures at both the person and household level for two panels for each calendar year.

The data used in this paper was collected from 2000 to 2007, i.e., we are using information from panel 5 to panel 10. A total of 117,994 individuals were interviewed about demographic characteristics, health conditions, health status, access to care, satisfaction with care, health insurance coverage, income, and employment. Since our main focus here is to estimate the impact of health insurance on missing working days, we only consider employed individuals whose ages are between 18 and 65. After adjusting the sample with these requirements 43,140 data points remain.

We use two different variables measuring missing working days: (a) missing working days due to illness (DDNWRK) and (b) days missed work stayed in bed (WKINBD). Means and standard deviations of these variables are presented in Table I. Definitions and summary statistics for the explanatory variables are presented in Table I. The health measures include Physical Component Summary (PCS) scores formed from the answers to the Short-Form 12 questions, if the individual currently holds a health insurance (HELD), if receives sick leave (SICPAY) if the individual smoke (ADSMOK). The demographic variables include AGE, race (BLACK), sex (MALE), marital status (MARRIED), family size (FAMSY) and education (SCHOOL). The economic variables include if the individual is part of an union (UNION), family income (TTLPY), if health insurance was offered to the individual (OFREEMP), the sector worked (PRIMARY, SECONDARY and TERCIARY) and firm size (NUMEMP). Finally, since we account for the endogeneity problem of health insurance, as an explanatory variable for # days missed work, we use some variables as instruments for health insurance. The main variables used as instruments for health insurance were dummies for region (NORTHEAST, MIDWEST, WEST). Details about Instrumental Variables will be discussed in the next Section.

4 The MEPS sampling frame reflects an oversample of minority groups such as blacks, Asians and Hispanics. MEPS also oversamples additional policy relevant sub-groups such as low income households.

5 We also used as instruments variables derived from questionnaires about the how the individual values health insurance, if you do not need Health Insurance (ADINSA), if you think that health insurance is not worth cost (ADINSB), and if you can overcome ills without medical help (ADOVER). Once results were qualitatively similar they were omitted.
### Table 1 Summary Statistics

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<th>SD</th>
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<tr>
<td>family income</td>
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<td>72176.92</td>
</tr>
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</table>

### 4 Econometric Specification

The main goal of this section is to test a crucial hypothesis implicitly assumed in our paper, which is: If a worker hold a health insurance, then she is going to miss less working days due to illness compared with a worker with similar characteristics but who is not covered by insurance. The decision to miss a working day can be treated within the random utility framework used in binary choice models. Denote by $U_{0i}$ de utility of not missing a working day while sick, while $U_{1i}$ is the utility of missing a working day. Let $U_0 = x_i \beta_0 + \varepsilon_{0i}$ and $U_1 = x_i \beta_1 + \varepsilon_{1i}$ where $x_i$ is a vector of covariates important to explain the number missed workdays and $\varepsilon_{ij}$ are random errors. Thus, If an individual misses a workday, we know that:

$$U_{1i} > U_{0i} \Rightarrow \pi_{10} < x_i (\beta_1 - \beta_0),$$

where $\pi_{10} = \Pr[\varepsilon_{0i} - \varepsilon_{1i}]$. Therefore, the decision to miss a workday can be represented by a Binomial Model. This is the model which motivates the Poisson econometric specification used in this section. Formally, let $X$ be the number of successes in a large number of $N$ independent Bernoulli trials with success probability $\pi_{10}$ of each trial being small. Then it is a well-known result that as $N \to \infty$ and $\pi_{10} \to 0$, and $N \pi_{10} = \mu > 0$, then this Binomial distribution function converges to a Poisson distribution function with parameter $\mu$. The above assertion is an application of a well-known argument used to justify the framework of count data models for the study of medical care utilization based on event counts. Here a missed workday is treated in the same way as a doctor consultation. This model can be generalized in a straightforward manner to allow for unobserved
heterogeneity which will imply an overdispersed count model like the negative binomial. We provide empirical
evidence suggesting overdispersion of number of missed workdays due illness, and for this reason this article also
analyzes the negative binomial family as the main specification.

4.0.1 Negative Binomial Specification

Let $y_i$ denotes the number of days missed work due illness, which is obviously a count variables that takes
non-negative integers values. The density function for the negative binomial (NB) model is given by:

$$
Pr[Y = m_j | \gamma, \lambda] = \frac{\Gamma(m_i + \gamma_i)}{\Gamma(\gamma_i)\Gamma(m_i + 1)} \left( \frac{\gamma_i}{\lambda_i + \gamma_i} \right)^\phi_i \left( \frac{\lambda_i}{\lambda_i + \gamma_i} \right)^{y_i},
$$

(1)

where

$$
\lambda_i = \exp(x_i'\beta)
$$

and the precision parameter is given by:

$$
\gamma_i = (1/\alpha)\lambda
$$

where $\alpha$ is an overdispersion parameter. As a result of this specification, we have:

$$
E(y_i|x_i) = \lambda_i
$$

and

$$
V(y_i|x_i) = \lambda_i(1 + \alpha)
$$

this model is called negative binomial-1 (NB1) model.

4.0.2 Estimation Procedure

In the next session we present some empirical support for our hypothesis that if a worker hold a health
insurance, then she misses less workdays. We account for the possible endogeneity of health insurance, since we
imagine that health insurance is only offered to healthy people, who naturally miss less working days. To deal
with this problem, we will estimate our regression using a two-step procedure.

Let $m_i$ denotes the number of days missed work. We are assuming that $m_i$ follows a NB1 distribution. Then we know that:

$$
\mu_i = E(m_i|h_i, x_i, u_i) = \exp(\beta_1 h_i + x_i'\beta_2 + u_i)
$$

(2)

Then, it is assumed that the error term $u_i$ is correlated with the dummy variable $h_i$ that assumes the
value 1 when a worker holds health insurance. We also assume that the error term $u_i$ is uncorrelated with
$x_i$, which is a vector of exogenous regressors.
In order to solve this endogeneity problem, we need to find instruments for the health insurance variable \( h_i \). Hence, we specify a probit equation for the dummy variable \( h_i \):

\[
h_i = \Phi (x'_{2i} \gamma) + \varepsilon_i \tag{3}
\]

where \( x_{2i} \) is a vector which may include some variables which affect days missed work, but also contains some variables which affect the probability of health insurance but only affect days missed work through \( h_i \). Similarly as the linear case, a condition for a robust identification of \( 2 \) is that there is available at least one valid excluded variable (instrument).

We also assume that there is a common latent factor \( \varepsilon \) which affects both \( h_i \) and \( m_i \) and is the only source of dependence between them, after controlling for the influence of the observable variables \( x_1 \) and \( x_2 \). We can model this assumption as follows:

\[
u_i = \rho \varepsilon_i + v_i
\]

where \( v_i \) is independent of \( \varepsilon_i \), \( v_i \) is i.i.d., and \( E[\varepsilon_i] = \text{constant} \).

Using this additional assumption, it is possible to show that:

\[
\mu_i = E(m_i | h_i, x_i, \varepsilon_i) = \exp(\beta_1 h_i + x'_{1i} \beta_2 \rho \varepsilon_i) \tag{4}
\]

If \( \varepsilon_i \) were observable, we could just include it as an additional regressor and this would solve the endogeneity problem. Since we cannot observe it, we replace it by a consistent estimate. Therefore, the first step of our estimation is to estimate \( 3 \) and obtain the residuals \( \hat{e}_i \). Then we estimate the parameters of the negative binomial given in 4 by replacing \( \varepsilon_i \) by \( \hat{e}_i \).

## 5 Results

Tables 2 and 3 report the results of our estimation procedure using different models and explanatory variables. To check the consistency of our estimation, we not only estimate the Negative Binomial model, but also estimate a Poisson model with a robust standard error estimate\(^6\). In table 2, we used an OLS estimator for health insurance in the first step of our procedure. In the table 3, we have used a Probit model in the first step, as described above.

We use the regional dummies as an instrumental variable for health insurance. The reason for using regional variables as an instrument is that there is a significant difference in health insurance coverage across regions in the US. However, we should not expect that the variable region would have any impact on the number of days a worker misses work. In fact, we run a regression using the regional variable as explanatory variables in the second step regression and we found that the regional dummies are uncorrelated with missed workdays, confirming the validity of these dummies as instruments for health insurance coverage. We also used other variables which try to measure how the worker values the importance of health insurance, assuming that if he thinks that the insurance

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\(^6\)We use the bootstrap method to control for the first stage estimation of \( \hat{e}_i \), as well as overdispersion.
is not worth its cost, then the probability of having health insurance is lower. Once results were similar, we
omitted the tables.

Before we start discussing the empirical results, it is important to notice that the coefficient assigned for
residuals was always significant, indicating that our data is characterized by overdispersion. This support our
choice of the Negative Binomial density distribution as our main model framework.

As for the first step regression, we found that the coefficients had the expected sign for explaining health
insurance coverage. We see that the variables measuring health status have a positive impact, indicating that
healthy people have a higher probability of being covered. This also justifies our two-step econometric procedure,
since we observe that healthy workers not only have a larger probability of being covered but also miss less
workdays. Therefore, we needed our regional instrument variables in order to isolate the effect of health insurance
coverage on missed workdays. The South region is the one omitted in our regression. Thus, we found that people
living in the Northeast, Midwest and West regions have a higher probability of having health insurance coverage
when compared to the South region. Our workers’ characteristic variables also indicate that the probability
of being covered increases with age, income, education and family size. Also, males have a larger probability
of receiving coverage as do workers who are members of unions. Finally, smoking seems not to influence the
probability of obtaining health coverage.

The main paper hypothesis is tested in the second step regression. Thus, we are interested in the held
insurance coefficient, which describes the influence of holding a health insurance plan on the number of days an
employee misses work. Given our specification, if the held insurance coefficient is negative, then a worker who
holds health insurance misses fewer working days. In all specifications shown below, we found a negative and
statistically significant coefficient for held insurance. The Poisson and Binomial Negative models have similar
coefficients for all specifications used. In all specifications this coefficient is of similar magnitude, the only large
difference in this coefficient was when we used more instruments and a different variable measuring health status
(RTHLTH). Also, this large difference is only observed when we use a linear regression in this first stage. Thus,
our empirical results support our paper’s hypothesis, and workers who hold health insurance are more productive.

The other explanatory variables had the expected sign coefficients in the second step regression. In order
to save some space, we will just discuss a few of them here. The health status and RTHLTH are indexes measuring
worker health, in almost all specifications those coefficients were negative, indicating that a healthier worker loses
fewer working days. After we control for these health indexes, the variable indicating if the worker smokes is not
significant for several of our model specifications. The PAYLEAVE variable coefficient was positive, an expected
sign, confirming that workers who have sick leave pay miss more working days.

The demographic variables indicate that the older the worker, the more work days missed. In addition,
family size also has a positive impact. This is expected since we think that these workers are missing working days
to help some other family member. The results also show that males miss more working days than females. We
also observe that married people miss more days of work as do members of unions. We have used dummy variables
indicating different economic activity sectors. We could not find a significant impact of secondary industries on
work days missed. However, the dummy for tertiary industries, whenever it was statistically significant, was
always negative, demonstrating that workers employed in this economic activity sector have a higher absentee
rate than the ones employed in other sectors. Finally, as indicated in Barmby and Stephan (2000), there is a
positive relationship between absence and firm size.

