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by

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Abstract

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Doctor of Philosophy in Business Administration

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In corporate finance, we study the investment decisions of firms. Most of the time we focus on investments in physical capital, but firms also invest in human capital. A major component of human capital is health capital, and firms already spend a large amount of money on the health of their employees. In 2005, for example, employers in the United States spent more than $500 billion on group health insurance, which firms use to invest in their workers' health capital. Corporate finance has not yet analyzed health expenditures as an investment. This research on health and human capital complements the corporate finance literature on investment in physical capital. Additionally, the results have important welfare implications, which may aid policymakers.

In the first chapter, I show how a firm's health capital investment depends on each employee's human capital, labor productivity, and firm size. Firms mitigate depreciation in a worker's human capital by investing in health to increase the productivity of human and physical capital. Results indicate that firms that have higher labor productivity, are larger, and spend more on research and development invest more in health capital. I estimate the subsequent effect of health capital investment on value using firm-level data on health insurance premiums. To identify the effect, I instrument for health insurance premiums with a time series of state health insurance mandates, state birth rates, and the number of persons covered by health insurance contracts. The marginal effect of health capital investment on firm value is zero, suggesting that firms are in equilibrium with respect to health capital investment. Market to book reflects the value of this investment because health capital is an intangible asset that the book value of assets does not capture. These results have implications for policymakers who target the employer-based system of health insurance provision as both a means of extending coverage and managing utilization.

In the second chapter, I present a model of the health capital investment decision of a firm using a moral hazard framework. Health capital investment increases the probability that a worker is present and productive. The firm cannot verify a worker's health capital investment decision. When a firm invests in health capital, the invest-

ment is verifiable because the firm contracts with the insurer. I derive the optimal contract for when the worker and for when the firm invests in health capital. When the firm invests in health capital, the level of investment is higher, wages are less volatile, and wages are higher relative to when the worker invests in health capital. I discuss the welfare implications. In my model, firms invest more than workers because of a production externality and because it is less costly to invest in health capital than to compensate the worker for bearing the risk of an uncertain labor realization. This result improves welfare, contrary to the benchmark that workers consume more health care than is efficient ex post when firms provide health insurance. Unlike the benchmark model of a worker and insurer, my model includes a profit maximizing firm, includes an endogenous probability of getting sick, and allows the insurer to set premiums by anticipating the health care investment level of the insured.

In the third chapter, I discuss how firms hedge risky human capital with health benefit plans. Firms can choose to fully hedge by contracting with an insurance company, remain unhedged by funding benefits out of general assets, or partially hedge by using a combination of insurance and the general assets of the firm. I adapt the model of Froot et al. (1993) to explore the firm's hedging decision. Consistent with the predictions of the model, firms that find external finance costly and that face a convex tax schedule are more likely to hedge. Additionally, the effect of cash flow on investment is lower for firms that partially hedge human capital risk.

Contents

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Chapter 1

Health Capital, Firm Investment, and Shareholder Value

1.1 Introduction

In 1992, employers in the United States spent $216 billion on group health insurance. By 2005, these expenditures had grown to more than $500 billion and are roughly 7% of total compensation. On average, in large publicly traded firms, health insurance premiums are 12% of the amount spent on capital expenditures, varying from 1% in the energy industry to 21% in the high tech industry.

Why do firms spend so much on the health of their employees, and how does it affect firm value? Labor and health economists typically view health insurance as part of workers' compensation, an assumption that has little empirical support (Currie and Madrian (1999)) and which ignores potential positive externalities. Firms use human capital in production, and therefore they, too, value worker health. Previous research in corporate finance, however, has not analyzed firms' expenditures on the health of their employees as an investment in health capital. With this paper, I aim to fill the gap in the current literature. My paper complements research that finds investment in physical capital positively affects shareholder value (McConnell and Muscareela (1985), Cho (1998)) by studying investment in health capital.

I develop a simple framework to show how a firm's health capital investment depends on each employee's human capital, on labor productivity, and on firm size. A firm uses labor and physical capital in production. Labor depends on human capital, which can depreciate when a worker is sick, making his human capital not present or less productive. Firms invest in health capital, mitigating this depreciation and making human and physical capital more productive.

Empirically, I proxy for health capital investment using health insurance premium data from IRS Form 5500, which I obtained through a Freedom of Information Act request.[1] I match these data to firm-level data from Compustat from 1992 to 2005. To estimate the effect of health capital investment on firm value, I regress market to book on health insurance premiums, controlling for variables that may affect firm value.

Because firms endogenously choose the level of health capital to maximize firm value, I instrument for health capital investment with three variables that are correlated with insurance premiums but do not affect firm value. First, I use a time series of state health insurance mandates, which are state laws that require insurers to provide certain benefits. Second, I use a time series of state birth rates to capture the propensity for dependent coverage. Many firms have establishments in more than one state, so using state-level variables biases me against finding any results. Third, I use the firm-level variation in the number of persons covered by the health insurance contracts, which is exogenous because firms cannot control their workers' outside options. These instruments are difficult to interpret because there is not always a clear direction of the effect. Although there are limitations, no one instrument drives the results.

If health capital investment affects value, then the ratio of market to book value should capture this effect because health capital is an intangible asset that the book value of assets does not capture. I find that the effect of health capital investment on firm value is not statistically distinguishable from zero, so it is not possible to reject that firms are in equilibrium with respect to health capital investment. The key to this result is controlling for unobserved heterogeneity across firms. Including state fixed effects controls for unobserved heterogeneity in the political environment, any strategic geographic considerations by firms, and any variation in medical costs across regions. Additionally, using panel data allows me to include firm fixed effects to control for the unobserved firm-specific contracting environment. Without these controls, the effect of health capital investment on shareholder value is positive, implying that firms are not in equilibrium and managers are leaving money on the table.

Results from the first stage of a two stage least squares regression suggest that firms that have higher sales per employee, spend more on research and development, and have a higher book value of assets invest more in health capital. In my theoretical framework, health capital investment increases with labor productivity because present workers exploit the firm's production technology. It increases with human capital because depreciation in higher levels of human capital reduces production by a larger amount. And it increases with the size of physical capital because the marginal product of capital depends on human capital.

The important assumption in my theoretical framework is that firms need workers' human capital in their production process, which increases the productivity of other

[1] Firms can invest in health capital in other ways that my proxy does not capture. For example, Kaiser Family Foundation and Health Research and Educational Trust report that 20% of large firms have on-site clinics at some establishments.

inputs. In a regression of total factor productivity on health insurance premiums, health capital investment positively affects total factor productivity. By measuring total factor productivity using labor and capital, I show how health capital affects firm value. Corporate finance research usually neglects the mechanism by which firm policies affect shareholder value.[2] It is natural in this case, however, to examine the underlying relation between health capital investment, productivity, and firm value.

These results have two important implications. First, the marginal effect of firms' investments in health on shareholder value is zero. This conclusion contrasts with the conventional wisdom that health benefits burden firms by exposing them to increasing health costs and focusing resources away from production. In fact, rather than destroying shareholder value, the effect indicates firms may not increase shareholder value more by decreasing health capital investment. Second, human capital and health capital are complements. Firms with higher labor productivity and higher research and development expenditures, a proxy for human capital, invest more in health capital. This observation suggests that we should see a positive relation between wages and health insurance.

Economists traditionally assert that health expenditures are part of worker compensation. Firms offer a total compensation package to workers, and workers are willing to trade some compensation in the form of wages for health benefits.[3] Previous research fails to find evidence of a tradeoff.[4] Furthermore, the compensating wage differential model in which workers have utility over wages and health insurance neglects two important effects. First, health capital can affect worker productivity, which directly affects firm profits. Second, when a worker's human capital is present and productive, it creates potential positive externalities that make other firm inputs more productive.[5]

To better understand a firm's investment in health capital, consider the following example of firms vaccinating workers against influenza.[6] To calculate if offering

[2]For exceptions see Palia and Lichtenberg (1999) and Bulan et al. (2007).

[3]For more details see Pauly (1998) or Gruber and Madrian (2002).

[4]Currie and Madrian (1999) and Morrisey (2001) describe many studies that attempt to find a tradeoff between wages and health benefits and indicate that most empirical evidence actually finds a positive relation between wages and benefits. On the other hand, Gruber (1994a) and Olson (2002) do find evidence of compensating wage differentials.

[5]In fact, while Pauly (1998) sets out to explain to businesses that they do not correctly view health expenditures as part of the total compensation packages, firms view these expenditures as an investment. Lisa Brummel from Microsoft Human Resources recently told the PBS program Frontline, "really you could say we have end to end support for just about every medical issue that you might face during your lifetime...And that's important to us because we really run the gamut of people who are just out of college all the way through to people who are, you know, well into and toward their retirement ages, so we really have to cover the whole spectrum, and we find that the investment in health care keeps that entire population healthier, coming to work more often, more alert, more productive." Transcribed from "Sick Around America" Frontline, PBS, originally aired March 31, 2009.

[6]In a survey of occupational health nurses, D'Heilly and Nichol (2004) report that 88% of re-

vaccinations is a positive NPV project for the firm, I use parameters from the Nichol (2001) cost-benefit analysis of vaccinating healthy workers between the ages of 18 and 64 years. The expected cash flow from vaccinating a worker is the probability of getting the flu (5% to 15%) times the vaccine effectiveness (67%) times the value of a worker per day.[7] The cost of the vaccine for one worker is $9.64. A worker misses 2.35 days of work due to the flu.[8]

When the worker is sick with the flu, he cannot contribute his human capital to the production process, which may also decrease productivity of other workers and of physical assets of the firm. Hence, giving a flu vaccine is positive NPV for a minimum value of the worker of $122.45 if the probability of getting the flu is 5% or a minimum value of $40.82 if the probability of getting the flu is 15%. The parameters used in the calculation are conservative given the evidence on prevalence of flu and reduced productivity due to illness, indicating that for many firms, flu shots are positive NPV projects. Moreover, when aggregating to the firm level, these numbers understate the value of vaccination if the probability of getting the flu is not independent.[9]

Studying health capital contributes to understanding the role of intangible investment and the factors affecting firms' utilization and investment in human capital as firms move toward a more human capital intensive production (Zingales (2000)). Quantifying the effect of health capital investment on firm value is more relevant than investment in human capital; many workers have already made big human capital investments in education, but firms continue to invest in the health capital of workers. Health capital investment expenditures are similar to research and development expenditures because they are investments in an intangible asset that may contribute to firm productivity (Warusawitharana (2008)).

This paper also provides an intermediate step between the individual benefits of health and aggregate spending on health. It suggests a basis for trying to better understand whether increases in income drive health spending (Acemoglu et al. (2009), Hall and Jones (2007)) by focusing on firms' investment decisions.

These results also have implications for policymakers who target the employer-based system of health insurance provision as both a means of extending coverage

spondents worked at an establishment where the flu vaccination was offered on site.

[7]The probability of getting the flu conditional on getting vaccinated depends on the vaccine efficacy, which in turn depends on whether the vaccine matches the strain of flu circulating that year. Nichol (2001) reports that the probability of a good match is 80%. The probability that the vaccine is effective is 75% conditional on a good match and 35% conditional on a poor match. Hence, the effectiveness is $0.8(0.75) + 0.2(0.35) = 0.67$, and the probability of getting the flu after getting vaccinated is 1.7% to 5%.

[8]Nichol (2001) assumes 2 missed days of work and 0.7 days at 50% of normal productivity.

[9]For example, Nichol et al. (2009) report that in a survey from a workplace flu study, 45% of participants who had influenza-like illness reported that they thought they had contracted the illness from someone at work. On the other hand, the results may not aggregate up to the firm level if not all workers choose to participate (D'Heilly and Nichol (2004)) or if there are decreasing returns to vaccination.

and managing utilization. As policymakers attempt to confront both the rising cost of health entitlement programs and the large number of Americans without health insurance, the role of the firm is key: sixty percent of Americans receive health insurance through employers. This paper contributes to understanding the value of health care by asking if shareholders benefit from a firm's health capital investment.

The theoretical framework draws on the previous literature on health capital. Health capital is a component of human capital (Mushkin (1962)). Currie and Madrian (1999) describe three measures of health that affect labor in the developed world: self-reporting ("I feel great/terrible"), health limitations on the ability to work, and medical care utilization. Health is a depreciating asset, and health expenditures can offset this depreciation (Grossman (1972)). The stock of health capital affects the amount of time that agents have to allocate between market and leisure activities. Health capital investments include medical care utilization like preventive care, treating illness, and mental health counseling, or lifestyle choices like diet, exercise, and smoking. Health insurance in the United States is a means of providing access to these health capital investments.

My research focuses on the level of health capital investment and how it affects shareholder value, but some studies of a firm's decision to offer health insurance explore explanations and outcomes besides compensating workers. Policy research examines whether employers offer insurance because it improves productivity and provides insurance against large financial losses for the individual (Fronstin and Werntz (2004)). Decressin et al. (2005) match the publicly available IRS Form 5500 data to confidential Census Bureau data on employer and employee characteristics and find that firms offering health benefits have higher rates of productivity and survival. Also, wages in these firms that offer health benefits are higher even when accounting for worker characteristics.

The paper proceeds as follows. The next section details the testable hypotheses and empirical methodology. Section 3 describes the data. Section 4 presents the main results, and Section 5 reviews robustness checks. Section 6 concludes. An appendix gives more details on the construction of the dataset.

1.2 Empirical methodology

1.2.1 Motivating framework

Consider the following simple model of a firm's investment in health capital. I use a production function that captures labor and physical capital because the firm's investment in health capital will have a direct effect on labor through a worker and possibly an indirect effect on capital if labor makes these assets more productive. A firm operates a production technology that uses labor, L, and physical capital, K, and is described by $f(K, L) = K^{1-\alpha} L^{\alpha}$, where α is a labor productivity parameter. Labor depends on human capital, n, which depreciates at some rate δ. Depreciation depends on an investment in health capital h; that is, depreciation is $\delta(h)$. Investing in health mitigates depreciation, but at a decreasing rate, so $\delta'(h) < 0$ and $\delta''(h) \geq 0$. Hence, labor is $L = (1 - \delta(h))n$.[10] The cost of the health capital investment is $m(h)$, with $m'(h) > 0$ and $m''(h) \geq 0$. The cost of physical capital and human capital is $c(K, n)$. In other words, this cost subsumes wages and investment, which are not important for the health capital investment decision.[11] The cost of human and physical capital is separable and does not depend on health capital. These assumptions are reasonable. Combining these inputs in the same function is primarily for ease of exposition.

Rather than following the common approach in which firms use health expenditures as part of total compensation to workers, I explore previously neglected benefits of health expenditures to the firm. Under the compensating wage differentials approach, workers tradeoff wages for health benefits. I emphasize that the firm is making a health capital investment decision. The firm does not own a stock of health capital, but it employs workers who have a stock of health capital. In other words, like research and development expenditures, firms cannot use health capital to produce a good, but firms can use it to increase the productivity of other factors.

The cost of human capital in this model is the wage specified by the optimal contract between a firm and a worker when the firm chooses to make a health capital investment as in Holland (2010b). The approach in that paper is a moral hazard framework following Holmström (1979). There is an optimal wage and health investment for the case in which the worker invests in health capital, which the firm cannot verify, and for the case in which the firm makes the investment which is subsequently verifiable. The model is consistent with several observable characteristics of firms' compensation policies.[12] I assume the wage in the model (the cost of human capital) is consistent with the optimal contract.

[10]One can view this depreciation in two ways. First, if labor is a random variable distributed binomially, it could represent the probability that $L = n$, i.e., the worker is present and productive, where $p(h) = (1 - \delta(h))$. Alternatively, one could view labor as $L_{t+1} = (1 - \psi)n_t + h_t = (1 - \delta(h))n_t$ where $\delta(h) = \psi + h_t/n_t$, which is closer to Grossman (1972).

[11]The firm also chooses optimal physical capital and labor, or human capital, but this motivating example focuses on the firm's health capital investment decision. One can interpret this approach as the firm chooses optimal capital and labor throughout the year, which are taken as given here, but the firm can only contract with an insurer once a year, which is akin to an open enrollment period.

[12]First, when the firm invests in the worker's health capital, the optimal investment is higher than if the worker makes the health capital investment. Second, health insurance and wages are positively correlated. Third, the model predicts that wages are more volatile when the firm does not invest in the worker's health capital. At firms where the worker invests in health, the wage contract specifies that the worker only gets paid when the labor realization is nonzero, which is analogous to a wage earner who does not receive sick pay. When the firm invests in health, the worker receives a constant wage regardless of the labor outcome, which is analogous to a worker receiving paid sick leave.

Firm value is then:

$$V = K^{1-\alpha}L^{\alpha} - m(h) - c(K,n). \tag{1.1}$$

This simple framework is consistent with several of the potential ways that health expenditures could affect firm value noted in the introduction.[13] In particular, one can interpret the depreciation of human capital, δ, which depends on the health capital investment, h, as absenteeism or presenteeism. If the health capital investment keeps workers present and productive, then the depreciation of human capital declines with the health capital investment so that $\delta'(h) < 0$.

Firms choose a level of health capital investment to maximize value.

$$\frac{\partial V}{\partial h} = -\alpha n^{\alpha}(1-\delta(h))^{\alpha-1}K^{1-\alpha}\delta'(h) - m'(h) = 0. \tag{1.2}$$

This condition yields some optimal level of health capital investment that depends on parameters for labor productivity (α), human capital (n), and size (K). In other words, one can write the level of health capital investment as a function of labor productivity, human capital, and size. By applying the implicit function theorem, we have the following predictions from the model: $\frac{\partial h}{\partial \alpha} > 0$, $\frac{\partial h}{\partial n} > 0$, and $\frac{\partial h}{\partial K} > 0$.[14]

In short, the simple example predicts that the optimal health capital investment increases with labor productivity, human capital, and size of physical capital as long as depreciation decreases with health expenditures. Firms with higher levels of labor productivity will invest more in health capital because labor depends on the realization of human capital, which will be higher if a health capital investment prevents depreciation. In firms where present workers are more productive in the technology employed by the firm, an investment in health capital increases the chance the human capital will be able to take advantage of that technology. Firms will invest more in health capital at higher levels of human capital because the same depreciation in higher levels of human capital reduces production by a larger amount. This model implicitly assumes that the human capital is not easily replaceable.[15] For example, the

[13] Corporate and individual taxes are absent from this simple model. There are two reasons for this omission. First, health expenditures are deductible from corporate income taxes under the ERISA statute. Including taxes, firm value would be $V = (K^{1-\alpha}L^{\alpha} - m(h) - c(K,n))(1-\tau)$, so taxes do not affect the optimal health capital investment. Second, under the approach described above, the firm uses health expenditures to mitigate depreciation rather than for compensation. Under the compensating wage differentials approach, firms offer health insurance because one dollar of health insurance is cheaper than one dollar of wages, but it is difficult to estimate taxes faced by individual workers on the firm's demand for health insurance. Gruber and Lettau (2004) discuss estimating the effect of taxes on the firm's elasticity of demand for health insurance. The health capital investment approach that I use avoids the need to incorporate individual taxes.

[14] In addition to assuming $\delta'(h) < 0$, in order for $\frac{\partial h}{\partial \alpha} > 0$ I need to assume $\alpha \log(K/L) > 1$.

[15] Hamermesh and Pfann (1996) reports results from surveys and accounting studies indicating that labor adjustment costs are larger for high-skilled workers.

worker could have firm-specific skills that are difficult to acquire in a short amount of time. These skills are consistent with higher levels of human capital. Firms will invest more in health capital as the size of physical capital increases because physical capital in turn becomes more productive. The presence of human capital affects the marginal product of physical capital, so mitigating any depreciation in human capital increases productivity.[16] For example, if a firm uses assets that require complementary human capital in order to realize full production potential, then employer-provided health benefits may make these assets more productive. Given these effects, we can explore the subsequent effect of health capital investment on firm value.

1.2.2 Health capital investment

The level of health capital investment depends on labor productivity, the worker's human capital, and firm size. The relevant regression is:

$$h_{ist} = \lambda_1 \alpha_{ist} + \lambda_2 n_{ist} + \lambda_3 size_{ist} + \theta_t + \psi_s + c_i + u_{ist}, \tag{1.3}$$

where the dependent variable for firm i in state s in year t is health capital expenditures, α_{ist} is a labor productivity measure, n_{ist} is a measure of human capital, $size_{ist}$ is a measure of firm size, θ_t is a year fixed effect, ψ_s is a state fixed effect, c_i is a firm fixed effect, and u_{ist} is an error term. Including state fixed effects controls for unobserved heterogeneity in the political environment, any strategic geographic considerations by firms, as well as variation in medical costs across regions. Following the simple framework outlined above, the null hypothesis is that the coefficients on labor productivity, human capital, and size are zero. The alternative hypothesis is that they are positive.

I proxy for the health capital investment using insurance premiums. In order to test the hypothesis described above, I need to be able to say something about how firms vary according to labor productivity, human capital, and size. To proxy for labor productivity, I use sales scaled by the number of employees. If labor is more productive, sales per employee should be higher. To proxy for human capital, I use research and development based on evidence of wage differentials in R&D intensive firms.[17] Bartel and Lichtenberg (1987) report that manufacturing industries where capital equipment was newer and R&D was more intensive employ relatively more

[16] This effect is important for understanding how the firm can benefit from investing in a worker's health capital. If the worker is more productive due to an investment in health capital, a worker paid according to the marginal product of his labor should be able to capture this increase in the form of higher wages. In this case, however, the firm captures some of the benefits because physical capital is also more productive.

[17] Wage is another proxy for human capital. Workers with higher human capital receive higher wages, but wage data is sparse. Ballester et al. (1999) report that only 10% of Compustat firms report labor expenses, and the probability of reporting is higher for larger and more labor intensive firms.

educated workers. Looking at the time series of wage differences, Mincer (1991) finds higher relative wages of better educated workers in R&D intensive industries compared to other industries. To proxy for size I use the natural log of assets. Although outside the simple model, larger firms may also benefit more from reduced administrative costs as well as a larger risk pool.

1.2.3 Firm value

The framework described above shows that the effect of the health capital investment depends on the human capital, labor productivity, and size of the firm. To estimate the partial effect of health capital investment on firm value, I use the ratio of market to book value as a proxy for value for two reasons. First, it is consistent with the literature.[18] Second, a firm's investment in worker health capital is an investment is an intangible investment that is treated as an expense for accounting purposes. The market to book value should then capture any effect on firm value.[19]

The relevant regression is:

$$M/B_{ist} = \beta h_{ist} + X_{ist}\gamma + \theta_t + \psi_s + c_i + \epsilon_{ist}, \tag{1.4}$$

where the dependent variable for firm i in state s in year t is market to book value, h_{ist} is health capital expenditures, X_{ist} is a set of controls, and ϵ_{ist} is an error term. The empirical analysis draws upon the regression specifications in the managerial compensation literature and uses similar control variables.[20] I include firm fixed effects, which may capture the unobserved, firm-specific contracting environment.

With data on firm value and health capital investment expenditures, this estimation is difficult because M/B_{ist} and health capital investment are simultaneously determined, so health capital investment is correlated with ϵ_{ist}.[21] In order to explore how health capital affects firm value, ideally one would like to force a firm to spend different exogenous amounts on health care and observe how firm value changes. It is possible, however, to find instruments that enable the identification of the coefficients of interest.