<table>
<thead>
<tr>
<th>Held insurance</th>
<th>health</th>
<th>Northeast</th>
<th>Midwest</th>
<th>West</th>
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<td>0.014</td>
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<td>(0.00038)</td>
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**First step regression: Linear Regression**

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**Second Step: Bootstrapped Errors**

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**Average Partial Effects**

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Second Step: Bootstrapped Errors

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6 Model

There is a continuum of risk neutral workers (measure m). While unemployed the worker receives a job offer with probability \( \lambda_0 \). When employed, the worker receives a job offer with probability \( \lambda_1 \). Once received, the offer can be accepted or rejected. There is no recall. While unemployed, the worker receives \( b \) (unemployment insurance or the utility of leisure). All agents discount future income at rate \( r \).

We assume risk neutral firms with measure normalized to 1. Firms offer a contract that is comprised of health insurance coverage and an hourly wage. To offer health coverage, the firm has to pay an up-front cost \( C \). Since the costs of insurance are shared by firm and worker, we allow an employee to decide if she wants coverage or not once it is offered. If yes, she has to pay a flow cost of \( c_w \) per period. Otherwise, nothing is paid. We do not assume that health is part of the worker’s utility function, but health insurance affects the probability that a worker gets sick (\( \pi \)) (preventive medicine) and/or the expected time she stays sick (\( \frac{1}{\gamma} \)). For instance, a worker who has health insurance has a lower probability to get sick (\( \pi_L \)) than a worker without coverage (\( \pi_H \)), that is, \( \pi_H \geq \pi_L \), as well as a higher probability of healing (\( \rho_L \geq \rho_H \)).

The proportion of firms not offering health insurance is \( \gamma_H \), while the proportion of firms offering it is \( \gamma_L \), these proportions being pin down in equilibrium. We assume that the (potentially trivial) distribution of
wages offered by firms providing health insurance is given by $F_L(z)$, while the distribution of wages offered by firms which don’t provide it is $F_H(z)$. From now on, we will call firms providing health insurance as low-risk firms, firms of type $L$, while firms not providing it will be called as high-risk firms, firms of type $H$.

A sick worker receives only a fraction of her wage $\alpha \in (0, 1)$. This assumption follows from the findings of the most recent available data from the Bureau of Labor Statistics’ National Compensation Survey (NCS) (covering March 2008) that shows that 39 percent of private-sector workers in the United States have no paid sick days or leave. Whenever paid leaves are available, they cover around 60% of the regular salary a worker receives. Since this value is not taxed, the amount can represent up to 80% of the regular wage. Similarly, a sick employee has a potentially higher job destruction rate ($\delta_S$) than a healthy employee ($\delta$), $\delta_S \geq \delta$. Finally, we assume that sick workers incur in additional medical costs of $\chi$. Since health insurance covers most costs to its members, we have $\chi_L \leq \chi_H$.

In this section, we will derive the steady state equilibrium in the labor market. We will first look at the workers’ optimal decision. Subsequently, we will look at the firm’s optimization problem, and how firms’ choice on health insurance coverage and wages will depend on workers’ and competitors’ behavior. All proofs and further calculations are in the appendix.

### 6.1 Worker’s Problem

From the framework outlined above, the expected discounted lifetime income when a worker is unemployed and healthy, $V_0$, can be expressed as the solution of the following equation:

$$rV_0 = b + \lambda_0 \sum_{i=H,L} \gamma_i \int \max \{V_i(z) - V_0, 0\} dF_i(z) + \pi_H (D_0 - V_0)$$

where $b$ can be seen as unemployment insurance as well as utility of leisure. A job offer arrives with a probability $\lambda_0$. A fraction $\gamma_H$ of offers comes from firms that don’t offer health insurance while the remainder comes from firms offering health coverage. Wages offered are seen by workers as draws from equilibrium distributions $F_i(z)$, where $i \in \{H, L\}$. $D_0$ is the value of being an unemployed sick worker. We assume that unemployed workers don’t have health insurance and that the only way a worker can obtain health insurance is through his employer. This is a simplifying assumption based on the very low percentage of the working population that has private insurance. It is also without loss of generality in our model, since firms offering wages that would induce workers to buy insurance would optimally offer health insurance. Notice that $D_0$ is given by:

$$rD_0 = b - \chi_H + \rho_H (V_0 - D_0)$$

where $\chi_H$ is an additional cost of being sick without health coverage, while $\rho_H$ is the probability a sick worker without coverage recovers. Rearranging the above expression and substituting it back, we have:

$$rV_0 = b + \lambda_0 \left[ \sum_{i=H,L} \gamma_i \int_{R_U}^\infty (V_i(z) - V_0) dF_i(z) \right] + \pi_H \left( \frac{b - \chi_H - rV_0}{r + \rho_H} \right)$$

---

7 Using the same approach as Burdett and Mortensen (1998), we assume that the distributions of wages, $F_i(z)$, $i \in \{H, L\}$ are given and we focus on the optimal workers’ decisions given these distributions. We assume the distributions are well-behaved: continuous, and differentiable (e.g. no mass points); we will derive these properties later.

8 Most buyers of private health insurance are entrepreneurs/self-employed, a choice that is not allowed in our model.
where \( R^H_U \) and \( R^H_L \) are the unemployed’s reservation wage for working in a health-coverage company and no health-coverage company, respectively\(^9\).

Once a worker is employed at a firm that does not offer health insurance, the value of holding a job with wage \( w \) at this company is:

\[
rV_H (w) = w + \lambda_1 \sum_{i=H,L} \gamma_i \int_{R^H_i (w)} (V_i (z) - V_H (w)) dF_i (z) + \delta (V_0 - V_H (w)) + \pi_H (D_H (w) - V_H (w))
\]

where \( \lambda_1 \) is the probability a job offer arrives. As before, a fraction \( \gamma_H \) of offers comes from firms that don’t offer health insurance while the remainder comes from firms offering health coverage. Offers above the reservation wage \( R^H_H (w) \in \{H, L\} \) are accepted. As expected, reservation wages can differ depending on the company offering health coverage or not. A job match between a firm and a healthy worker is destroyed with probability \( \delta \). Finally, \( D_H (w) \) is the value of holding a job that pays a wage rate of \( w \) at a company that does not offer health coverage:

\[
rD_H (w) = \alpha w - \chi_H + \rho_H (V_H (w) - D_H (w)) + \delta_S (D_0 - D_H (w))
\]

where \( \alpha \) is the reduction in wages given by the sick leave. We will assume from here on that \( \alpha \leq \frac{\tau \delta}{r + \delta + \lambda_1} \). As before, a worker without health insurance heals with probability \( \rho_H \) and a job match is destroyed with probability \( \delta_S \geq \delta \) if the worker is sick.

In the case in which a firm offers health coverage, we need to take into account the worker’s decision of accepting the coverage or not. Therefore, the value of holding a job at wage \( w \) in a company that offers health coverage is:

\[
V_L (w) = \max \{ V_L (w, y), V_L (w, n) \}
\]

where \( y \) and \( n \) indicate if the worker accepted or not the coverage, respectively. But notice that \( V_L (w, n) = V_H (w) \). Therefore:

\[
rV_L (w) = \max \{ V_L (w, y); V_H (w) \}
\]

where:

\[
rV_L (w, y) = w - c_e + \lambda_1 \sum_{i=H,L} \gamma_i \int_{R^L_i (w)} (V_i (z) - V_L (w, y)) dF_i (z) + \delta (V_0 - V_L (w, y)) + \pi_L (D_L (w) - V_L (w, y))
\]

As mentioned before, in this case the worker pays a flow cost of \( c_e \). We assume that this cost is paid even when the worker is sick, which implies that the value of being a sick worker at this company is given by:

\[
rD_L (w) = \alpha w - c_e - \chi_L + \rho_L (V_L (w, y) - D_L (w)) + \delta_S (D_0 - D_L (w))
\]

Notice that a firm would only pay the cost \( C \) if the worker opts to buy insurance, while a worker would only buy the offered health coverage if at the offered wage \( w^\wedge \), \( V_L (w^\wedge, y) \geq V_H (w^\wedge) \). In Appendix A we show that a worker would buy the coverage offered if the wage received \( w^\wedge \) is larger than a threshold \( \bar{w} \).

**Finding Reservation Wages:** In principle, we could have four types of job-to-job transitions to consider (two kinds of transition between companies of different types, two kinds between companies of the same type.). However, it is trivial that the reservation wage for transitions between jobs at the same type of firm is simply the present wage, i.e.

\[
R^i_t (w_i) = w_i,
\]

\(^9\)The fact that the optimal policy is a reservation policy is straightforward and standard. If one accepts wage \( w_1 \) as part of an optimal policy, then any wage \( w_2 > w_1 \) for firms that are otherwise identical, gives more utility and hence should be accepted as well.
When we consider the transition between different types of firms, the following simple result simplifies the problem.

**Lemma 1** Given that $V_i(w)$ is continuous and strictly increasing in $w$ for both $i = L, H$, for a wage $x$ at a high-risk firm, and a wage $y$ at a low-risk firm, the following should hold

$$R_H^L(y) = x \iff R_H^L(x) = y. \quad (10)$$

Hence, we can find a function $\omega^*$, such that for $x = \omega^*(y)$,

$$R_H^L(y) = \omega^*(y), \text{ and } R_H^L(x) = \omega^*(x).$$

The function $\omega^*$ is continuous and strictly increasing.

In Appendix B, we show that $\omega^*(w) > w$, i.e. that the function $\omega^*(\cdot)$ is above the 45 degree line, as well as that $\frac{d\omega^*(w)}{dw} > 1$, for every wage above the threshold $\bar{w}$. These properties not only imply that all wages can be rescaled into ‘health-coverage firm equivalent’ wages without loss of generality$^{11}$, but they also show that workers will ask a wage premium to work in a company that does not offer health coverage ($\omega^*(w) > w$) and this premium is increasing with the wage rate ($\frac{d\omega^*(w)}{dw} > 1$).

Since by definition, $w_H$ and $w_L = \omega^{-1}(w_H)$ have the same utility values, we can also replace $V_H(w_H)$ by $V_L(\omega^{-1}(w_H))$ in the integrals of the value function, and integrate over the cumulative distribution of low-risk firm equivalent wages in the economy, $F(z)$ (notice the absence of the subscript!), which we define as follows:

$$F(z) = \gamma_L F_L(z) + (1 - \gamma_L) F_H(\omega^*(z))$$

Once we have this adjustment, the only thing that matters for the worker’s decision is the wage level in terms of ‘health-coverage firm equivalent’ terms.