I estimate the effect of health capital investment on firm value by estimating Eq. (1.4) using two-stage least squares.[22] The first stage of this regression explores which

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[18] For some examples, see McConnell and Servaes (1990), Morck et al. (1988), Gompers et al. (2003), Himmelberg et al. (1999), Lang and Stulz (1994), and Palia (2001).

[19] The market to book ratio is also a proxy for Tobin's Q, which is a noisy measure affected by unobservable variables when used as proxy for firm investment opportunities (see Erickson and Whited (2000)).

[20] See for example Palia (2001).

[21] There may also be measurement error and unobserved variables, but the simultaneity-induced endogeneity is most apparent, and I focus on that problem in the discussion. The econometric approach should alleviate all endogeneity bias.

[22] Unreported results from a Hausman test confirm the existence of endogeneity.

variables drive the level of investment in health capital as in Eq. (1.3). The first stage regressions from the estimation also show the effect of the instrumental variables on health capital investment.

Instrumental variables

The total amount that firms spend on insurance is the variable *premiums*, which is premium per person times the number of persons covered or $premiums = \frac{premiums}{person} * \#\ persons\ covered$. Taking logs yields $ln(premiums) = ln(\frac{premiums}{person}) + ln(\#\ persons\ covered)$. The premium per person, $\frac{premiums}{person}$, is a function of a number of variables such as the number of persons covered, whether the contracts are experience rated or not,[23] whether the coverage is for families or individuals, whether the plan is part of a Health Maintenance Organization (HMO) or Preferred Provider Organization (PPO), state insurance laws, demographics, industry, human capital, and bargaining power of the firm. Any of these variables that are not correlated with the residual in the firm value regression would be an appropriate instrument. I propose using state health insurance mandates, state birth rates, and the number of persons covered as appropriate instruments. In order to use these proposed variables as instruments, the correlation between the instruments and the error term in Eq. (1.4) should be zero.

I use three instrumental variables. The first is state mandates. In order to offer insurance in a state, insurers are mandated to provide certain benefits such as contraceptives, access to certain providers such as physical therapists, and coverage of certain groups such as dependent students. These mandates differ by state. I have obtained data on health insurance mandates by state and the year of enactment from the Blue Cross and Blue Shield Association.[24] Each mandated benefit has a different effect on premiums. The Council for Affordable Health Insurance reports that most mandates increase premiums by less than one percent, but several can increase premiums by five to ten percent. The mandate variable is the sum of the number of mandates in that state per year. I merge this data with the state identifier in Compustat. Many firms will have establishments in states other than the Compustat identifier, but this data limitation should bias against finding any results.

While mandates are convincingly exogenous, there are two issues that may make interpreting this instrument difficult. First, if firms contract with an insurer already providing more than the mandated benefits, then there will be no effect of the mandates. Second, if providing these benefits positively affects firm value and the firm did not offer these benefits, then the effect of these mandates is to increase firm value. On the other hand, if the mandates require benefits that the firm does not value, then the effect of these mandates is to decrease firm value. In this case, we should see firms

[23] With an experience rated contract, insurers base "the premium on the prior or current claims of a group" (Morrissey (2008)), as opposed to community rating, which may lower premiums.

[24] I thank Professor Amanda Kowalski for providing me with this data.

scaling back coverage or opting to self-insure, but Gruber (1994b) provides evidence that self-insured firms also provide benefits mandated by states. Hence, this scenario is likely not a major concern in the current setting.

My second instrument is the birth rate (number of births per 1,000 people per year) in the state in which the firm is headquartered. Because the variable is at the state level, there is again a bias against finding results if firms have establishments in more than one state. The birth rate reflects characteristics of states that encourage families to move to those states and therefore captures the propensity for dependent coverage.

Finally, because the first two instruments are state level variables, I also incorporate a firm level instrument: the number of persons covered, defined as the sum of employees who take up the insurance and their dependents. The number of persons covered is outside the scope of the firm's decision making ability because the firm cannot control for the household's outside option. For instance, if the spouse of a worker has 'better' health insurance, the worker and his household will not participate in the firm's program (but the firm still benefits from the outside option). Alternatively, the spouse's outside option may be 'worse' than the worker's health insurance through the company, and so the worker and his household will participate in the firm's program. Finally, the household may choose both options. Empirically, the decision of the worker will be outside of the firm's maximization problem, making the number of persons covered a reasonable instrument because the number of persons covered will provide exogenous variation in health expenditures.[25]

It is useful to understand why the number of persons covered can change. First, a newly hired employee enrolls in the plan, possibly with dependents. Second, an employee drops out of the plan because he leaves the firm, he takes an outside insurance option, or he deems the coverage unaffordable. Third, a currently enrolled employee has a family event and enrolls (marriage, birth) or drops (divorce, outside option) coverage. In light of these reasons, there are two potential problems with using the number of persons covered as an instrument. First, the number of persons covered may be associated with unobservables in the value regression that would affect employee events such as entering or exiting a firm. To control for how the number of employees affects the number of persons covered by insurance contracts, I construct a hiring rate variable for each firm as $\frac{employees_t - employees_{t-1}}{employees_{t-1}}$ following Bazdresch et al. (2009). I regress the number of persons covered on the hiring rate and use the residuals from this linear projection to capture the variation in number of persons covered not related to employee turnover.

Second, investing in a dependent's health capital might be optimal for the firm. It is not necessarily a mistake to provide benefits to dependents. In fact, the health

[25] Cutler (2003) shows that the reduction in employer-provided insurance over the 1990s is due to employees' decision to take up the insurance rather than a decline in the number of firms offering insurance.

capital model can potentially include providing health benefits for dependents. For example, the worker may not be at home nursing his own cold, but rather that of his spouse or child. Hence, the firm still has an incentive to invest in the health capital of the household. While the instrument is still valid econometrically, it might make it difficult to interpret the results. It is reasonable, however, to assume that firms would not offer dependent coverage if it were value destroying, but I use two other instruments that help with the interpretation of results. Furthermore, including the state birth rate should control for the propensity to cover dependents.

Because the number of persons covered is the only firm level instrument included in the regressions, I spend some more time justifying its inclusion, and in particular, the assertion that the correlation between the error and the number of persons covered is zero. The error term may include the contracting environment of the firm. For instance, the firm may be better at negotiating with insurance companies. If a firm is good at negotiating with insurance companies, then the price it pays per employee may be lower which might then cause them to cover more employees. A firm that is good at negotiating with insurance companies, however, may also be good at negotiating with employees, and so they might offer benefits that would cover fewer workers than a firm that was bad at negotiating. Overall, the correlation between the contracting environment and number of persons covered is zero.

The error term may also include whether or not the management of the firm is good or bad. If the manager is good and acts to maximize shareholder value, then he might know that covering employees increases shareholder value, and so more employees would be covered, or he might know that it hurts shareholder value, and so the firm will cover fewer employees. Alternatively, if he is a bad manager, then he might try and give more people insurance so he is a popular manager or cover fewer people because he does not understand how health benefits affect firm value. If the manager is a good manager, then he might be able to cover more people at a lower cost, similar to the discussion of the contracting environment. Once again, the correlation between the contracting environment and number of persons covered is zero. Managerial tenure and board oversight will have similar effects.

Finally, the error term may also measure the ratio of men to women at the firm. If women are more likely to take a job because it offers health insurance, then firms that have a higher ratio of women to men might cover more people. On the other hand, if women who are in the workforce are less likely to have children (because women are more likely to quit their jobs when children are born), then firms where the ratio of women to men is higher might have fewer people covered. Given these competing stories, it seems reasonable that the correlation between the ratio of men to women and number of persons covered is zero. There are several other unobservable features of firms that may affect this ratio including the length of the school day where the firm is located, whether or not child care is available, physical intensity of the job, or whether the firm allows for or encourages telecommuting. Because some of the regressions also include firm and industry fixed effects, the empirical approach will control for these types of concerns.

1.2.4 Productivity

In the simple framework described above, investment in health capital mitigates depreciation in human capital and makes labor and physical capital more productive. Hence, I explore the effect of health capital investment on total factor productivity as a natural analog to understanding the effect of health capital investment on shareholder value.

I first estimate total factor productivity from a Cobb-Douglas model by regressing the log of deflated sales on log of number of employees and log of capital stock. To control for possible endogeneity, I estimate the model using firm fixed effects. The residuals from this regression are estimates of total factor productivity. I then examine the effect of health capital investment on total factor productivity. The regression of interest is:

$$TFP_{ist} = \beta_{tfp} h_{ist} + \gamma employees_{ist} + \theta_t + \psi_s + c_i + \upsilon_{ist}, \tag{1.5}$$

where the dependent variable for firm i in state s in year t is total factor productivity, h_{ist} is log health insurance premiums, $employees_{ist}$ is the number of employees controls, and υ_{ist} is an error term. The null hypothesis is that the marginal effect of another dollar spent on health care is zero.

One can interpret total factor productivity as the deviation from mean productivity. I control for the number of employees because if a firm has more employees, then there is a higher probability that some human capital is present and productive. If investment in health capital mitigates depreciation, then in the absence of the health capital investment, the deviation from average efficiency should be negative when a shock causes the human capital to be absent from the production process. Similarly, a health capital investment should cause a corresponding positive deviation in average efficiency. A change in total factor productivity captures the effect on both labor and physical capital, and the comparative statics discussed above indicate that health capital should affect both, either directly or indirectly.

The total factor productivity regression tests the assumptions of the framework, but it also helps reinforce the effect on firm value. While the instrumental variables proposed in the firm value section meet the requirements for exogenous variation, they are not ideal for interpreting the results. In light of this potential drawback, estimating the effect of health capital investment on total factor productivity provides a way to judge the consistency of the results. Because unobserved variables may drive both health capital investment and productivity, I use the same instruments for health insurance premiums and estimate Eq. (1.5) using a two-stage least squares regression.

1.3 Data description

This section provides an overview of the data; more details are available in the data appendix. While it would be optimal to have expenditures on all types of health care, extensive data of this type is not available. Data on welfare benefits, however, including medical and dental benefits, is available from the IRS Form 5500. All benefit plans with over 100 participants need to file this form every year;[26] and this data is available on request from the Department of Labor. Although the filing requirements limit the sample to larger firms, by examining the question from a shareholder value perspective, I focus on publicly traded companies, which will likely meet the requirement. Also, this research does not consider firms' decisions to offer insurance, but rather on the level of health care the manager chooses.

I construct the sample by starting with the universe of Compustat firms between 1992 and 2005 and merging with any welfare benefit plan for which the benefit code indicates a health, dental, or vision plan.[27] Firms on average file two welfare plans, and I aggregate welfare plans at the firm level. Firms in the sample must also have basic financial data that I discuss further below.

I restrict the sample to firms that have contracts with insurance companies. These restrictions reduce the sample to 13,631 firm-year observations for 3,956 firms. Table 1.1 shows summary statistics for the sample for firm characteristics that may be related to firm value. These values are in line with summary statistics reported in papers on managerial compensation and firm value such as Palia (2001) and Coles et al. (2006). Table 1.1 also details how I construct the control variables. Compared to the Compustat universe, the firms in my sample are larger as measured by total assets, but have lower labor productivity, research and development expenditures, and market to book.

Premiums vary across years. Table 1.2 shows the average premiums per year. Premiums during the 1990s appear to be generally falling, but average premiums in the 2000s appear to be rising.[28] This trend is consistent with the overall change in health care spending nationally. Table 1.2 also shows the average number of persons covered per year, the average number of persons covered per insurance contract, and the average number of firm employees.

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[26] In some cases welfare plans with fewer than 100 participants are also required to file, but those plans are excluded from the current analysis.

[27] In general, welfare benefit plans can include "medical, dental, life insurance, apprenticeship and training, scholarship funds, severance pay, and disability" according the the Form 5500 Instructions. Some plans in the sample include more than one of the health benefits in addition to other welfare benefits such as life insurance or disability, for example.