### 6.2 Firm’s Problem

In this section, we take the behavior of workers as given, and derive the firms’ optimal response. Firms post wages that maximize their profits taking as given the distribution of wages posted by their competitors ($F_i(w), \ i \in \{H, L\}$) and the distribution of wages healthy employed workers are currently earning at other firms, given by distributions $G_i(w), \ i \in \{H, L\}$. We will assume here that all distributions are stationary and well-behaved. In addition, firms decide about the provision of health insurance. If a firm offers health insurance, then it has to pay an up-front cost of $C$. Note that firms have to pay taxes $t$ on wages, but they do not pay taxes on health insurance coverage expenditures $C$.

As we saw previously, a worker’s decision only depends on whether an offer is higher in terms of equivalent wage to health coverage firms. Therefore, we can construct a cumulative distribution of employed workers’ equivalent-wages as follows:

$$G(w) = (1 - v_H) G_L(w) + v_H G_H(\omega^*(w))$$

$^{10}$A particular case of the result above is $R_H^L(R_H^L) = R_H^H$.

$^{11}$Of course, we alternatively could rescale all solid wages into risky firm equivalents.
where \( v_H \) is the proportion of healthy employed workers in no health-coverage companies.

When a firm is choosing the optimal wage level, it has to take in consideration the amount of active workers they can attract at any given wage. For this reason, before we analyze the firm’s wage decision, let’s derive the firm’s labor force:

\[
\frac{dl_i(w)}{dt} = \lambda_0 u + \lambda_1 G(w)(m-u-s_e-s_u) + \rho_i d_i(w) - [\delta + \pi_i + \lambda_1 (1 - F(w))] l_i(w)
\]

where \( d_i(w) \) is the amount of sick workers the firm keeps in any given period, while \( u, s_e, s_u \) is the measure of healthy unemployed workers, sick employed workers and sick unemployed workers in the economy, respectively. Therefore, every period a firm receives an inflow of unemployed workers at rate \( \lambda_0 \), an inflow of currently employed workers at rate \( \lambda_1 G(w) \), and an inflow coming from previously sick employees at rate \( \rho_i \). Similarly, every period it loses worker at rate \( \delta \) to unemployment, \( \lambda_1 (1 - F(w)) \) to other firms and \( \pi_i \) to sickness. Since in steady state we have \( \frac{dl_i(w)}{dt} = 0 \), we have, after substituting \( d_i(w) \):

\[
l_i(w) = \frac{\lambda_0 u + \lambda_1 G(w)(m-u-s_e-s_u)}{\delta + \lambda_1 (1 - F(w)) + \frac{s_u}{\rho_i + s_u} \pi_i}
\]

where \( i \in \{H, L\} \).

Note that the steady state amounts of workers are different, even when equivalent wages are offered, because of different outflows into sickness. Since \( \pi_H \geq \pi_L \) and \( \rho_L \leq \rho_H \), with at least one inequality strict, \( l_L > l_H \) at any ‘health-coverage firm equivalent’ wage. In terms of the total amount of sick workers kept, the result is ambiguous, although we know that companies that offer health coverage keeps a smaller fraction of its labor force in sick leave at any period in time. For any wage offered lower than \( R^*_L \), \( l_i(w) = 0 \). As is standard in on-the-job search models build, we focus on the maximization of steady state profits\(^{12}\).

**Profit Maximization**  In the equilibrium every wage in distributions \( F_L, F_H \) must be optimal: this means necessarily that all wages offered by firms of the same type must yield the same profit. Thus, for a health coverage firm’s maximization, the following must be true in equilibrium

\[
Profit_L = \max_w (p - w(1+t)) l_L(w) - \omega(1+t)d_L(w) - C, \quad \text{given } F(w), G(w), \quad (5)
\]

\[
F_L(w) \subseteq \{w' | w' \in \arg \max (p - w(1+t)) l_L(w) - \alpha(1+t)wd_L(w) - C\}.
\]

And, for a firm that does not offer health coverage:

\[
Profit_H = \max_w (p - \omega^* (w) (1+t)) l_H(w) - \alpha(1+t)\omega^* (w) d_H(w) \quad \text{given } F(w), G(w), \quad (6)
\]

\[
F_H(\omega^*(w)) \subseteq \{\omega^*(w') | w' = \arg \max (p - (1+t)\omega^* (w)) l_H(w) - \alpha(1+t)\omega^* (w) d_H(w)\}.
\]

However, we do not know yet how the distributions \( F(w), F_L(w_L), F_H(w_H) \) look like. All we know at this stage is that in the equilibrium, every equivalent-wage in the support of \( F(w) \) must be offered by either a firm offering or not offering health coverage.

To construct the wage offer (firm wage) distributions, we need to know more than just this. The next proposition will help us by telling what kind of wages each type of firm is offering. In the process, it will already tell us more about compensating differentials.

\(^{12}\)See Coles (2001) for a discussion of this focus.
But before that, let’s present formally the result previously mentioned that no firm that offer health-coverage will offer a wage below $\bar{w}$.

**Lemma 4** Any firm that pays the up-front cost $C$ will offer a wage that induces the workers to buy join the health insurance plan.

Now we are ready to present the result that allow us to pin down the wage distributions:

**Theorem 1** Suppose that $w_L$ and $w_H$ are profit maximizing equivalent-wages offered in equilibrium by resp. a firm providing health insurance and not providing it, i.e. for these wages it holds that

$$w_L \in \arg \max_w \{ (p - w(1 + t)) l_L(w) - \alpha w(1 + t) d_L(w) - C \};$$

$$w_H \in \arg \max_w \{ (p - \omega^*(w)(1 + t)) l_H(w) - \alpha(1 + t) \omega^*(w) d_H(w) \}$$

Then, we must have $w_L \geq w_H$. Moreover, the sets of equivalent-wages offered by health-coverage firms, and likewise by no health-coverage firms, are connected sets.

The importance of this proposition is that it shows that the compensating wage differentials demanded by the worker for an increase in health risk, are not ‘supplied’ by the other side of the market. In the labor market equilibrium, firms which not provide health insurance cannot profitably compete in wages with firms providing it, especially when the required compensating differential becomes large. As a result, they prefer to make more profit per worker and to keep this worker for a shorter period than to pay higher wage rates and have the risk to keep a unproductive worker for a long period of time due to sickness. Firms offering health insurance on the other hand, pay higher wages to attract and keep the workers for a longer period since they have already invested in health insurance to keep them healthy and therefore more productive\(^{13}\).

An important last remark is that since all firms are identical at the beginning of each period, they all must have the same profit, otherwise either all firms will invest in health insurance or no firm will invest in it. Therefore, the fraction of firms not investing in health insurance ($\gamma_H$) is endogenously determined by the following equal profit condition. For any wages $w_L$ and $w_H$ offered in equilibrium by firms offering and not offering health coverage, respectively, we have:

$$\text{Profit}_L = \left( p - \left[ 1 + \frac{\alpha \pi_L}{\rho_L + \delta_S} \right] w_L(1 + t) \right) l_L(w_L) - C =$$

$$\text{Profit}_H = \left( p - \left[ 1 + \frac{\alpha \pi_H}{\rho_H + \delta_S} \right] w_H(1 + t) \right) l_H(w_H) = \text{Profit}_H$$

\(^{13}\)This result is similar to the one found in Chao(2008) in a different context. Chao(2008) have proved that in an environment with search friction, firms will pay part of the investment in General Human Capital. In the introduction we have argued that we can interpret health as a kind of General Human Capital since it is valued by employers and employees take it with them from job to job.
Clearly, depending on the parameters, we may have three possible outcomes:

1.) All firms offer health insurance;
2.) No firm offers health insurance;
3.) A fraction \((1 - \gamma_H) \in (0, 1)\) offers health insurance.

As expected, in the next section, our discussion will focus in the third case.

We are now ready to define the steady state equilibrium formally:

**Definition 1** A steady state equilibrium in the labor market is a tuple \(\{R_U^H, \omega^*(\cdot), F_L(\cdot), F_H(\cdot), G_L(\cdot), G_H(\cdot), u, s_e, s_u, \gamma_H\}\), such that

1. Given \(\{F_L, F_H\}\), \(R_U^H, \omega^*\) follow from worker’s optimization
2. Given \(\{F_L, F_H, G_L, G_H, u, s_e, s_u, R_U^H, \omega^*\}\) firms maximize;
3. \(G_L, G_H\) are stationary distributions, \(u\) is stationary unemployment for healthy workers, \(s_e\) is stationary measure of sick employees, \(s_u\) is stationary measure of sick unemployed workers, given the optimal decisions of workers in (1), and firms in (2);

The first two items have been covered in the last two sections. We can show existence and characterize the equilibrium by using the results presented up to now to construct stationary distributions, in particular those in (iii), and find the unemployment rate, as well as the measure of sick workers employed and unemployed.

In Appendix C, we explicitly characterize these equilibrium distributions (and outline the existence of a steady state equilibrium by construction).

### 7 Discussion and Policy Analysis

The benefit of an equilibrium analysis is that it allows us to analyze the impact of changes in policy, while taking into account the overall effect and potential externalities of such a measure. In this section, we present some policy exercises in order to evaluate the impact of changes in health costs and health treatments (preventive vs. curative) on relevant endogenous variables, such as the measure of firms offering health coverage, the measure of workers with health coverage, the measure of sick workers in steady state, and unemployment.

We calibrate the parameters in our model according to the data for the American economy in 2004. The unit of time considered is 1 month. First of all, labor product \(p\) is obtained from the output per worker provided by the Bureau of Economic Analysis (BEA) through the Survey of Current Business for 2004$^{14}$. Unemployed benefits \(b\) are set to 36% of monthly average wage, which is the national average according to the National Employment Law Center. The measure of workers relative to the number of firms, \(m\), is obtained from the 2004 Census, by dividing the total number of employer firms by the number of establishments. For the labor-market arrival rates, \(\lambda\), we use the estimates by Jolivet et. al. (2002), based on data from the Panel Study of Income Dynamics (PSID) for 1994-1997. The probabilities of getting sick and healing, \(\pi\) and \(\rho\) respectively, are derived from our estimates of the number of days lost using the MEPS dataset described in a previous section. Cost of

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$^{14}$We also calculated \(p\) as the GDP per employed worker for 2004, which gave us similar qualitative results.
health insurance, $C$, is pinned down by taking into account the 2004 average premium of an individual health insurance plan reported by the Kaiser Family Foundation. The exogenous termination rates are computed from the MEPS data set to match the unemployment rate of the healthy workers, $\delta$, and the unemployment rate of sick workers, $\delta_S$. Finally, the disutility of getting sick without health insurance, $\chi_H$, is determined by the average cost of health services in the MEPS data set. The calibrated parameters are presented in the table below:

<table>
<thead>
<tr>
<th>Parameters</th>
<th>$p$</th>
<th>$b$</th>
<th>$H.I. , \text{cost}$</th>
<th>$m$</th>
<th>$\chi_H$</th>
<th>$\chi_L$</th>
<th>$\alpha$</th>
<th>$\lambda_0$</th>
<th>tax</th>
</tr>
</thead>
<tbody>
<tr>
<td>7049</td>
<td>804</td>
<td>3695</td>
<td>19.96</td>
<td>4400</td>
<td>0</td>
<td>0.75</td>
<td>0.143</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameters</th>
<th>$\lambda_1$</th>
<th>$\pi_H$</th>
<th>$\pi_L$</th>
<th>$\rho_H$</th>
<th>$\rho_L$</th>
<th>$\delta$</th>
<th>$\delta_S$</th>
<th>$r$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0112</td>
<td>0.088</td>
<td>0.086</td>
<td>3.33</td>
<td>12.05</td>
<td>0.072</td>
<td>0.033</td>
<td>0.001</td>
<td></td>
</tr>
</tbody>
</table>