[28] There is a large jump in average number of firms per year and the average premiums per year between 1998 and 1999. This difference reflects a change in IRS Form 5500 and does not reflect a trend in the data.

1.4 Results

1.4.1 Health capital investment and firm value

Table 1.3 shows results from the instrumental variables regression of firm value on health capital investment. There are four specifications. In each case, the first column shows results from a regression of health capital expenditures on proxies for labor productivity, human capital, and size as in Eq. (1.3) and other variables including proposed instruments. The second column shows results from tests of the second main hypothesis, which is the effect of health capital investment on firm value as in Eq. (1.4). In other words, the left column shows the first stage results, and the right column shows the second stage firm value results.

The first specification in Table 1.3 includes labor productivity, size, and research and development expenditures as in Eq. (1.3). More productive labor will generate higher sales per employee. The coefficient on labor productivity is negative, which is inconsistent with the hypothesis from the theoretical framework. If larger firms are more likely to face a lower cost for the health capital investment, then larger firms should spend more on health care. The sign on the coefficient on firm size is positive and significant, which is consistent with the intuition captured by the theoretical framework. Research and development expenditures proxy for human capital because firms that are more human capital intensive may also invest more in R&D. The coefficient on research and development is positive and significant, which supports the model's prediction that more human capital intensive firms will invest more in the health capital of workers.

In order to find the subsequent effect of health capital investment on firm value, I include exogenous instruments in the health capital investment regression. The proposed instrumental variables are the number of insurance mandates in the state of the firm and the annual birth rate in each state of the firm. Essentially, the residual term u in Eq. (1.4) includes these instrumental variables. In order to use these instruments for health expenditures, the instruments should be uncorrelated with the residual in Eq. (1.4), and the number of mandates and birth rate should be related to health expenditures even when controlling for other variables that may effect firm value. In particular, the coefficients on the proposed instruments from a regression of the endogenous variable onto the instruments and all other exogenous variables should be jointly statistically different from zero.

The coefficient on mandates is positive and statistically significant, which is consistent with the claim that mandates increase health insurance premiums. The coefficient on birth rates is positive and statistically significant. This result is consistent with the idea that states with higher birth rates increase the propensity for dependent coverage. The explanatory power of the regression is high with an adjusted R-squared of 34% for the first specification.

Now that the first stage regression has controlled for factors that affect both firm value and health capital investment, it is possible to estimate the effect of health capital on firm value. The right column of each specification in Table 1.3 shows the second stage estimates from a two-stage least squares regression of market to book on log health insurance premiums as in Eq. (1.4). The coefficient on insurance premiums is negative, but not statistically distinguishable from zero. This result, while contrary to the conventional wisdom that health benefits are a burden for firms, is consistent with the theoretical framework outlined above. If managers choose a level of health capital investment to maximize firm value, the partial effect is zero, which is what the coefficient indicates.

Although not shown, this specification includes state level fixed effects. In a pooled OLS regression without state level fixed effects, the partial effect of health capital investment on shareholder value is positive and significant. Controlling for unobserved heterogeneity in the political environment, any strategic geographic considerations by firms, as well as variation in medical costs across regions is important when evaluating this effect.

While the predictions from the framework described above motivate the first three determinants of health capital investment, there may be other variables that affect health capital investment that the framework does not capture. The second specification includes other variables, which might also be important controls for firm value. Capital intensive firms may depend on present and productive workers to make capital in turn more productive as described in the theoretical framework. The coefficient on capital intensity is positive and statistically significant, which is consistent with the theoretical framework.

Free cash flow may also affect investment in health capital. One alternative hypothesis is that when firms are doing well, they provide more health benefits. Additionally, Pauly (1998) notes that the business perspective on health benefits is to provide insurance when it is affordable. From a finance perspective, however, cash flow should not affect the insurance decision. The coefficient on free cash flow is positive and significant, which is not consistent with finance theory.

The Form 5500 data also indicates whether or not a particular plan is subject to collective bargaining agreements, which may affect firms' investment in health capital via insurance premiums. In light of this information, I include a dummy variable if any plan is subject to collective bargaining agreements and find that a union presence at a firm does positively affects the level of health capital investment. In addition to other controls that might affect health capital investment, the second specification also includes advertising expenditures and leverage, which previous research suggests affect firm value (Palia (2001)). Results do not change much qualitatively with these additional controls, but the coefficient on mandates is no longer statistically significant.

The third specification in Table 1.3 includes industry fixed effects based on the Fama and French 48 industries. Industry fixed effects may capture unobserved differences in human capital that are industry specific. For example, Neal (1995) investigates differences in wages for workers changing jobs within an industry versus changing to another industry and finds evidence that industry specific human capital influences the differential. Industry fixed effects may also control for differences in occupational risk, which may affect health insurance premiums. Finally, it may be important to control for unobserved heterogeneity across firms, but because firms do not change states, it is impossible to include firm and state fixed effects. If there is less variation among firms within industries, including firm fixed effects is a first pass at controlling for this unobserved heterogeneity. In short, results are robust to the inclusion of industry fixed effects, and the adjusted R-squared increases to 41%.

Because the instrumental variables mandates and birth rate are state level variables, Table 1.4 shows results including the variation in number of persons covered that is orthogonal to the hiring rate. This instrument is the only firm level variable. Like Table 1.3, there are three specifications. The left column of each specification is the first stage regression of health capital investment on controls and instruments, and the right column is the second stage regression of market to book on health capital investment on health insurance premiums and other controls.

The coefficient on the variation in persons covered is positive and statistically significant. The results are qualitatively similar for mandates and birth rates, but the magnitude and statistical significance of birth rates decline. This decline is not surprising since the number of persons covered may capture some of the effect, but it is important to control for the propensity for dependent coverage when including the number of persons covered. The explanatory power does increase, with an adjusted R-squared of 55% now. The coefficients on size and research and development are still positive and statistically significant, but there are some interesting changes when the regressions include the variation in the number of persons covered. The coefficient on labor productivity in the first stage is positive, which is consistent with the theoretical framework, but it is not statistically significant. Additionally, the coefficient on health capital investment is positively and statistically significant, implying that health capital investment positively affects firm value. When the regression includes additional controls in the second specification, the coefficient on labor productivity is positive and now statistically significant and the coefficient on free cash flow is negative and statistically significant, but the other results are robust. In the second stage firm value regression, the coefficient on insurance premiums is no longer statistically difference from zero as in Table 1.3. With the inclusion of industry fixed effects in the third specification, the results are qualitatively similar, but now the negative coefficient on firm value is statistically significant, which is contrary to the hypothesis that firms invest in health capital when times are flush. Again, the second stage firm value results indicate that the partial effect of health capital investment is zero.

The results thus far indicate that firms that are larger and have higher levels of human capital invest more in health capital, and that firms are in equilibrium with respect to the level of investment. These results, however, do not include firm fixed effects. There may be unobserved heterogeneity in the contracting environment because firms are contracting both with workers and with insurers, which may affect the level of health capital investment and the subsequent effect on firm value, so including firm fixed effects may be important. Table 1.5 shows results with firm fixed effects. The first specification uses only state level instrumental variables while the second specification includes the firm level variation in the number of persons covered. The main results are qualitatively similar to Tables 1.3 and 1.4, but the magnitude of the coefficient on mandates drops and is not statistically significant in either specification. One concern with mandates is that the time fixed effects captures the trend in mandates and reduces the power of that instrument. The third specification shows results with firm fixed effects but without allowing for time fixed effects. In this case, the coefficient on mandates is positive and statistically significant, but other results are qualitatively similar, including the effect of health capital investment on firm value.

In sum, the results indicate that labor productivity, human capital, and size affect health capital investment. Subsequently, the partial effect of this health capital investment on firm value is zero. Given these results, one cannot reject that firms are in equilibrium with respect to health capital investment. This result is consistent with the theoretical framework in which firms choose a level of health capital investment to maximize firm value, but contradicts the conventional wisdom that health expenditures are destroying firm value. The effect on market to book captures the effect on firm value because investment in health capital is investment in an intangible asset, but the book value of assets does not capture this investment.[29]

1.4.2 Productivity

The theoretical framework outlined in Section 2.4 assumes that firms invest in a worker's health capital to mitigate depreciation, making labor and physical capital more productive. Testing the effect on total factor productivity is similar to testing the assumption of the framework. Additionally, these tests try to connect productivity to firm value.

Table 1.6 shows results from estimating a regression of total factor productivity on a proxy for health capital investment described by Eq. (1.5). Because there may be unobserved variables that affect both productivity and health capital investment, I use the same instrumental variables for health capital investment as in the firm value regressions. I control for the log of number of employees because in the theoretical motivation health capital investment affects production through labor. Controlling for size using number of employees is analogous to estimating the effect on productivity of investment per worker.

In Panel A of Table 1.6, the instrumental variables are mandates, state birth rate, and the variation in the number of persons covered. The coefficient on log

[29] Chan et al. (2001) make a similar point regarding firm expenditures on research and development.

insurance premiums is positive and significant, which is consistent with the assertion that health capital investment positively affects productivity. In effect, investment per employee has a positive and significant effect on total factor productivity. In the second specification, the regression includes industry fixed effects with qualitatively similar results. In the third specification, the regression includes firm fixed effects. Health insurance premiums are still positively related to total factor productivity, but the magnitude of the coefficient is higher. By controlling for the number of employees, I am trying to capture the presence of human capital. If a firm has more employees, then there is a higher probability that some human capital is present and productive. This argument will depend on whether or not the human capital of these employees are complements or substitutes, and firm fixed effects may be able to capture this characteristic of the production process.

Many firms use a combination of insurance and other arrangements to fund health benefits. In light of this evidence, insurance premiums are not capturing all health capital investment, especially for larger firms. As a result, the coefficient estimates in the specifications with all firms will likely be biased downward. I reestimate the first three specifications with a sample restricted only to firms that use insurance to fund health benefits. Again, health capital investment has a positive and statistically significant effect on total factor productivity, and the magnitude of the effect is even higher. Including firm fixed effects does not change the results qualitatively, but the magnitude of the coefficient is again larger.

In Panel B of Table 1.6, the instrumental variables are only mandates and state birth rate. The specifications are identical to Panel A, but the coefficients on health insurance premiums and number of employees are never statistically significant. The lack of significance indicates that it is important to control for the variation in the number of persons covered, a firm level variable, to estimate the effect of health insurance premiums on total factor productivity. Indeed, in unreported first stage regressions, mandates and state birth rates alone do not have much explanatory power.

In sum, the total factor productivity results provide evidence for why health capital investment positively affects firm value. These tests reinforce the assumption of the theoretical framework. Additionally, these results provide simple evidence of a link between productivity and firm value.

1.5 Robustness

1.5.1 Insurance only funding arrangement

In this section I discuss results in which I restrict the sample to firms that only use insurance to fund welfare benefit plans. The number of observations decreases substantially. Most plans use either insurance or a combination of insurance and general assets of the sponsor to fund welfare benefit plans with health, dental, or vision coverage. I limit the sample to firms that only use insurance because this should capture the total health capital investment of a firm instead of just the portion measured by the premiums from firms' contracts with insurers. Despite the decrease in observations, the results remain relatively robust.

Table 1.7 shows regression results for estimating the effect of health capital investment on firm value using all proposed controls and instruments. The left column of each regression shows the first stage results for health capital investment. The right column in each specification shows the second stage results from the instrumental variables regression of market to book on log health insurance premiums and other controls.

The first specification includes state and year fixed effects. The results are very similar to the health capital investment results of Table 1.4, but the coefficient on research and development, while still positive, is no longer statistically significant. The reduction in the number of observations may explain the loss of significance since many firms do not have research and development expenditures. The overall explanatory power of the first stage regression is still high with an adjusted R-squared of 51%. When I restrict the sample to firms that only use insurance to fund health capital investment, the coefficient on premiums is now positive and marginally statistically significant, which may not be surprising since in these specifications the premium measures a larger portion of the health capital investment. The second specification includes industry fixed effects, and results in both stages are qualitatively similar to the first specification.