The model performance can be evaluated in table 5. The model does a reasonably good job matching the measure of firms offering health insurance in equilibrium and the measure of workers with health insurance in equilibrium. The model overestimates the percentage of workers unemployed in equilibrium, although this is probably related to a problem with the PSID as presented by Brown et. al. (1996). The model also performs well at estimating equilibrium wages. While the wages of workers covered by health insurance plans are underestimated by 10%, the wages of workers without coverage are overestimated by 10%. One potential issue here is that the PSID has been criticized for having noisy and often inconsistent measures of job turnover, which result from questions on job tenure that are somewhat ambiguous. In order to overcome that criticism, we also calibrate the model in which the labor-market arrival rates are derived from the NLSY by Bowlus et. al. (1995) with results that are qualitatively similar.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Model</th>
<th>Actual data</th>
<th>% Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Share of firms offering health insurance</td>
<td>53%</td>
<td>59%</td>
<td>-6%</td>
</tr>
<tr>
<td>Unemployment</td>
<td>6.5%</td>
<td>5.1%</td>
<td>1.4%</td>
</tr>
<tr>
<td>Average wage of workers covered</td>
<td>2,924.92</td>
<td>3,285.55</td>
<td>-11%</td>
</tr>
<tr>
<td>Average wage of workers not covered</td>
<td>2,258.82</td>
<td>2,048.48</td>
<td>10.3%</td>
</tr>
<tr>
<td>STDV of covered workers</td>
<td>940.24</td>
<td>1,235</td>
<td>-23.9%</td>
</tr>
<tr>
<td>STDV of not covered workers</td>
<td>871.54</td>
<td>1,051</td>
<td>-17.1%</td>
</tr>
</tbody>
</table>

Let’s now consider the impact of rising health insurance costs on the measure of firms that offer coverage in equilibrium. This is initially tricky once the cost is divided among firms and employees. According to Buchmueller and Monheit (2009), the share of premiums paid directly by employees has remained constant over the past decade at around 15 percent for single coverage and 25 percent for family coverage. Therefore, we will assume that the

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15 This probability is hard to pin down from the data. We tried several values and it does not change the results significantly.
16 Brown and Light (1992) show that the coefficients from probit estimation using PSID turnover measures as the dependent variable are quite sensitive, both in sign and magnitude, to how one cleans the data.
worker pays 19 percent of the cost while the company pays the rest of it. The graph below summarizes our results:

As we can see, an increase in health insurance costs steeply reduces the fraction of firms offering health coverage in equilibrium. Since firms offering health coverage tend to be larger in equilibrium, the reduction in health coverage among workers is not as pronounced, but it is still significant. As expected, both the measure of sick and unemployed workers in steady state goes up\(^\text{17}\).

Considering an increase in 10% of the health insurance premium, while keeping the share paid by employee and firm constant, we have the following result, where the first column represents the values of the current calibration:

<table>
<thead>
<tr>
<th></th>
<th>Benchmark</th>
<th>Higher Premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Share of firms offering health insurance</td>
<td>0.4482</td>
<td>0.3960</td>
</tr>
<tr>
<td>Share of workers covered by insurance</td>
<td>0.7359</td>
<td>0.6922</td>
</tr>
<tr>
<td>Measure of sick workers</td>
<td>0.0114</td>
<td>0.0121</td>
</tr>
<tr>
<td>Unemployment rate</td>
<td>3.14%</td>
<td>3.18%</td>
</tr>
</tbody>
</table>

Therefore, an increase in 10% in the price of health insurance generates a reduction in health coverage of 11.65%, as well as an increase in the measure of sick workers in steady state by 6.14%.

Now, let’s suppose that the U.S. government decides to introduce a social security tax paid by employers. We will consider here a tax rate of 7.87%, which is the sum of the payroll taxes for social security and Medicare. We simulate the model with this new assumption and obtain the results presented in table 7. The main results is the larger number of firms providing health insurance, which increased from 53% in the benchmark model to 89% with the introduction of social security taxes. Since health insurance expenditures have tax deductibility, increments in the social security tax rate affect proportionally more the profits of firms not offering coverage.

\(^{17}\)This results are qualitatively independent from \(\delta_S > \delta\).
than the profits of firms offering coverage. Thus, when this tax rate is increased, it is more profitable to offer health insurance and the share of firms offering health insurance increases. Another significant outcome is that the unemployment rate is almost unchanged in this new scenario. Even though salaries are reduced, there is a larger share of firms offering health coverage and these firms employ more workers and pay better salaries than firms that do not offer health coverage. This offsets the effect of the lower salaries on employment.

### Table 7: Model with Taxes vs Benchmark

<table>
<thead>
<tr>
<th>Variables</th>
<th>Benchmark</th>
<th>Taxes</th>
<th>% Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Share of firms offering health insurance</td>
<td>53%</td>
<td>89%</td>
<td>36%</td>
</tr>
<tr>
<td>Unemployment</td>
<td>6.5%</td>
<td>6.6%</td>
<td>1.5%</td>
</tr>
<tr>
<td>Average wage of workers covered</td>
<td>2,924.92</td>
<td>2,574.49</td>
<td>-12%</td>
</tr>
<tr>
<td>Average wage of workers not covered</td>
<td>2,258.82</td>
<td>1,909.0</td>
<td>-15.5%</td>
</tr>
<tr>
<td>STDV of covered workers</td>
<td>940.24</td>
<td>1071.4</td>
<td>12.2%</td>
</tr>
<tr>
<td>STDV of not covered workers</td>
<td>871.54</td>
<td>560.21</td>
<td>-55.6%</td>
</tr>
</tbody>
</table>

Using our calibrated model, we can also analyze the effects of a policy change in which the U.S. government mandates that all firms provide health insurance. The main outcomes predicted by the model in this hypothetical situation are described in table 8 below. As a result of this new policy, firms’ profits are reduced, as expected by the requirement of forced health insurance coverage, but the monthly product increases as a result of more productive workers. We also see that the salaries of workers previously covered by health insurance go down, and that the unemployment rate does not change much. Finally, welfare goes down, and the extra utility gained by new covered workers is more than fully compensated by the reduction in firms’ profit.

### Table 8: Effects of Government Mandate

<table>
<thead>
<tr>
<th>Variables</th>
<th>Benchmark</th>
<th>Mandate</th>
<th>% Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Profit</td>
<td>58,577.44</td>
<td>56,857.86</td>
<td>-3%</td>
</tr>
<tr>
<td>Product</td>
<td>91,604</td>
<td>92,213.9</td>
<td>0.7%</td>
</tr>
<tr>
<td>Average wage of workers covered</td>
<td>2,924.92</td>
<td>2,513.0</td>
<td>-16.4%</td>
</tr>
<tr>
<td>Average wage of workers not covered</td>
<td>2,258.82</td>
<td>2,513.0</td>
<td>10.1%</td>
</tr>
<tr>
<td>Unemployment</td>
<td>6.5%</td>
<td>6.6%</td>
<td>1.5%</td>
</tr>
<tr>
<td>Welfare</td>
<td>38,310,878.4</td>
<td>36,904,630.67</td>
<td>-3.8%</td>
</tr>
</tbody>
</table>

Another interesting topic is to evaluate which would be the better health insurance coverage, one that reduces the probability that a worker gets sick (preventive medicine - reduction in \( \pi \)) or one that reduces the time that a worker stays sick (curative medicine - reduction in \( \rho \)). In order to further investigate the impact of investments in preventive versus curative medicine, let’s consider the following exercise: Let’s assume that the government has as its main goals to reduce the number of sick workers, as well as increase the number of workers with health insurance. In order to achieve such goals the government can invest a given amount on scientific advances for preventive or curative medicine. This investment can reduce the probability a worker gets sick, or increase the probability that he or she recovers once sick by 10%. Considering that only workers with health
insurance could benefit from the medical advance, which choice would be the best? The following table compares the results of both cases to the benchmark calibrated model:

<table>
<thead>
<tr>
<th></th>
<th>Benchmark</th>
<th>Preventive</th>
<th>Curative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Share of firms offering health insurance</td>
<td>53%</td>
<td>57%</td>
<td>55.2%</td>
</tr>
<tr>
<td>Share of workers covered by insurance</td>
<td>78%</td>
<td>82%</td>
<td>79%</td>
</tr>
<tr>
<td>Measure of sick workers</td>
<td>0.0114</td>
<td>0.01047</td>
<td>0.01083</td>
</tr>
<tr>
<td>Unemployment rate</td>
<td>6.5%</td>
<td>6.3%</td>
<td>6.4%</td>
</tr>
</tbody>
</table>

As expected, even though both investments have a positive impact, the preventive medicine has a greater impact than the curative one. From the results above, we can see that choosing to invest in preventive care represents a gain of almost 4% in health coverage, compared to less than 2% for curative care, and a reduction of 5.53% in the number of sick workers in steady state, a larger reduction than the curative method. Another important result is that more efficient health treatment - preventive or curative - increases the probability a firm will offer health insurance as well as the probability a worker holds health insurance, even without any other external force pushing in that direction (such as tax benefits or other kinds of incentives).

Clearly, this is just a first step in this topic. Natural extensions of this exercise need to consider differences in the cost of investments, as well as differences in the cost of treatments in both cases, as well as a deeper discussion of social welfare.

8 Concluding Remarks

In this paper, we show that health coverage has a positive impact on labor productivity by reducing the number of sick days a worker needs to take. Our empirical results using data from the Medical Expenditure Panel Survey (MEPS) show that a worker with health coverage misses on average 4.7 fewer workdays per year than workers without health coverage. We introduce this productivity edge to an on-the-job search model in which employers not only post wages, but also decide if they offer health coverage or not. In equilibrium, firms offering health coverage are bigger and offer higher wages on average. These results are also corroborated by our empirical findings with the MEPS: Increases in firm size as well as wages augment the probability of a worker having health insurance coverage, and these variables are more important than other worker specific characteristics, such as previous general health condition, health habits or addictions.

Once we calibrated the model using US data for 2004, we were able to evaluate the impact of a series of policy changes in the health insurance sector on labor market outcomes. We show that an increase of 10% on health insurance premiums reduces the proportion of workers with health coverage by 11.65%, and increases the number of sick workers in steady state by 6.14%. We also study the impact of introducing social security taxes paid by employers on earnings but not health insurance expenses. We see that such a policy would almost double the share of firms providing health insurance from the benchmark of 53% to coverage of 89% with the tax rate. Another outcome of this policy would be a lower average salary for workers and a change in the composition of
employment, with workers migrating to larger firms which offer health insurance. We also evaluate a theoretical scenario in which the government mandates that all firms provide health insurance. We show that while such a policy reduces firms’ profit but increases firms’ production and improves workers’ welfare, the total welfare effect is still negative.