The third specification includes firm and year fixed effects. In the first stage, the coefficient on labor productivity is no longer statistically significant. The coefficients on the state level instruments are not statistically different from zero. The coefficient on insurance premiums is again zero, which is similar to the main results and consistent with the theoretical framework. In sum, there are some different results using a sample restricted to firms that use insurance only, but in general they do not deviate much from general results presented above.

1.5.2 Other

In this section I report results of other robustness checks that are not shown. In constructing the dataset, I aggregate across Form 5500 Schedule A which has insurance information, including the number of persons covered. Some insurance contracts are for different benefits. For example, one contract may be for health benefits, and a separate contract and hence separate Schedule A may be for dental benefits. By summing the number of persons across Schedule A, I may be effectively double counting some persons covered. To try and get around this possible double counting, I perform the same tests above using the mean number of persons covered as an instrument.

Coefficients in the health capital investment regressions are roughly the same, but the magnitudes of the coefficients on size and research and development are larger. State level mandates and birth rates are generally not significant. The magnitude of the coefficient on mean number of persons covered is positive and significant, but the magnitude is lower. The overall explanatory power is still relatively high. In the second stage firm value regressions, the coefficient on insurance premiums is positive and statistically significant in the specifications with state and year fixed effects, but the magnitude is larger. With firm and year fixed effects, however, the coefficient on health capital investment is not different from zero.

The results on health capital investment are robust to these alternative specifications. The positive effect of insurance premiums on firm value is at odds with the conclusion that firms are in equilibrium with respect to health capital investment, but the loss in significance of the state level instruments makes the identification of this effect less likely. Nonetheless, in concert with the result including firm fixed effects, the conclusion that health capital investment does not destroy firm value remains.

Finally, the main regressions address total health capital investment, but it may be useful to look at health capital investment per employee for two reasons. First, market to book is a scaled variable, and hence it may be more appropriate to use a scaled explanatory variable like health insurance premiums per employee. Second, looking at insurance per employee may be akin to looking at investment per project where the project in this case is an individual employee.

In unreported results, I examine what drives health capital investment per employee and the subsequent effect on firm value. The proxy for health capital investment is the log of health insurance premiums scaled by the number of employees. There are two main differences relative to the main results in Tables 1.3 and 1.4. First, in the first stage regression of health capital investment on proposed determinants and instruments, the coefficient on size is now negative and significant. At first, this result seems to contradict both the simple framework outlined above as well as conventional wisdom that larger firms provide more health insurance. This result makes sense, however, if it represents the advantages of a larger risk pool, lower administrative costs, or more bargaining power with insurers so that larger firms will be able to get the same amount of investment for a lower price per employee. Second, the coefficient on labor productivity is positive and significant in the specifications with state and industry fixed effects, but not firm fixed effects.

The results in the second stage regressions of the effect of health capital investment on firm value are qualitatively similar. The main questions addressed in this paper are what drives total health capital investment and what is the subsequent effect of an extra dollar of investment. Using health capital investment per employee makes it difficult to answer these questions. Also, this transformation is problematic because it is hard to interpret premiums per employee when these premiums also cover dependents. Indeed, it is because of the inclusion of dependents that I am able to find an appropriate instrumental variable at the firm level. In short, it does not make much sense to use health capital investment per employee.

1.6 Conclusion

Economists typically view health insurance as part of workers' compensation, an assumption that has little empirical support and ignores potential positive externalities. I propose a framework in which firms are investing in health capital. I show how a firm's health capital investment depends on each employee's human capital, their labor productivity, and firm size. Firms mitigate depreciation in a worker's human capital by investing in health to increase the productivity of human and physical capital.

I find evidence that firms that are larger and spend more on research and development, a proxy for human capital, invest more in health capital. There is additional evidence that firms that have higher levels of labor productivity, as measured by sales per employee, invest more in health capital. Results from the second stage of a two stage least squares regression indicate that the marginal effect of health capital investment on shareholder value is zero. Contrary to the conventional wisdom that health expenditures are destroying firm value, it is not possible to reject the hypothesis that firms are in equilibrium with respect to health capital investment. These results are statistically significant when regressions control for other factors that affect firm value, including factors that may be correlated with labor force characteristics. To identify the effect, I instrument for health insurance premiums with a time series of state level health insurance mandates, state birth rates, and the number of persons covered by health insurance contracts.

The ratio of market to book value reflects the value of this investment because health capital is an intangible investment treated as an accounting expense. Hence, we expect to observe this effect in market value rather than book value. Furthermore, health capital investment positively affects productivity, a connection between firm value and productivity that is often absent in the literature.

While there are many remaining questions about the firm's decision to invest in health capital, there are also questions about how firms finance these health capital investments and subsequently how this might affect the firm's physical capital investment decisions.

Finally, this research provides useful information for policymakers. Understanding firm motives is important in any health care reform because it affects the number of people covered and because firm incentives and actions are going to affect changing health costs.

1.7 Data Appendix

I obtain data from IRS Form 5500 from the Department of Labor, which is available to anyone who files a Freedom of Information Act Request. This form is an annual report of employee benefit plans including pension benefits, welfare benefits, and fringe benefits. All plans subject to Employee Retirement Income Security Act (ERISA) must file this form.

Firms file Form 5500 data on a per plan basis. I first match Form 5500 data to Compustat data using an identifier. There were several changes in the form between 1998 and 1999. Until 1999, firms submitted a CUSIP number with Form 5500. For 1991 to 1998, I matched filings to Compustat using CUSIP. After 1999, firms no longer reported a CUSIP, so I matched Form 5500 data to Compustat using the Employer Identification Number. In both cases, I handchecked the data to eliminate any false positives. This merge resulted in approximately 40,000 to 50,000 observations per year. The only exception is for 2006 which had half as many observations. This is most likely because I filed the request in 2007 before all forms for year 2006 were filed. I then restricted the data to welfare benefit plans, which include benefits such as medical, dental, life insurance, apprenticeship and training, scholarship funds, severance pay, and disability. This step reduces the number of observations by about 25%. I then restrict the sample to plans with medical, dental, and vision plans. This reduces the sample to 4,000 to 9,000 observations per year. (Additionally, this reduces the sample for 1991 to 44 observations.) There are more observations following the change in form starting in 1999 because small and large plans are consolidated on the same form.

If firms use contracts with insurers for welfare plan funding and benefit arrangements, they must file Schedule A. After restricting the sample to welfare benefit plans with medical, dental, and vision benefits, I merge these plans with Schedule A data. Schedule A contains information about the insurance contract, including coverage and fees. For welfare benefit contracts, it also has detailed information about experience-rated and nonexperience-rated contracts, including premiums. A single welfare benefit plan may have more than one Schedule A. I then aggregate all Schedule A at the Form 5500 level. I subsequently aggregate Form 5500 data at the firm level. This aggregation leaves 44,237 firm year observations for 7,136 firms from 1991 to 2006.

From this data set, I then drop observations based on data availability. I require observations to have basic financial data as well as health insurance data. I drop any observation that does not have data on sales, number of employees covered, or the number of persons covered by insurance contracts. I also drop data from 1991 and 2006 because of data limitations described above. These reduction lead to 31,028 firm year observations for 5,788 firms from 1992 to 2005.

Health insurance premiums are the some of experience rate premiums received by the insurer plus nonexperience rated premiums. I drop outliers for health insurance premiums and leverage by dropping any observations below the 1st percentile and above the 99th percentile. This step leaves 26,375 firm year observations for 5,206 observations from 1992 to 2005. The first panel of Table 1.8 shows the number of plans filed by type of filing entity. Most plans are filed by single employers or a controlled group of corporations.[30] I further restrict data to plans that are either filed by a single employer or the plan of a controlled group of corporations.

Firms have many options in funding and providing benefits for welfare plans. The bottom two panels show the number of plans that are funded through a trust, trust and insurance, insurance, exclusively through the general assets of the sponsor (i.e., unfunded), or some combination of unfunded and insured. In general, funding and benefit arrangements follow similar patterns. The majority of plans are funded with insurance or with a combination of insurance and the general assets of the sponsor. The choice of funding depends on the level of risk the firm is willing to bear as well as the best use of firm funds. If the firm chooses to contract with an insurance company, all of the risk is shifted to the insurance company. The insurance firm typically invests the premiums and may or may not credit the employer for the unused portion of the premiums. If the firm chooses to fund health benefits using the general assets of the sponsor, the firm can invest the funds as they choose, but the firm also bears all or part of the risk that is not insured. For more information about the firm's choices, see Part Eight of Rosenbloom (2005). Table 1.8 shows that plans using insurance or a combination of insurance and self-funding are more likely to be subject to collective bargaining agreements. It is interesting to note that the data available on health capital investment is much more detailed than physical capital expenditure data. In particular, there is additional information on how different firms choose to finance the health capital investment.

In the regressions, I also only use data for firms that are single employer plans or the plan of a controlled group of corporations. As detailed in Table 1.1, I use research and development expenditures and advertising expenditures scaled by total assets as control variables. Because there are many missing observations in Compustat, and I do not want to bias results by only using those firms which report these variables, I set any missing observations to zero following Palia (2001).

[30] A controlled group of corporations is two or more corporations that are component members of a 'parent-subsidiary' controlled group, a 'brother-sister' controlled group or a 'combined control' group.

Table 1.1: **Summary Statistics for Firm Characteristics**

The table shows summary statistics for firm characteristics. The sample includes 4,233 firms from 1992 to 2005. All data is from Compustat.

Variable	Description	Mean	Standard Deviation	Firm-Year Observations
Market to Book Value	(Total assets - book value of equity + market value of equity)/(Total assets)	1.89	1.27	13,631
Labor Productivity	Sales scaled by number of employees	0.27	0.41	13,631
Size	Logarithm of total assets	5.82	1.72	13,631
Research and Development	Research and development expenses scaled by total assets	0.05	0.11	13,631
Capital Intensity	Capital stock scaled by total assets	0.25	0.22	13,413
Free Cash Flow	Operating profits scaled by total assets	0.08	0.19	13,631
Leverage	Long-term debt scaled by book value of equity	0.55	1.35	13,631
Advertising	Advertising expenses scaled by total assets	0.01	0.06	13,631

Table 1.2: **Summary Plan Data by Year.**

This table shows mean and standard deviation information on welfare benefit plans by year. Firms is the number of firms per year. Premiums is the sum of the amount of experience rated premiums received and nonexperience rated premiums from Schedule A of IRS Form 5500. The table reports thousands of dollars. Persons Covered is the total number of persons covered summed across all insurance contracts. Mean Persons Covered is the average number of persons covered per plan. Employees is the number of employees reported by Compustat.