Finally, we study the difference in the impact of improvements on preventive versus curative care. We consider the case of a governmental investment in medical research that makes preventive methods 10% more efficient, and then compare this to the case of a governmental investment that makes curative methods 10% more efficient. Our results show that even though both of these more efficient methods have positive impacts, choosing to invest in preventive care improves health coverage by almost 4% and results in a larger reduction in the number of sick workers, whereas curative care results in an improvement of less than 2% in health coverage and a smaller reduction in the number of sick workers.
9 Appendix A

In this appendix, we look at $V_L (w) = \max \{V_L (w, y) ; V_H (w) \}$. A firm would only pay the cost $C$ if the worker opts to buy insurance. Therefore, we can continue with $V_L (w, y)$ and $V_H (w)$ and at the end check that for any wage $w^\wedge$ offered by a company that pays $C$, $V_L (w^\wedge , y) \geq V_H (w^\wedge)$. Given this, assuming that the value functions are increasing in $w$ (which we are going to check later), we may have a cut off (that could be below zero) $\bar{w}$, such that for $w > \bar{w}$, $V_L (w, y) > V_H (w)$ (this is only true if we have a single crossing condition - i.e., we will need log concavity. We can show by obtaining $\frac{dV_L (w, y)}{dw} > \frac{dV_H (w)}{dw}$). So, first of all, let’s look at the conditions for the cut off.

First of all, let’s obtain $\frac{dV_H (w)}{dw}$. Manipulating the integrals and using the result that, by definition $V_L (R_H^L (w) , y) = V_H (w)$, we have that:

$$\frac{dV_H (w)}{dw} = \frac{1 + \frac{\alpha \pi \gamma_H}{\rho_H + \delta S}}{r + \delta + \frac{\pi_H (r + \delta S)}{\rho_H + \delta S} + \lambda_1 \left[1 - F \left( R_H^L (w) \right) \right]}$$

where $F (\cdot)$ is defined as follows:

$$F (z) = \gamma_H F_H \left( R_H^L (z) \right) + (1 - \gamma_H) F_L (z)$$

Notice that if $w > \bar{w}$, we must have $R_H^L (w) > w$ and $R_H^L (w) < w$:

$$V_H \left( R_H^L (w) \right) = V_L (w)$$

and

$$V_H (w) = V_L \left( R_H^L (w) \right)$$

Therefore, if $R_H^L (w) > w$, for monotonicity of the value functions, we must have $R_H^L (w) < w$. This implies that:

$$\lambda_1 \left[1 - F \left( R_H^L (w) \right) \right] > \lambda_1 \left[1 - F (w) \right], \text{for any } w > \bar{w}$$

Now, looking at the derivative for $V_L (w, y)$, we obtain:

$$\frac{dV_L (w, y)}{dw} = \frac{\left(1 + \frac{\alpha \pi \gamma_H}{\rho_H + \delta S}\right)}{r + \delta + \frac{\pi_H (r + \delta S)}{\rho_H + \delta S} + \lambda_1 \left(1 - F (w) \right)}$$

We already know that the last term in the denominator is smaller for $\frac{dV_L (w, y)}{dw}$, Now, notice that $\frac{\pi_H}{\rho_H + \delta S} > \frac{\pi_L}{\rho_L + \delta S}$, to consider the impact of the increase in this value, let’s assume that $x = \frac{\pi_H}{r + \rho_H + \delta S}$ and to simplify consider the last term in the denominator equals to $\lambda_1 (1 - F (\bar{w}))$ (this actually helps $\frac{dV_H (w)}{dw}$). Then, we have that:

$$\frac{d}{dx} \left(\frac{1 + \alpha x}{r + \delta + (r + \delta S) x + \lambda_1 (1 - F (w))}\right) = \frac{\alpha (r + \delta + \lambda_1 (1 - F (\bar{w}))) - (r + \delta S)}{(r + \delta + (r + \delta S) x + \lambda_1 (1 - F (\bar{w})))^2}$$

and this is negative if:
\[ \alpha (r + \delta) - (r + \delta_S) < 0 \Rightarrow \alpha < \frac{(r + \delta_S)}{(r + \delta + \lambda_1(1 - F(\bar{w}))} \]

Since we assume that \( \alpha \leq \frac{r + \delta_S}{r + \delta + \lambda_1} \), this is always satisfied and we have the single-crossing property that we need.

Therefore, whenever \( \delta_S > \delta \), for any \( w > \bar{w} \), \( \frac{dV_L(w, y)}{dw} > \frac{dV_H(w)}{dw} \). Since \( V_L(\bar{w}, y) = V_H(\bar{w}) \Rightarrow V_L(w) = V_L(w, y) \), for \( w > \bar{w} \). This also implies that for \( w > \bar{w} \), \( R_L^H(w) > w \), as we show in the Lemma B.1.

Now, let’s find an implicit expression for \( \bar{w} \). From \( V_L(\bar{w}, y) = V_H(\bar{w}) \), we obtain:

\[ c_e = \pi_L(D_L(\bar{w}) - V_L(\bar{w}, y)) - \pi_H(D_H(\bar{w}) - V_H(\bar{w})) \]

Since:

\[ \pi_H(D_H(\bar{w}) - V_H(\bar{w})) = \frac{\pi_H}{r + \delta_S + \rho_H} (\alpha \bar{w} - \chi_H - (r + \delta_S) V_H(\bar{w}) + \delta_S D_0) \]

and

\[ \pi_L(D_L(\bar{w}) - V_L(\bar{w}, y)) = \frac{\pi_L}{r + \delta_S + \rho_L} (\alpha \bar{w} - c_e - \chi_L - (r + \delta_S) V_L(\bar{w}, y) + \delta_S D_0) \]

Substituting the terms inside parenthesis, we have:

\[ \left[ 1 + \frac{\pi_L}{r + \delta_S + \rho_L} \right] c_e = \left\{ \begin{array}{l} \left( \frac{\pi_L}{r + \delta_S + \rho_L} - \frac{\pi_H}{r + \delta_S + \rho_H} \right) \left[ \alpha \bar{w} - (r + \delta_S) V_H(\bar{w}) + \delta_S D_0 \right] \\ + \frac{\pi_H}{r + \delta_S + \rho_H} \chi_H - \frac{\pi_L}{r + \delta_S + \rho_L} \chi_L \end{array} \right\} \]
10 Appendix B

Proof of Lemma 1:

Proof. At the reservation wage $y$ of a move from a solid firm with wage $x$ to a risky firm (i.e. we suppose that $y = R^H_L(x)$), and the reservation wage $R^L_H(y)$ of the reverse transition, it must be the case that

$$V_L(x) = V_H(R^H_L(x)) = V_H(y) = V_L(R^L_H(y)).$$

But then it follows that $R^L_H(y) = x$. Similarly, it follows if $R^L_H(y) = x$, then $R^H_L(x) = y$. By the strict monotonicity of the value functions the mapping $R^L(x) = y$ is unique. It is straightforward to see that the resulting function must be continuous and increasing, if the value functions are increasing and continuous. ■

Lemma B.1 $\omega^*(w) > w$.

Proof. From the previous result, we obtain through manipulations that:

from $V_H (R^H_H (w)) = V_L (w)$, we obtain:

$$\omega^* (w) = \frac{1}{1 + \frac{\alpha \pi_L}{r + \delta S + \rho_L}} \left\{ \right.$$

$$\left. + \left( \frac{\pi_H}{r + \delta S + \rho_H} - \frac{\pi_L}{r + \delta S + \rho_L} \right) \left[ \frac{1 + \frac{\pi_L}{r + \delta S + \rho_L}}{1 + \frac{\alpha \pi_L}{r + \delta S + \rho_L}} + (r + \delta) (V_L (w, y) - V_H (\tilde{w})) \right] \right\}$$

Rearranging the expression obtained for $\omega^* (w)$, we have:

$$\omega^* (w) = w + \left( \frac{\pi_H}{r + \delta S + \rho_H} - \frac{\pi_L}{r + \delta S + \rho_L} \right) \left[ \frac{1 + \frac{\pi_L}{r + \delta S + \rho_L}}{1 + \frac{\alpha \pi_L}{r + \delta S + \rho_L}} + (r + \delta) (V_L (w, y) - V_H (\tilde{w})) \right]$$

Rearranging the expressions for $V_L (w, y)$ and $V_H (\tilde{w})$, we obtain:

$$V_L (w, y) - V_H (\tilde{w}) = \left( 1 + \frac{\alpha \pi_L}{r + \rho_L + \delta S} \right) \int_{\tilde{w}}^{w} \frac{1}{r + \delta + \frac{\pi_L (r + \delta S)}{r + \delta S + \rho_L} + \lambda_1 (1 - F (z))} dz$$

$$> \left( 1 + \frac{\alpha \pi_L}{r + \rho_L + \delta S} \right) \int_{\tilde{w}}^{w} \frac{1}{r + \delta + \frac{\pi_L (r + \delta S)}{r + \delta S + \rho_L} + \lambda_1 (1 - F (\tilde{w}))} dz$$

$$= \frac{\left( 1 + \frac{\alpha \pi_L}{r + \rho_L + \delta S} \right)}{r + \delta + \frac{\pi_L (r + \delta S)}{r + \delta S + \rho_L} + \lambda_1 (1 - F (\tilde{w}))} (w - \tilde{w})$$

Therefore, we have:

$$\omega^* (w) > w + \left( \frac{\pi_H}{r + \rho_H + \delta S} - \frac{\pi_L}{r + \rho_L + \delta S} \right) \left\{ \right.$$

$$\left. + \left( \frac{r + \delta}{r + r + \pi_L (r + \delta S) + \lambda_1 (1 - F (\tilde{w}))} \right) \left[ \frac{1 + \frac{\pi_L}{r + \delta S + \rho_L}}{1 + \frac{\alpha \pi_L}{r + \delta S + \rho_L}} + (r + \delta) (1 - \frac{\pi_L}{r + \delta S + \rho_L} + \lambda_1 (1 - F (\tilde{w})) \right] \right\}$$
Therefore, if:
\[
\frac{(r + \delta_S) \left( 1 + \frac{\alpha \pi_H}{r + \rho_L + \delta_S} \right)}{r + \delta + \frac{\pi_L(r + \delta_S)}{r + \delta_S + \rho_L} + \lambda_1 (1 - F(\bar{w}))} > \alpha
\]
the second term in the RHS is positive. Rearranging the above inequality, we have:
\[
\alpha < \frac{(r + \delta_S)}{r + \delta + \lambda_1 (1 - F(\bar{w}))}
\]
which is satisfied by \( \alpha \), once \( \alpha \leq \frac{r + \delta_S}{r + \delta + \lambda_1} \).

Lemma B.2 \( \forall w > \bar{w}, \frac{d \omega^*(w)}{dw} > 1 \).

Proof.
\[
\omega^*(w) = w + \left( \frac{\pi_H - \pi_L}{1 + \frac{\alpha \pi_H}{r + \rho_H + \delta_S}} \right) \left\{ \alpha \bar{w} - \omega \right\} + \left( r + \delta_S \right) \left( V_L(w, y) - V_H(\bar{w}) \right)
\]
\[
V_L(w, y) - V_H(\bar{w}) = \left( 1 + \frac{\alpha \pi_L}{r + \rho_L + \delta_S} \right) \int_{\bar{w}}^{w} \frac{1}{r + \delta + \frac{\pi_L(r + \delta_S)}{r + \delta_S + \rho_L} + \lambda_1 (1 - F(z))} dz
\]
Taking the integral, we have:
\[
\frac{d (V_L(w, y) - V_H(\bar{w}))}{dw} = \left( 1 + \frac{\alpha \pi_L}{r + \rho_L + \delta_S} \right) \frac{1}{r + \delta + \frac{\pi_L(r + \delta_S)}{r + \delta_S + \rho_L} + \lambda_1 (1 - F(w))}
\]
Then:
\[
\frac{d \omega^*(w)}{dw} = 1 + \left( \frac{\pi_H - \pi_L}{1 + \frac{\alpha \pi_H}{r + \rho_H + \delta_S}} \right) \left\{ \left( \frac{(r + \delta_S) \left( 1 + \frac{\alpha \pi_L}{r + \rho_L + \delta_S} \right)}{r + \delta + \frac{\pi_L(r + \delta_S)}{r + \delta_S + \rho_L} + \lambda_1 (1 - F(w))} - \alpha \right) \right\}
\]
The second term is positive if:
\[
\alpha < \frac{(r + \delta_S)}{r + \delta + \lambda_1 (1 - F(\bar{w}))}
\]
Since the RHS of the inequality above is decreasing in \( w \), we have that it is satisfied for any \( w > \bar{w} \) if:
\[
\alpha < \frac{(r + \delta_S)}{r + \delta + \lambda_1 (1 - F(\bar{w}))}
\]

Proof of Lemma 4:

Proof. Suppose that a firm that pays the up-front \( C \) and offers a wage lower than \( \bar{w} \). As we saw, the worker will not differentiate it from a firm that does not pay the up-front cost, therefore \( \omega^*(w) = w \). Therefore, at the end the number of workers this firm keeps in steady state \( l_H(w) \). Therefore:
Now, for any $w$, \( \forall w < \tilde{w} \)

\[
\text{Profit}_L (w) = [p - w (1 + t)] l_H (w) - \alpha w (1 + t) d_H (w) - C = \text{Profit}_H (w) - C
\]

Therefore, this firm would have a profitable deviation, which would be not pay the up-front cost $C$ and become a $H$ firm.

**Proof of Theorem 1:**

**Proof.** Suppose there exists $w_B, w_A$, such that $w_B > w_A$, and $w_B$ is offered by a risky firm while $w_A$ by a low-risk firm. Then it must be that

\[
\left( p - \left[ 1 + \frac{\alpha \pi_H}{\rho_H + \delta_S} \right] \omega^* (w_B) (1 + t) \right) l_H (w_B) \geq \left( p - \left[ 1 + \frac{\alpha \pi_H}{\rho_H + \delta_S} \right] \omega^* (w_A) (1 + t) \right) l_H (w_A)
\]  

(7)

Now, note that:

\[
\frac{l_L (w)}{l_H (w)} = \frac{\delta + \lambda_1 (1 - F (w)) + \frac{\delta \sigma_H}{\rho_H + \delta_S}}{\delta + \lambda_1 (1 - F (w)) + \frac{\delta \sigma_L}{\rho_L + \delta_S}} > 1
\]

Since $\pi_H > \pi_L$ and $\rho_L > \rho_H$.

By taking derivatives, we have:

\[
\frac{d}{dw} \left( \frac{l_L (w)}{l_H (w)} \right) = \lambda_1 F' (w) \frac{\frac{\pi_H}{\rho_H + \delta_S} - \frac{\pi_L}{\rho_L + \delta_S}}{\left\{ \delta + \lambda_1 (1 - F (w)) + \frac{\delta \sigma_L}{\rho_L + \delta_S} \right\}^2} > 0
\]

Therefore, this ratio is larger than 1 and increasing. In particular, it follows that:

\[
\frac{l_L (w_B)}{l_L (w_A)} > \frac{l_H (w_B)}{l_H (w_A)}
\]

(8)

To study the instantaneous profit per worker, notice:

\[
\frac{d}{dw} \left( \frac{p - \left( 1 + \frac{\alpha \pi_L}{\rho_L + \delta_S} \right) w (1 + t)}{p - \left( 1 + \frac{\alpha \pi_H}{\rho_H + \delta_S} \right) \omega^* (w) (1 + t)} \right) = \left\{ \frac{- \left( \left[ 1 + \frac{\alpha \pi_L}{\rho_L + \delta_S} \right] (1 + t) \left( p - \left[ 1 + \frac{\alpha \pi_H}{\rho_H + \delta_S} \right] \omega^* (w) (1 + t) \right) \right) + \left( 1 + \frac{\alpha \pi_H}{\rho_H + \delta_S} \right) (1 + t) \left[ \frac{\delta \sigma_H}{\rho_H + \delta_S} \right] \omega^* (w) (1 + t) \right\} \frac{dw^* (w) {dw} \frac{p - \left( 1 + \frac{\alpha \pi_H}{\rho_H + \delta_S} \right) w (1 + t)}{\left\{ p - \left( 1 + \frac{\alpha \pi_H}{\rho_H + \delta_S} \right) \omega^* (w) (1 + t) \right\}^2} = \left\{ \frac{- \left[ \left[ 1 + \frac{\alpha \pi_H}{\rho_H + \delta_S} \right] (1 + t) \left( p - \left[ 1 + \frac{\alpha \pi_H}{\rho_H + \delta_S} \right] \omega^* (w) (1 + t) \right) \right] \left( 1 + \frac{\alpha \pi_L}{\rho_L + \delta_S} \right) + \left[ \left[ 1 + \frac{\alpha \pi_H}{\rho_H + \delta_S} \right] - \left[ 1 + \frac{\alpha \pi_L}{\rho_L + \delta_S} \right] \right] (1 + t) \left[ \omega^* (w) - w \right] \right\} \frac{p - \left( 1 + \frac{\alpha \pi_H}{\rho_H + \delta_S} \right) \omega^* (w) (1 + t)}{\left\{ p - \left( 1 + \frac{\alpha \pi_H}{\rho_H + \delta_S} \right) \omega^* (w) (1 + t) \right\}^2} > 0
\]

Now, for any $w > \tilde{w}$, $\frac{d w^* (w)}{dw} > 1$, which implies that:

\[
\frac{d}{dw} \left( \frac{p - \left( 1 + \frac{\alpha \pi_L}{\rho_L + \delta_S} \right) w (1 + t)}{p - \left( 1 + \frac{\alpha \pi_H}{\rho_H + \delta_S} \right) \omega^* (w) (1 + t)} \right) > \left\{ \frac{- \left[ \left[ 1 + \frac{\alpha \pi_H}{\rho_H + \delta_S} \right] (1 + t) \left( p - \left[ 1 + \frac{\alpha \pi_H}{\rho_H + \delta_S} \right] \omega^* (w) (1 + t) \right) \right] \left( 1 + \frac{\alpha \pi_L}{\rho_L + \delta_S} \right) + \left[ \left[ 1 + \frac{\alpha \pi_H}{\rho_H + \delta_S} \right] - \left[ 1 + \frac{\alpha \pi_L}{\rho_L + \delta_S} \right] \right] (1 + t) \left[ \omega^* (w) - w \right] \right\} \frac{p - \left( 1 + \frac{\alpha \pi_H}{\rho_H + \delta_S} \right) \omega^* (w) (1 + t)}{\left\{ p - \left( 1 + \frac{\alpha \pi_H}{\rho_H + \delta_S} \right) \omega^* (w) (1 + t) \right\}^2} > 0
\]

since by Lemma 3, no firm that offers health insurance would offer a wage lower than $\tilde{w}$, there is no loss of generality.
Therefore:

\[
\frac{d}{dw} \left( \frac{p - \left( 1 + \frac{\alpha \pi_L}{\rho_L + \delta_S} \right) w_B (1 + t)}{p - \left( 1 + \frac{\alpha \pi_H}{\rho_H + \delta_S} \right) \omega^*(w) (1 + t)} \right) > 0
\]

But this means that:

\[
\frac{p - \left( 1 + \frac{\alpha \pi_L}{\rho_L + \delta_S} \right) w_B (1 + t)}{p - \left( 1 + \frac{\alpha \pi_L}{\rho_L + \delta_S} \right) w_A (1 + t)} > \frac{p - \left( 1 + \frac{\alpha \pi_H}{\rho_H + \delta_S} \right) \omega^*(w_B) (1 + t)}{p - \left( 1 + \frac{\alpha \pi_H}{\rho_H + \delta_S} \right) \omega^*(w_A) (1 + t)}
\]

(9)

Now, putting (8) and (9) together, it follows that (7) implies

\[
\left( p - \left[ 1 + \frac{\alpha \pi_L}{\rho_L + \delta_S} \right] w_B (1 + t) \right) l_B (w_B) - C \geq \left( p - \left[ 1 + \frac{\alpha \pi_L}{\rho_L + \delta_S} \right] w_A (1 + t) \right) l_A (w_A) - C,
\]

which contradicts that \( w_A \) was the profit maximizing choice of the solid firm. The connectedness follows (be it a bit loosely formulated here) from the fact that any 'holes' will give an opportunity for a profitable deviation by the next (higher) firm, it can increase instantaneous profit per worker, without losing workers faster, or gaining slower. ■

**Corollary B.1** The minimum wage posted by a firm that do not offer health insurance is \( R^H_U \), while the minimum wage posted by a firm that offers health insurance is \( \bar{w} \).