Year	Firms	Premiums	Persons Covered	Mean Persons Covered	Employees
1992	1,171	5,317	9,302	1,699	10,957
		13,157	18,825	4,277	31,188
1993	1,352	5,490	9,101	1,595	10,402
		13,867	18,499	3,868	35,361
1994	1,396	5,224	8,736	1,685	10,116
		13,529	17,396	3,564	30,576
1995	1,455	3,656	7,513	1,926	12,393
		10,442	17,181	4,141	39,030
1996	1,426	3,393	6,724	1,730	12,573
		9,369	14,673	3,313	37,743
1997	1,445	3,424	7,382	1,863	13,352
		8,852	15,983	4,108	42,697
1998	1,223	3,463	7,135	1,918	14,012
		8,768	14,768	4,430	40,089
1999	1,963	6,065	9,775	1,266	8,677
		14,407	19,859	2,922	26,279
2000	2,492	6,573	10,820	1,221	8,003
		14,877	21,598	2,627	24,716
2001	2,547	6,988	10,904	1,161	7,932
		16,174	21,356	2,209	24,610
2002	2,580	7,202	11,246	1,223	7,575
		16,487	21,656	2,302	23,733
2003	2,540	7,202	11,514	1,319	8,034
		15,310	21,402	2,379	25,167
2004	2,471	8,240	12,522	1,363	8,439
		17,931	23,827	2,379	25,997
2005	2,314	7,696	12,425	1,495	8,554
		15,571	23,012	2,709	26,360

Table 1.3: **Health Capital Investment and Firm Value I**

This table shows results from the following two stage least squares regression of a proxy for firm value on health capital expenditures and other controls:

$$h_{ist} = \lambda_1 \alpha_{ist} + \lambda_2 n_{ist} + \lambda_3 size_{ist} + \theta_t + \psi_s + c_i + u_{ist}$$
$$M/B_{ist} = \beta h_{ist} + X_{ist}\gamma + \theta_t + \psi_s + c_i + \epsilon_{ist},$$

where the dependent variable for firm i in state s in year t is market to book, h_{ist} is log insurance premiums, X_{ist} is a set of controls, and ϵ_{ist} is an error term. In each specification, the left column is the first stage of the instrumental variables regression. The right column shows results from an instrumental variables regression of market to book on explanatory variables. The endogenous variable is log of insurance premiums. The instruments are the number of insurance mandates in the state, the number of births per 1,000 in the state, and the remaining exogenous variables. Standard errors clustered by firm are shown in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively. Each specification is from 1992 to 2005. The sample is restricted to single employer and controlled group plans.

	(1)		(2)		(3)	
	h	Q	h	Q	h	Q
Mandates	0.009*		0.008		0.004	
	(0.006)		(0.005)		(0.005)	
Birth rate	0.052**		0.050*		0.051**	
	(0.025)		(0.025)		(0.025)	
Insurance Premiums		-0.792		-1.334		-1.534
		(0.673)		(0.965)		(1.172)
Labor Productivity	-0.269***	-0.290	-0.205***	-0.334	-0.164***	-0.235
	(0.068)	(0.195)	(0.064)	(0.222)	(0.056)	(0.217)
Size	0.442***	0.344	0.443***	0.593	0.518***	0.814
	(0.007)	(0.298)	(0.007)	(0.429)	(0.008)	(0.610)
Research and Development	0.611***	3.515***	1.106***	6.202***	0.858***	4.804***
	(0.085)	(0.489)	(0.119)	(1.197)	(0.113)	(1.131)
Capital Intensity			0.141**	-0.171	0.139**	-0.315
			(0.055)	(0.203)	(0.070)	(0.272)
Free Cash Flow			0.557***	2.845***	0.193***	2.311***
			(0.068)	(0.602)	(0.063)	(0.332)
Collectively Bargained			0.375***	0.332	0.249***	0.295
			(0.046)	(0.378)	(0.047)	(0.315)
Leverage			-0.041***	-0.148***	-0.015*	-0.102***
			(0.008)	(0.043)	(0.008)	(0.027)
Advertising			-0.038	1.495**	-0.193	1.544**
			(0.170)	(0.607)	(0.201)	(0.761)
Adjusted R^2	0.34		0.36		0.41	
F-statistic	286.30		277.94		197.26	
Number of Observations	13,553		13,287		13,287	
Year Fixed Effects	yes		yes		yes	
State Fixed Effects	yes		yes		yes	
Industry Fixed Effects	no		no		yes	

Table 1.4: **Health Capital Investment and Firm Value II**

This table shows results from the following two stage least squares regression of a proxy for firm value on health capital expenditures and other controls:

$$h_{ist} = \lambda_1 \alpha_{ist} + \lambda_2 n_{ist} + \lambda_3 size_{ist} + \theta_t + \psi_s + c_i + u_{ist}$$
$$M/B_{ist} = \beta h_{ist} + X_{ist}\gamma + \theta_t + \psi_s + c_i + \epsilon_{ist},$$

where the dependent variable for firm i in state s in year t is market to book, h_{ist} is log insurance premiums, X_{ist} is a set of controls, and ϵ_{ist} is an error term. In each specification, the left column is the first stage of the instrumental variables regression. The right column shows results from an instrumental variables regression of market to book on explanatory variables. The endogenous variable is log of insurance premiums. The instruments are the number of insurance mandates in the state, the number of births per 1,000 in the state, and the remaining exogenous variables. Standard errors clustered by firm are shown in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively. Each specification is from 1992 to 2005. The sample is restricted to single employer and controlled group plans.

	(1)		(2)		(3)	
	h	Q	h	Q	h	Q
Mandates	0.009*		0.008		0.007	
	(0.005)		(0.005)		(0.005)	
Birth rate	0.041*		0.046**		0.042**	
	(0.021)		(0.021)		(0.021)	
Persons Covered	0.633***		0.631***		0.619***	
	(0.009)		(0.009)		(0.010)	
Insurance Premiums		0.105***		0.028		0.024
		(0.021)		(0.019)		(0.021)
Labor Productivity	0.030	-0.048	0.054***	-0.053**	0.045**	0.022
	(0.021)	(0.029)	(0.018)	(0.024)	(0.018)	(0.025)
Size	0.087***	-0.046***	0.089***	-0.005	0.109***	0.010
	(0.008)	(0.013)	(0.008)	(0.013)	(0.009)	(0.016)
Research and Development	0.849***	3.058***	0.709***	4.865***	0.538***	3.667***
	(0.080)	(0.246)	(0.096)	(0.415)	(0.101)	(0.388)
Capital Intensity			-0.222***	-0.351***	-0.068	-0.493***
			(0.046)	(0.066)	(0.060)	(0.099)
Free Cash Flow			-0.066	2.124***	-0.127**	2.052***
			(0.055)	(0.194)	(0.054)	(0.180)
Collectively Bargained			0.255***	-0.175***	0.192***	-0.090**
			(0.041)	(0.040)	(0.042)	(0.037)
Leverage			-0.018**	-0.091***	-0.013*	-0.077***
			(0.007)	(0.010)	(0.007)	(0.009)
Advertising			-0.581***	1.509***	-0.206	1.792***
			(0.167)	(0.411)	(0.162)	(0.430)
Adjusted R^2	0.55		0.56		0.57	
F-statistic	577.14		555.80		358.53	
Number of Observations	13,278		13,017		13,017	
Year Fixed Effects	yes		yes		yes	
State Fixed Effects	yes		yes		yes	
Industry Fixed Effects	no		no		yes	

Table 1.5: **Health Capital Investment and Firm Value - Firm Fixed Effects**
This table shows results from the following two stage least squares regression of a proxy for firm value on health capital expenditures and other controls:

$$\begin{aligned} h_{ist} &= \lambda_1 \alpha_{ist} + \lambda_2 n_{ist} + \lambda_3 size_{ist} + \theta_t + c_i + u_{ist} \\ M/B_{ist} &= \beta h_{ist} + X_{ist}\gamma + \theta_t + c_i + \epsilon_{ist}, \end{aligned}$$

where the dependent variable for firm i in state s in year t is market to book, h_{ist} is log insurance premiums, X_{ist} is a set of controls, and ϵ_{ist} is an error term. In each specification, the left column is the first stage of the instrumental variables regression. The right column shows results from an instrumental variables regression of market to book on explanatory variables. The endogenous variable is log of insurance premiums. The instruments are the number of insurance mandates in the state, the number of births per 1,000 in the state, and the remaining exogenous variables. Standard errors clustered by firm are shown in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively. Each specification is from 1992 to 2005. The sample is restricted to single employer and controlled group plans.

	(1)		(2)		(3)	
	h	Q	h	Q	h	Q
Mandates	0.002		0.000		0.042***	
	(0.007)		(0.007)		(0.004)	
Birth rate	0.069*		0.077**		0.054**	
	(0.037)		(0.032)		(0.024)	
Persons Covered			0.513***		0.556***	
			(0.020)		(0.019)	
Insurance Premiums		-1.893		0.023		0.012
		(1.189)		(0.030)		(0.027)
Labor Productivity	0.006	0.112*	0.030	0.099**	0.069***	0.114**
	(0.023)	(0.060)	(0.019)	(0.045)	(0.026)	(0.053)
Size	0.412***	0.442	0.146***	-0.356***	0.171***	-0.297***
	(0.029)	(0.498)	(0.028)	(0.042)	(0.028)	(0.040)
Research and Development	0.689***	3.232***	0.410***	2.144***	0.482***	2.138***
	(0.178)	(1.116)	(0.149)	(0.607)	(0.150)	(0.601)
Capital Intensity	0.584***	0.422	0.075	-0.747***	-0.259	-0.822***
	(0.187)	(0.806)	(0.175)	(0.222)	(0.173)	(0.220)
Free Cash Flow	0.031	2.051***	-0.055	1.995***	-0.094	2.027***
	(0.081)	(0.274)	(0.073)	(0.204)	(0.075)	(0.204)
Collectively Bargained	-0.035	-0.043	-0.093	0.022	-0.148**	0.001
	(0.076)	(0.152)	(0.062)	(0.040)	(0.060)	(0.034)
Leverage	0.002	-0.021	0.000	-0.022**	-0.002	-0.024**
	(0.009)	(0.020)	(0.008)	(0.010)	(0.008)	(0.010)
Advertising	-0.023	0.720	-0.157	0.836	-0.157	0.947*
	(0.332)	(0.856)	(0.367)	(0.521)	(0.389)	(0.561)
Adjusted R^2	0.24		0.37		0.35	
F-statistic	42.44		77.16		149.37	
Number of Observations	12,253		11,996		11,996	
Firm Fixed Effects	yes		yes		yes	
Year Fixed Effects	yes		yes		no	

Table 1.6: **Total Factor Productivity**

This table shows results from the following two stage least squares regression of total factor productivity on a proxy for health capital investment and size controls:

$$TFP_{ist} = \beta h_{ist} + \gamma employees_{ist} + \theta_t + \psi_s + c_i + \upsilon_{ist},$$

where the dependent variable for firm i in state s in year t is total factor productivity, h_{ist} is log health insurance premiums, $employees_{ist}$ is log of number of employees, and υ_{ist} is an error term. The instruments are the the number of insurance mandates in the state, the number of births per 1,000 in the state, the variation in the log of number of persons covered orthogonal to the hiring rate, and the remaining exogenous variables. Standard errors clustered by firm are shown in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively. Each specification is from 1992 to 2005. The sample is restricted to single employer and controlled group plans.

	All Firms			Insurance Only		
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Instruments - Mandates, Birth Rate, and Persons Covered						
Insurance Premiums	0.026***	0.029***	0.066***	0.043***	0.043***	0.129***
	(0.006)	(0.006)	(0.013)	(0.013)	(0.013)	(0.040)
Employees	-0.024***	-0.028***	-0.096***	-0.035***	-0.036***	-0.161***
	(0.004)	(0.005)	(0.026)	(0.009)	(0.010)	(0.058)
Number of Observations	12,146	12,146	11,215	4,056	4,056	3,391
Year Fixed Effects	yes	yes	yes	yes	yes	yes
State Fixed Effects	yes	yes	no	yes	yes	no
Industry Fixed Effects	no	yes	no	no	yes	no
Firm Fixed Effects	no	no	yes	no	no	yes
Panel B: Instruments - Mandates and Birth Rate						
Insurance Premiums	-0.044	-0.079	0.197	0.262	0.295	0.270
	(0.130)	(0.148)	(0.253)	(0.175)	(0.203)	(0.305)
Employees	0.010	0.032	-0.157	-0.121*	-0.143*	-0.227
	(0.064)	(0.081)	(0.117)	(0.068)	(0.086)	(0.158)
Number of Observations	12,311	12,311	11,380	4,142	4,142	3,463
Year Fixed Effects	yes	yes	yes	yes	yes	yes
State Fixed Effects	yes	yes	no	yes	yes	no
Industry Fixed Effects	no	yes	no	no	yes	no
Firm Fixed Effects	no	no	yes	no	no	yes

Table 1.7: **Health Capital Investment and Firm Value - Insurance Only**
This table shows results from the following two stage least squares regression of a proxy for firm value on health capital expenditures and other controls:

$$\begin{aligned} h_{ist} &= \lambda_1 \alpha_{ist} + \lambda_2 n_{ist} + \lambda_3 size_{ist} + \theta_t + \psi_s + c_i + u_{ist} \\ M/B_{ist} &= \beta h_{ist} + X_{ist}\gamma + \theta_t + \psi_s + c_i + \epsilon_{ist}, \end{aligned}$$

where the dependent variable for firm i in state s in year t is market to book, h_{ist} is log insurance premiums, X_{ist} is a set of controls, and ϵ_{ist} is an error term. In each specification, the left column is the first stage of the instrumental variables regression. The right column shows results from an instrumental variables regression of market to book on explanatory variables. The endogenous variable is log of insurance premiums. The instruments are the the number of insurance mandates in the state, the number of births per 1,000 in the state, the variation in the log of number of persons covered orthogonal to the hiring rate, and the remaining exogenous variables. Standard errors clustered by firm are shown in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively. Each specification is from 1992 to 2005. The sample is restricted to single employer and controlled group plans that use only insurance to fund welfare benefit plans.