**Corollary B.2** There is no mass point in the distribution of offered wages.
11 Appendix C

Using the stationary offer distributions $F_L(w_L), F_H(w_H)$, and the optimal decisions of workers, we can derive the stationary distribution of workers of wages. Employing that all equivalent-wages offered by solid firms are higher, we can derive the stationary risky firm distribution. First, looking at the more general case to, to use derivatives to find the change in the wage distribution $G_L$ over time:

$$\frac{dG_L(w,t)}{dt} = \lambda_0 (1 - \gamma_H) F_L(w,t) u(t) + \lambda_1 (1 - \gamma_H) F_L(w,t) v_H (m - u - s_e - s_u)$$

$$+ \rho_L S_L(w,t) (1 - s_H) s_e$$

$$- \left[ \lambda_1 (1 - \gamma_H) (1 - F_L(w,t)) + \delta + \pi_L \right] G_L(w,t) (1 - v_H) (m - s_e - s_u - u)$$

in steady state:

$$G_L(w) = \frac{\left[ \lambda_0 u + \lambda_1 v_H (m - u - s_e - s_u) \right] (1 - \gamma_H) F_L(w)}{\rho_L S_L(w) (1 - s_H) s_e}$$

while the proportion of sick employees at health-coverage firms working at wage $\leq w$

$$\frac{dS_L(w,t)}{dt} = \pi_L G_L(w,t) (1 - v_H) (m - s_e - s_u - u) - (\delta + \rho_L) S_L(w,t) (1 - s_H) s_e$$

in steady state:

$$S_L(w) = \frac{\pi_L G_L(w) (1 - v_H) (m - s_e - s_u - u)}{(\delta + \rho_L) (1 - s_H) s_e}$$

Similarly:

$$\frac{dG_H(w,t)}{dt} = \lambda_0 \gamma_H F_H(w,t) u(t) + \rho_H S_H(w,t) s_H s_e$$

$$- \left[ \lambda_1 \gamma_H (1 - F_H(w,t)) + \lambda_1 (1 - \gamma_H) + \delta + \pi_H \right] G_H(w,t) v_H (m - s_e - s_u - u)$$

Since in steady state $\frac{dG_H(w,t)}{dt} = 0$, we have:

$$G_H(w) = \frac{\lambda_0 \gamma_H F_H(w) u + \rho_H S_H(w) s_H s_e}{\lambda \gamma_H (1 - F_H(w)) + \lambda_1 (1 - \gamma_H) + \delta + \pi_H} v_H (m - s_e - s_u - u)$$

while:

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\[ \frac{dS_H(w, t)}{dt} = \pi_H G_H(w, t) v_H(m - s_e - s_u - u) - (\delta_S + \rho_H) S_H(w, t) \delta_H s_e \]

in steady-state, we have:

\[ S_H(w) = \frac{\pi_H G_H(w) v_H(m - s_e - s_u - u)}{(\delta_S + \rho_H) \delta_H s_e} \]

To obtain \( F_L(\cdot) \), we use the profit equality condition for all wages offered by companies that supply health insurance:

\[
\left( p - \left[ 1 + \frac{\alpha \pi_L}{\rho_L + \delta_S} \right] w^L_0 (1 + t) \right) \frac{\lambda_0 u + \lambda_1 G(w^L_0) (m - u - s_e - s_u)}{\delta + \lambda_1 (1 - F(w^L_0))} + \frac{\delta_s}{\rho + \delta_S} \pi_L - C = \left( p - \left[ 1 + \frac{\alpha \pi_L}{\rho_L + \delta_S} \right] w_L (1 + t) \right) \frac{\lambda_0 u + \lambda_1 G(w_L) (m - u - s_e - s_u)}{\delta + \lambda_1 (1 - F(w_L))} + \frac{\delta_s}{\rho_L + \delta_S} \pi_L - C
\]

where \( F(z) = \gamma_H F_H(\omega^*(z)) + (1 - \gamma_H) F_L(z) \) and \( G(z) = v_H G_H(\omega^*(z)) + (1 - v_H) G_L(z) \). Then, since \( w^L_0 \) is the minimum wage offered by a company with health insurance and therefore it must be the highest wage offered by a company that does not offer health insurance from Theorem 1, we have that \( F(w^L_0) = \gamma_H \). Similarly, \( G(w^L_0) = v_H \). Therefore, introducing this values and the expression obtained previously to \( G(\cdot) \), we obtain:

\[
F_L(w) = \frac{\delta + \lambda_1 (1 - \gamma_H) + \frac{\delta_s}{\rho_L + \delta_S} \pi_L}{\lambda_1 (1 - \gamma_H)} \left\{ 1 - \left( \frac{p - \left[ 1 + \frac{\alpha \pi_L}{\rho_L + \delta_S} \right] w_L (1 + t)}{p - \left[ 1 + \frac{\alpha \pi_L}{\rho_L + \delta_S} \right] w^L_0 (1 + t)} \right)^{\frac{1}{\lambda_1 (1 - \gamma_H)}} \right\}
\]

Using this expression we can obtain \( G_L(w) \) and \( S_L(w) \).

Now let’s look at \( F_H(\cdot) \). From previous results, we know that the minimum wage offered by a firm not offering health insurance is \( R^H_U \). Then, we have that:

\[
\left( p - \left[ 1 + \frac{\alpha \pi_H}{\rho_H + \delta_S} \right] R^L_U (1 + t) \right) \frac{\lambda_0 u + \lambda_1 v_H G_H(\omega^*(w_H)) (m - u - s_e - s_u)}{\delta + \lambda_1 (1 - \gamma_H) F_H(\omega^*(w_H)) + \frac{\delta_s}{\rho_H + \delta_S} \pi_H} = \left( p - \left[ 1 + \frac{\alpha \pi_H}{\rho_H + \delta_S} \right] \omega^*(w_H) (1 + t) \right) \frac{\lambda_0 u + \lambda_1 v_H G_H(\omega^*(w_H)) (m - u - s_e - s_u)}{\delta + \lambda_1 (1 - \gamma_H) F_H(\omega^*(w_H)) + \frac{\delta_s}{\rho_H + \delta_S} \pi_H}
\]

Substituting \( G(\cdot) \) and rearranging, we have:

\[
F_H(\omega^*(w_H)) = \frac{\delta + \lambda_1 + \frac{\delta_s}{\rho_H + \delta_S} \pi_H}{\lambda_1 \gamma^*_H} \left\{ 1 - \left( \frac{p - \left[ 1 + \frac{\alpha \pi_H}{\rho_H + \delta_S} \right] \omega^*(w_H) (1 + t)}{p - \left[ 1 + \frac{\alpha \pi_H}{\rho_H + \delta_S} \right] R^L_U (1 + t)} \right)^{\frac{1}{\lambda_1 \gamma^*_H}} \right\}
\]

with few manipulations, we have:

\[
F_H(w_H) = \frac{\delta + \lambda_1 + \frac{\delta_s}{\rho_H + \delta_S} \pi_H}{\lambda_1 \gamma^*_H} \left\{ 1 - \left( \frac{p - \left[ 1 + \frac{\alpha \pi_H}{\rho_H + \delta_S} \right] w_H (1 + t)}{p - \left[ 1 + \frac{\alpha \pi_H}{\rho_H + \delta_S} \right] R^H_U (1 + t)} \right)^{\frac{1}{\lambda_1 \gamma^*_H}} \right\}
\]
Using the wage distributions obtained above, we are able to fully characterize the wage offered in equilibrium. From Theorem 1 we know that in equivalent-wage terms, no health-coverage firms pay lower wages than firms that offer health coverage. This means that the very lowest nominal wages \((R_H^U)\) are always offered by the risky firms.\(^ {18} \)

In this case, to fully characterize the wages offered in equilibrium we need to find the reservation wage, \(w^R_H\), and the maximum wage paid by firm which does not provide health insurance, \(\bar{w}_H\). With these information we are able to determine the high risk firms’ offered wage range, \([R_0, \bar{w}_H]\), and the low risk firms’ wage range, \([w^L_0, \bar{w}_L]\).

First let’s find the highest wage offered by a firm which doesn’t offer health insurance (to find it, put \(F_H(w_H) = 1\), and solve,

\[
\bar{w}_H = \frac{1}{1 + \frac{\alpha \pi_H}{\rho_H + \delta_S}} (1 + t) \left\{ p - \left[ \left( \frac{\delta + \lambda_1 (1 - \gamma_H) + \frac{\delta \pi_H}{\rho_H + \delta_S}}{\delta + \lambda_1 + \frac{\alpha \pi_H}{\rho_H + \delta_S}} \right)^2 \times \left( p - \left( 1 + \frac{\alpha \pi_H}{\rho_H + \delta_S} \right) R_H^U (1 + t) \right) \right] \right\}
\]

Note that the value of \(\bar{w}_H\) depends crucially on \(\gamma_L\). Indeed, as \(\gamma_H \to 0\), \(\bar{w}_H \to R_0\). Since the dispersion of wages offered by risky companies on the interval \([R_0, \bar{w}_H]\) are generated by the competition between no health-coverage companies, as the measure of no health-coverage companies reduces, this dispersion shrink to 0.

Similarly, we can derive the maximum wage paid by a solid company,

\[
\bar{w} = \frac{1}{1 + \frac{\alpha \pi_L}{\rho_L + \delta_S}} (1 + t) \left\{ p - \left[ \left( \frac{\delta + \lambda_1 (1 - \gamma_H) + \frac{\delta \pi_L}{\rho_L + \delta_S}}{\delta + \lambda_1 + \frac{\alpha \pi_L}{\rho_L + \delta_S}} \right)^2 \times \left( p - \left( 1 + \frac{\alpha \pi_L}{\rho_L + \delta_S} \right) w^L_0 (1 + t) \right) \right] \right\}
\]

Again, as \(\gamma_H \to 1\), we have that \(\bar{w}_L \to w^L_0\).

To obtain \(w^L_0\), we need to no compare the minimum wage asked by employees to accept health coverage once offered, \(\bar{w}\) and the optimal wage \(w^*_0\) obtained calculating: \(\omega^* (w^*_0) = \bar{w}_H\), since once the constraint \(\bar{w}\) is not binding, we can easily show that the wage set must be connected. Then:

\[
w^L_0 = \max \{ w^*_0, \bar{w} \}
\]

Finally, we can obtain an expression for \(R_H^U\), as we substitute the results obtained previously.

To close the model, we use the profit equality condition to pin down \(\gamma_H\). We can show that the equilibrium is unique.

\[ \rightarrow u: \text{unemployed healthy;} \]
\[ \text{inflow: } \delta (m - u - s_e - s_u) + \rho_H s_u; \]
\[ \text{outflow: } \pi_H u + \lambda_0 u \]

Rearranging:

\[ u = \frac{\delta (m - s_e - s_u) + \rho_H s_u}{\pi_H + \lambda_0 + \delta} \]

\[ \rightarrow s_u: \text{sick out of job workers;} \]
\[ \text{inflow: } \delta s_e + \pi_H u; \]

\(^{18}\)Provided there is a positive mass of risky firms.
outflow: $\rho_H s_u$

Rearranging:

$$s_u = \frac{\delta s s_e + \pi_H u}{\rho_H}$$

Substituting it back in the expression for $u$:

$$u = \frac{\delta m + \left( \delta_S - \delta \left( 1 + \frac{\delta_S}{\rho_H} \right) \right) s_e}{\lambda_0 + \delta + \frac{\delta \pi_H}{\rho_H}}$$

$\rightarrow s_e$ : sick and employed workers:

inflow: $v_H (m - u - s_e - s_u) \pi_H + (1 - v_H) (m - s_e - s_u - u) \pi_L$;

outflow: $s_H s_e \rho_H + (1 - s_H) s_e \rho_L + \delta s s_e$

Rearranging:

$$s_e = \frac{(v_H \pi_H + (1 - v_H) \pi_L) (m - u - s_u)}{s_H \rho_H + (1 - s_H) \rho_L + \delta S + v_H \pi_H + (1 - v_H) \pi_L}$$

Now, equations to obtain the proportions : $v_H, s_H$.