	(1)		(2)		(3)	
	h	Q	h	Q	h	Q
Mandates	-0.014		-0.013		-0.017	
	(0.011)		(0.011)		(0.015)	
Birth rate	0.119**		0.130**		-0.007	
	(0.052)		(0.052)		(0.078)	
Persons Covered	0.615***		0.592***		0.464***	
	(0.021)		(0.022)		(0.040)	
Insurance Premiums		0.072*		0.083*		0.123
		(0.038)		(0.042)		(0.093)
Labor Intensity	0.070***	-0.052**	0.064**	0.018	0.065	0.173***
	(0.026)	(0.025)	(0.028)	(0.027)	(0.064)	(0.060)
Size	0.060***	-0.046**	0.100***	-0.031	0.186***	-0.547***
	(0.017)	(0.022)	(0.020)	(0.029)	(0.043)	(0.093)
Research and Development	0.158	3.657***	0.080	2.764***	0.094	1.264*
	(0.127)	(0.516)	(0.123)	(0.467)	(0.131)	(0.646)
Capital Intensity	0.090	-0.351***	0.205	-0.519***	0.199	-0.771
	(0.101)	(0.113)	(0.134)	(0.165)	(0.267)	(0.514)
Free Cash Flow	-0.126*	1.311***	-0.176**	1.350***	-0.183**	1.626***
	(0.074)	(0.249)	(0.074)	(0.227)	(0.083)	(0.278)
Collectively Bargained	0.362***	-0.364***	0.362***	-0.220***	0.046	-0.111
	(0.114)	(0.068)	(0.110)	(0.078)	(0.152)	(0.125)
Leverage	-0.008	-0.093***	-0.002	-0.074***	0.016	-0.019
	(0.013)	(0.017)	(0.012)	(0.016)	(0.011)	(0.021)
Advertising	-0.201	1.614**	-0.015	2.158***	-0.368	-0.726
	(0.269)	(0.800)	(0.271)	(0.764)	(0.332)	(1.148)
Adjusted R^2	0.51		0.52		0.32	
F-statistic	29.53		10.30		28.14	
Number of Observations	4,392		4,392		3,683	
Year Fixed Effects	yes		yes		yes	
State Fixed Effects	yes		yes		no	
Industry Fixed Effects	no		yes		no	
Firm Fixed Effects	no		no		yes	

Table 1.8: **Appendix: Plan Types and Funding Arrangements.**
This table shows information on the types of filers, how welfare benefit plans are funded, and how welfare benefits are distributed. The first panel shows the number of filers for each of the possible four entities. The other plan types include multiple employer plans and and group insurance arrangements. The second panel shows the method used during the plan year for the receipt, holding, investment, and transmittal of plan assets prior to the time the plan actually provides the benefits promised under the plan. The third panel shows the method by which benefits were actually provided during the plan year to participants by the plan. There are 29,032 firm-year observations, of which 4,125 have at least one plan subject to a collective bargaining agreement. The sample includes 5,655 firms from 1992 to 2005. Note that some plans report more than one funding or benefit arrangement and some firms use different arrangements for different plans.

Description of filer	Number
Single employer plan	22,251
Plan of controlled group of corporations	4,198
Multiemployer plan	227
Other	1,042

	Collectively Bargained		
Funding Arrangement	Yes	No	Total
Trust	470	816	1,2860
Trust and insurance	826	2,233	3,059
Insurance	1,086	8,957	11,043
Exclusively from general assets of sponsor (unfunded)	867	2,977	3,844
Partially insured and partially from general assets of sponsor	1,669	10,282	11,951
Other	1,100	2,795	3,895

	Collectively Bargained		
Benefit Arrangement	Yes	No	Total
Trust	531	634	1,165
Trust and insurance	1,063	2,560	3,623
Insurance	1,482	9,658	11,140
Exclusively from general assets of sponsor (unfunded)	1,030	2,781	3,811
Partially insured and partially from general assets of sponsor	2,040	10,696	12,736
Other	258	1,748	2,006

Chapter 2

The Welfare Implications of Health Capital Investment

2.1 Introduction

Each year between 1998 to 2008, U.S. employer contributions to group health insurance for employees were on average $483 billion. This amount represents 6.4 percent of employee compensation and 22.4 percent of capital expenditures. Additionally, almost 60 percent of Americans receive health insurance through an employer. In this paper, I consider firms' health care decisions, how these health care expenditures affect firm value, and the effect on social welfare.

Labor is a risky input in production. Firms or workers can invest in health capital, which increases the probability that a worker's human capital is present and productive. They can make this investment by contracting with an insurer, which enables access to medical care. Insurers offer a contract that specifies the premium and the payout schedule. Insurers operate in a competitive market, but can adjust the premium and insurance payout depending on whether they contract with the firm or the worker.

If the worker contracts with the insurer, the investment is not verifiable by the firm. The worker benefits from the investment because it increases the probability that he gets paid. Importantly, if the firm makes the investment by contracting with the insurer, the firm can verify the investment.

My model follows the spirit of Grossman (1972) in which health expenditures are capital investments. In previous work, firms offer a level of health insurance that depends on the preferences of the worker. Workers are willing to trade some level of wages for health insurance because they have utility over health insurance (Currie and Madrian (1999), Gruber (2001), Gruber and Madrian (2002)). In my model, worker's have utility over health implicitly because it keeps their human capital present and productive, but the firm also values health. Increasing the productivity of the worker's human capital increases the productivity of other factors. A firm captures a production externality that a theory of compensating wage differentials ignores.

For each case, I derive the optimal contract between the worker and the firm following Holmström (1979), which specifies the structure and level of wages and health capital investment. Insurers set premiums by anticipating the level of health capital investment. Firms compare profits under each investment option and choose to invest when profits are higher. I then use the results from this decision to address welfare consequences.

The conventional welfare analysis of Pauly (1968), which I describe in more detail below, leaves out many features of the markets for health and health insurance. First, the probability that an individual becomes sick and utilizes medical care is exogenous. In particular, it "excludes preventive medicine from consideration, and it also ignores the effect that medical insurance might have on the purchase of preventive care." Second, there are no income effects (Nyman (2003)). Third, it does not model the insurance market. Fourth, prices are exogenous (Gaynor et al. (2000)). Fifth, the model ignores production externalities that may arise from medical care utilization. A related omission is that the benchmark welfare analysis does not include a firm as an agent.

My model will address three of these shortcomings. First, as already noted, in the United States, the firm often makes an investment in the health capital of workers by, for example, offering insurance. The firm may benefit from health capital investment because it increases the probability that the worker is present and productive. Second, the probability that an individual becomes sick and utilizes medical care is endogenous. Third, the insurer can offer a contract contingent on the optimal actions of the firm and the worker-consumer.

In addition to analyzing the investment decision of the firm, I derive empirical implications for the level of health capital investment, the level of wages, and features of the insurance contracts. I then use the results from the model to discuss welfare implications and compare these to a benchmark model of the literature.

First, health capital investment increases with the level of human capital, productivity, and size of the firm. Firms that use higher human capital, higher labor productivity, and are larger invest in health capital by insuring their workers. Second, when the firm invests in the worker's health capital, the optimal investment level is higher than that optimally chosen by the worker. The firm invests more because it captures the production externality and because it is cheaper to insure the worker's human capital rather than give the worker an incentive to invest. I elaborate on this more below when I discuss the welfare consequences of this investment.

The optimal contract yields several predictions on wages. First, wages increase with the level of human capital, productivity, and size of the firm. Second, wages can be higher at firms that invest in health capital, which we observe in the data, because larger firms with higher levels of human capital and productivity find it optimal to invest in health capital. Third, wages are less volatile at firms that invest in health capital. Firms that do not invest in health capital offer a contract that provides the worker with incentives to invest in his own human capital by paying a nonzero wage only when his human capital is present and productive.

In addition to the firm's decision to invest in the health capital of the worker and the subsequent optimal level of investment, the model also yields some predictions on the cost of insurance. An insurance contract specifies a premium and a payout in the event of loss. First, when premiums are increasing in the level of health capital investment, the premium when the firm invests will be higher than when the worker invests. However, if the premium includes a loading fee which depends on the number of persons, increasing the size of the insured workforce will mitigate the effect on the premium of increasing the level of health capital investment. In short, the premium when the firm invests in health capital can be lower even though the optimal level of investment is higher. Second, interpreting the marginal payout as coinsurance for which the worker is responsible, the optimal health capital investment declines as the coinsurance rate increases, but this decline is faster if the firm invests in health capital rather than the worker under certain conditions.

Finally, I use these results to explore welfare consequences. In the compensating wage differentials argument, workers are paid their marginal product of labor. Risk neutral firms also compensate risk averse workers by insuring their risky human capital (Harris and Holmström (1982)). Health capital is an important component of human capital (Mushkin (1962)), and it is clearly risky. In my model, firms that invest directly in the health of their employees insure the worker's uncertain labor realization. This result, in conjunction with the production externality, implies that firms invest more in health capital investment, which has important welfare implications.

The examination of welfare and health began with the assertion by Arrow (1963) that by nature health outcomes were uninsurable and so there might be welfare benefits from an outside agent (the government) stepping in to provide health insurance.[1] Pauly (1968) challenged this conclusion by asserting that health insurance might lead to a moral hazard problem because people behave differently after becoming insured. Briefly, when someone has insurance, he pays a lower price for medical care under the terms of the insurance contract. He purchases insurance based on the expected medical care ex ante, but with insurance, the amount of care demanded will be higher ex post, resulting in a moral hazard welfare loss.[2] Introducing a copay or coinsurance

[1] In particular, Arrow (1963) states that "a great many risks are not covered, and indeed the markets for services of risk-coverage are poorly developed or nonexistent" because "it is impossible to draw up insurance policies which will sufficiently distinguish among risks, particularly since observation of the results will be incapable of distinguishing between avoidable and unavoidable risks, so that incentives to avoid losses are diluted."

[2] The moral hazard here is slightly different from the typical moral hazard description because the consumer is making an economically rational decision based on the new price that he pays as opposed to "moral perfidy" (Pauly (1968)).

can mitigate this problem and reduce the moral hazard welfare loss, but it will not eliminate it.

To see this, consider Figure 2.1, which shows demand for medical care.[3] The price is the marginal cost (MC) of providing care. At P=MC, without insurance, the consumer demands M_u of medical care. With insurance, the consumer faces a price P=0 and now demands M_i of medical care. The cost of moral hazard is the box under the MC line between M_u and M_i. The value of moral hazard is the lower triangle. Hence, the welfare loss due to moral hazard is the upper triangle. That is, the moral hazard welfare loss is the amount by which the additional medical care costs exceed the value to the consumer. Pauly (1968) notes that only if the demand for medical care "is perfectly inelastic with respect to price is an expense 'insurable' in the strict sense envisioned by Arrow's welfare proposition." While there have been critiques of this approach,[4] Pauly (1968) is still the benchmark model.