$\rightarrow v_H$:

inflow: $\lambda_0 \gamma_H u + \rho_H s_H s_e$;

outflow: $\delta v_H (m - s_e - s_u - u) + \pi_H v_H (m - s_e - s_u - u) + \lambda_1 (1 - \gamma_H) v_H (m - s_e - s_u - u)$

Rearranging:

$$v_H = \frac{\lambda_0 \gamma_H u + \rho_H s_H s_e}{\delta \pi_H + \lambda_1 (1 - \gamma_H) \pi_L (m - s_e - s_u - u)}$$

$\rightarrow s_H$:

inflow: $\pi_H v_H (m - s_e - s_u - u)$;

outflow: $\delta s_H s_e + \rho_H s_H s_e$.

$$s_H = \frac{\pi_H v_H (m - u - s_e - s_u)}{(\delta_S + \rho_H) s_e}$$

Now, we are going to solve this system with 5 equations and 5 unknowns ($v_H, s_e, s_H, u, s_u$). Rearranging the above expressions, we have:

$$\begin{align*}
(m - u - s_e - s_u) &= (\delta_S + \rho_H) s_e s_u \pi_H v_H \\
(m - u - s_e - s_u) &= \frac{s_H s_e (1 - s_H) \rho_L + \delta s s_e}{v_H \pi_H + (1 - v_H) \pi_L} \\
(m - u - s_e - s_u) &= \frac{\lambda_0 \gamma_H u + \rho_H s_H s_e}{\delta \pi_H + \lambda_1 (1 - \gamma_H) \pi_L} \\
\delta (m - u - s_e - s_u) + \rho_H s_u &= \pi_H u + \lambda_0 u \\
\delta s s_e + \pi_H u &= \rho_H s_u
\end{align*}$$
Then, substituting \((s_u)\) into \((u)\), we have:

\[
\begin{align*}
(m - u - s_c - s_u) &= \frac{(\delta s + \rho_H) s_u s_H}{\pi_H \rho_H} \quad (s_H) \\
(m - u - s_c - s_u) &= \frac{[\mu + (1 - s_H) \rho_L + \delta s] s_u}{v_H \pi_H + (1 - v_H) \pi_L} \quad (s_c) \\
(m - u - s_c - s_u) &= \frac{\lambda_0 \gamma_H + \mu (1 - \gamma_H) s_u}{v_H \pi_H + (1 - v_H) \pi_L} \quad (v_H) \\
\delta (m - u - s_c - s_u) + \delta s s_c &= \lambda_0 u \quad (u)
\end{align*}
\]

Then multiplying \((u)\) by \(\gamma_H\) and substituting into \((v_H)\), we have:

\[
\begin{align*}
(m - u - s_c - s_u) &= \frac{(\delta s + \rho_H) s_u s_H}{\pi_H \rho_H} \quad (s_H) \\
(m - u - s_c - s_u) &= \frac{[\mu + (1 - s_H) \rho_L + \delta s] s_u}{v_H \pi_H + (1 - v_H) \pi_L} \quad (s_c) \\
(m - u - s_c - s_u) &= \frac{\lambda_0 \gamma_H + \mu (1 - \gamma_H) s_u}{v_H \pi_H + (1 - v_H) \pi_L} \quad (v_H)
\end{align*}
\]

Then, equalizing \((s_H)\) and \((s_c)\), we obtain:

\[
\begin{align*}
\frac{(\delta s + \rho_H) s_H}{\pi_H \rho_H} &= \frac{[\mu + (1 - s_H) \rho_L + \delta s]}{v_H \pi_H + (1 - v_H) \pi_L} \\
\delta_H &= \frac{\pi_H \rho_H + (1 - \delta_H) \rho_L + \delta s}{\pi_H \rho_H + (1 - \delta_H) \rho_L + \delta s}
\end{align*}
\]

Similarly, equalizing \((s_H)\) and \((v_H)\), we have:

\[
\begin{align*}
\frac{(\delta s + \rho_H) \delta s}{\pi_H \rho_H} &= \frac{[(\delta s + \rho_H) \gamma_H]}{[(\delta + \pi_H + \lambda_1 (1 - \gamma_H)) v_H - \delta \gamma_H]} \\
\delta_H &= \frac{\pi_H \rho_H + (1 - v_H) \pi_L}{[(\delta + \pi_H + \lambda_1 (1 - \gamma_H)) v_H - \delta \gamma_H] (\delta s + \rho_H) - \rho_H \pi_H v_H}
\end{align*}
\]

Then, we have:

\[
\begin{align*}
(\rho_L + \delta s) \left\{[(\delta + \pi_H + \lambda_1 (1 - \gamma_H)) v_H - \delta \gamma_H] (\delta s + \rho_H) - \rho_H \pi_H v_H\right\} &= \delta s \gamma_H \left\{(v_H \pi_H + (1 - v_H) \pi_L) (\delta s + \rho_H) + (\rho_L - \rho_H) \pi_H v_H\right\}
\end{align*}
\]

From this expression we can obtain \(v_H\). Rearranging it, we have:

\[
v_H = \frac{(\delta s + \rho_H) \delta s + \rho_H \delta s \pi_L}{(\delta s + \rho_H) \pi_L \delta s \gamma_H + (\delta s + \rho_H) (\delta s + \rho_L) (\delta + \lambda_1 (1 - \gamma_H))) + \rho_L \delta s \pi_H (1 - \gamma_H)}
\]

Substituting this into \(s_H\), we have:

\[
\begin{align*}
\delta_H &= \frac{\pi_H (\delta s + \rho_H) (\delta s + \rho_L) \gamma_H \delta (\delta s + \rho_L) + \delta s \pi_L}{\pi_H (\delta s + \rho_H) (\delta s + \rho_L) \gamma_H [\delta (\delta s + \rho_L) + \delta s \pi_L]} \quad \left\{\frac{\pi_H (\delta s + \rho_H) (\delta s + \rho_L) \gamma_H [\delta (\delta s + \rho_L) + \delta s \pi_L]}{\pi_L (1 - \gamma_H) (\delta s + \rho_L) [(\delta s + \rho_H) (\delta s + \rho_L) (\delta + \lambda_1) + \rho_L \delta s \pi_H]} \right\}
\end{align*}
\]

Few more calculations, we obtain:
\[ s_e = \frac{\lambda_0 \rho_H \left( v_H \pi_H + (1 - v_H) \pi_L \right)m}{\left\{ \begin{array}{c} \delta + s_H \rho_H + (1 - s_H) \rho_L \left( \lambda_0 \rho_H + \delta (\pi_H + \rho_H) \right) \\ + v_H \pi_H + (1 - v_H) \pi_L \left( \lambda_0 (\pi_H + \delta_s) + (\pi_H + \rho_H) \delta_s \right) \end{array} \right\}} \]

Substituting \( s_H \) and \( v_H \), we have:

\[ s_e = \frac{\lambda_0 \rho_H \left( (\delta + s_H + \rho_H) (\delta + s_H + \rho_H) + \delta_s \pi_L \right)}{(\delta + s_H + \rho_H) (\delta + s_H + \rho_H) + \delta_s \pi_L \pi_H (\delta + s_H + \rho_H) + \rho_L \delta_s \pi_H (\delta + s_H + \rho_H)} \left[ \begin{array}{c} \delta + s_H + \rho_H \\ \delta (\delta + s_H + \rho_H) + \delta_s \pi_L \\ \delta (\delta + s_H + \rho_H) + \rho_L \delta_s \pi_H \\ (\delta + \lambda_1) + \rho_L \delta_s \pi_H + \rho_L \\ \lambda_0 \rho_H + \delta (\pi_H + \rho_H) \\ v_H (\pi_H - \pi_L) + \pi_L \end{array} \right] \left[ \begin{array}{c} \delta + s_H + \rho_H \\ \delta (\delta + s_H + \rho_H) + \delta_s \pi_L \\ \delta (\delta + s_H + \rho_H) + \rho_L \delta_s \pi_H \\ (\delta + \lambda_1) + \rho_L \delta_s \pi_H + \rho_L \\ \lambda_0 \rho_H + \delta (\pi_H + \rho_H) \\ v_H (\pi_H - \pi_L) + \pi_L \end{array} \right] \]

12 Appendix D

In this appendix, we present the calibration following the values obtained by Bowles et. al. (1995), using the NLSY. Since they present results for whites and blacks separately, we consider the convex combinations of the parameters for whites and blacks with weights that represent the proportion of whites and minorities in the American population (70 and 30%, respectively). This gives us the following calibration:

<table>
<thead>
<tr>
<th>Calibration</th>
</tr>
</thead>
<tbody>
<tr>
<td>( p )</td>
</tr>
<tr>
<td>7477</td>
</tr>
</tbody>
</table>

| \( \lambda_1 \) | \( \pi_H \) | \( \pi_L \) | \( \rho_H \) | \( \rho_L \) | \( \delta \) | \( \delta_s \) | \( r \) |
| 0.0344 | 12.72 | 0.0908 | 4.09 | 12.72 | 0.02312 | 0.0319 | 0.001 |

We can see that both on-the-job search, as well as job destruction are much higher than in the calibration with the PSID. By comparing the results of this calibration with the averages obtained in the data, we find that the measure of workers with health coverage and working for firms offering health coverage is much lower than

\(^{19}\)This probability is hard to pin down from the data. We tried several values and it does not change the results significantly.
the one seen in the data for the US economy. This is expected since NLSY is a much younger sample. Salaries are lower than the ones obtained from the PSID and closer to the US average, but with a much bigger dispersion.

Now, let’s repeat our previous exercises on changes in health insurance premium and investments on Curative versus preventive medicine:

1.) Changes in Health insurance cost:

While an increase in 10% in the cost of health insurance premium - keeping the share paid by employee and firm constant gives us:

<table>
<thead>
<tr>
<th>Benchmark</th>
<th>Higher Premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - γ₁₀₀</td>
<td>0.4170</td>
</tr>
<tr>
<td>1 - v₁₀₀</td>
<td>0.6409</td>
</tr>
<tr>
<td>(s₁₀₀ + s₁₀₀) / m</td>
<td>0.0142</td>
</tr>
<tr>
<td>s₁₀₀ / m</td>
<td>0.0102</td>
</tr>
<tr>
<td>m</td>
<td>0.173905</td>
</tr>
</tbody>
</table>

where Benchmark is given by the NLSY calibration before the increase in health costs. As we can see, an increase in premium reduces the measure of workers with health coverage in 11.3%, while increasing the fraction of worker sick in steady state by 5.634%.

Now, let’s consider the changes in the probabilities of getting sick and the probability of recovering once sick:

Now, let’s consider the exercise of governmental investment on health developments on preventive or curative medicine, as presented in section 4. Then, we obtain:

<table>
<thead>
<tr>
<th>Benchmark</th>
<th>Preventive</th>
<th>Curative</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - γ₁₀₀</td>
<td>0.4170</td>
<td>0.4344</td>
</tr>
<tr>
<td>1 - v₁₀₀</td>
<td>0.6409</td>
<td>0.6573</td>
</tr>
<tr>
<td>(s₁₀₀ + s₁₀₀) / m</td>
<td>0.0142</td>
<td>0.0136</td>
</tr>
<tr>
<td>m</td>
<td>0.173905</td>
<td>0.1738756</td>
</tr>
</tbody>
</table>

Similarly as before, the investment in Preventive medicine generates a higher health coverage and lower fraction of sick workers in steady state.
References