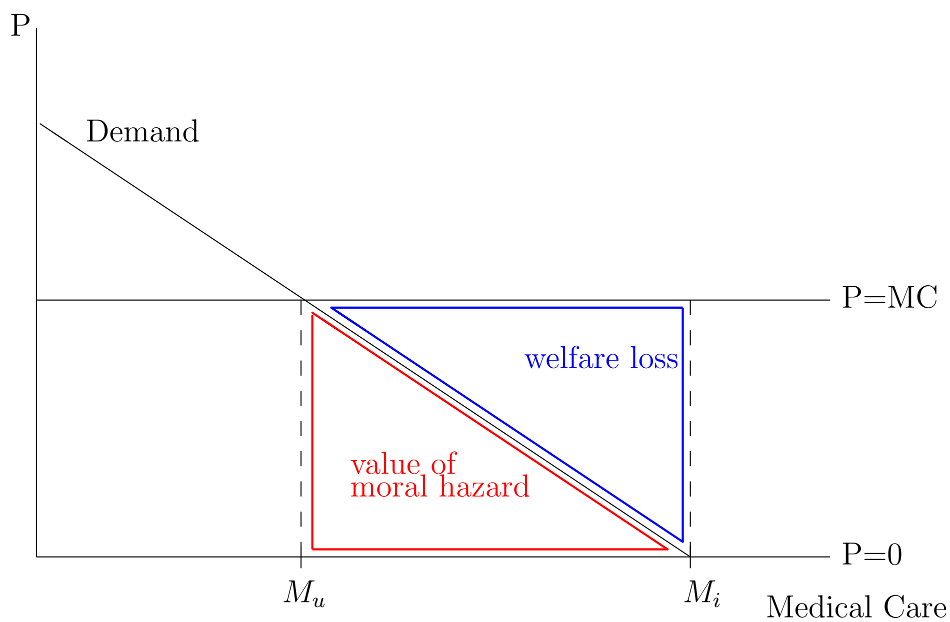

Figure 2.1: Moral Hazard Welfare Loss

Figure 2.2 demonstrates graphically the effect from introducing a firm into the moral hazard model. First, the demand of the firm is to the right of the demand of the worker because there is a production externality that a firm can capture when it invests in the worker's health capital. Second, marginal cost is lower because it is cheaper for the firm to provide health care and bear the risk of the uncertain labor

[3]This presentation follows Nyman (2003).
[4]See for example Nyman (2003).

realization. Marginal cost may also be lower for other reasons not captured by my model. Oftentimes the cost of medical care that the firm faces is lower for tax reasons, because firms can negotiate with health insurance providers, there may be economies of scale, and because it may alleviate the adverse selection problem. Hence, the individual *still* receives an amount of medical care M_i in the graph, but the moral hazard welfare loss is zero.

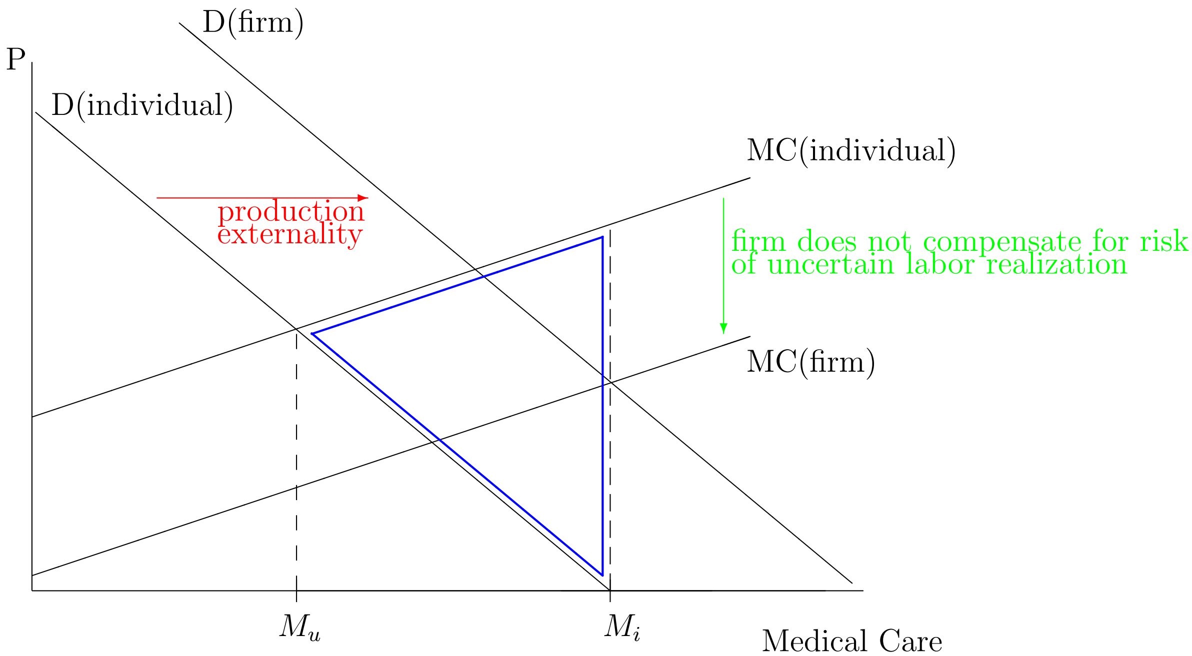

Figure 2.2: Eliminating Moral Hazard Welfare Loss

These results have important policy implications. Using the conventional Pauly (1968) moral hazard framework, some have argued that employer-sponsored health insurance encourages workers to overconsume health care, leading to a moral hazard welfare loss. Extending this argument, current U.S. tax law exacerbates the problem because a firm's health expenditures are tax deductible. The firm can deduct the health insurance portion of employee wages from its tax bill, so one dollar spent on health benefits is cheaper than one dollar spent on wages. When the firm shifts compensation from wages to health insurance, it effectively lowers the worker's cost of health insurance (Morrisey (2001)). In addition, the IRS has ruled that the firm's contribution to health insurance is a tax-deductible business expense which lowers the firms taxable income (Congressional Research Service (2005)). In fact, health economists have used this argument to call for the repeal of this tax deduction.[5] In contrast, my model shows that a firm's health capital expenditures will be higher

[5]See Nyman (2004) for more details.

even in the absence of taxes.[6] Additionally, understanding how firms benefit from production externalities of health will help policymakers as they search for ways to increase the number of Americans with health insurance and to manage utilization.

The paper proceeds as follows. The next section introduces the model. Section 3 presents the solution under the cases where the worker or firm make the health capital investment and describes the model's predictions. Section 4 discusses the welfare implications. The last section concludes.

2.2 Model description

Consider the following two period model of a worker, a firm, and an insurer. At $t = 1$ the firm uses labor, L, to generate revenue per worker. Let $\tilde{R} = g(\tilde{L}; N, \alpha, K)$ represent the revenue function which depends on the number of workers at the firm, N, labor productivity, α, and physical capital, K. Revenue per worker is increasing in all its arguments. At $t = 2$ firms pay a wage, w, to workers, and realized profits are therefore:

$$\pi(L, w; N, \alpha, K, n) = \tilde{R} - w.$$

Labor is a random variable that depends on both human capital investment, n, and health capital investment, h, made by the agent. An agent who has made a human capital investment can produce a maximum level of labor of $n > 0$. The probability, however, that the labor realization is $n > 0$ is $p(h)$, and with complementary probability it is zero. Here $p(h)$ is strictly increasing h and concave; that is, $p'(h) > 0$ and $p''(h) \leq 0$.

The uncertainty of the labor realization reflects two possible states. Either the worker and hence the human capital are present and productive so that the realization of labor is $n > 0$. Or the worker is not productive, in which case the labor realization is $n = 0$.[7] The labor, health, and policy literature document both absenteeism (for example, the worker could be at home sick nursing a cold) and presenteeism (for example, the worker could be on the job but suffering from a disease such as alcoholism or depression that makes the worker unproductive).[8] The firm pays wages that depend on the labor realization. If the labor is present and productive, wages are w_n. Otherwise, wages are w_0.

[6] I can add taxes to explore the implications of health capital investment in this more realistic context.

[7] In keeping with the spirit of the Grossman (1972) model, one can also interpret this description of labor as a potential depreciation of human capital from n to 0. In the Grossman (1972) framework, health capital is a depreciating asset, and agents can make an investment in health capital (through medical care utilization or lifestyle choices) to mitigate this depreciation. Agents have utility over health because it effects how much time they can devote to labor or leisure.

[8] See Hemp (2004) for a discussion of the impact of presenteeism on business decisions. See Gilleskie (1998) for a model of absenteeism.

The worker has utility over wages, w, given by $u(w)$, with $u'(w) > 0$ and $u''(w) < 0$.[9] The utility function is invertible, with $u^{-1} = v(\cdot)$. The worker has some outside option, so his reservation utility is $u_R \geq 0$. When the worker gets sick, he incurs a verifiable monetary loss, $\ell > 0$. This loss is a random variable that depends on the health capital investment, $\ell(h)$, with $\ell'(h) > 0$.

The insurer is part of a competitive insurance market and offers the following contract: in exchange for a premium, m, the insurer pays out some amount $\lambda(\ell(h)) > 0$ to the worker, with $\lambda'(\ell(h)) > 0$.[10] This payout depends on the size of the loss, ℓ, that the worker incurs when he is sick; that is, when the labor realization is zero. The worker therefore receives a net payoff of $\lambda(\ell(h)) - \ell(h)$. The net payoff is increasing in the health capital investment h.

The expected payout of the insurer is just the probability that the worker is sick, $1 - p(h)$, times the size of the payout, $E_\ell[\lambda(\ell(h))]$. The actuarially fair premium is then $E_\ell[1 - p(h)]\lambda(\ell(h))$. Additionally, the insurer incurs costs for running the plan such as administration, marketing, and overhead. These costs are loading fees, which are the portion of premiums not used to pay benefits (Pauly and Percy (2000)). The loading fee, $f(N)$, is decreasing in the number of persons covered so that $f'(N) < 0$. Therefore, if the insurer makes zero profits on each worker, $m(h; N) = E_\ell[1 - p(h)]\lambda(\ell(h))f(N)$.

If the worker is present and productive, he gets his utility of wages $u(w_n)$. If the worker is not present and productive, he gets utility of wages $u(w_0)$, but he also gets utility of the loss and the payout. Suppose the worker has some amount s.[11] His expected utility is then:

$$Eu(w) = p(h)u(w_n) + [1 - p(h)]u(w_0) + [1 - p(h)]u(s + \lambda(\ell(h)) - \ell(h)).$$

In the analysis of the model, it will be useful summarize the percentage change in the cost of health relative to the percentage change in the probability of the worker getting sick as the following elasticity.

Definition 1. $\eta \equiv \frac{d(u(s+\lambda(\ell(h))-\ell(h))-\lambda(\ell(h))f(N))/dh}{u(s+\lambda(\ell(h))-\ell(h))-\lambda(\ell(h))f(N)} \Big/ \frac{d(1-p(h))/dh}{1-p(h)}$

The model analysis focuses on three cases that depend on the verifiability of the health capital investment and whether it is the worker or the firm who makes the health capital investment. I focus on these three cases because I want to describe how the health capital investment differs when the worker invests in health capital versus the firm, and I want to compare both of these cases to the first best investment. Given these cases, the timing of the model is as follows. At $t = 0$, the firm offers a

[9] Note that although the worker does not have preferences over wages and health (for example, $u(w, h)$) as some models in the labor literature propose, the worker will implicitly prefer some level of health benefit through the effect it has on wages.

[10] I assume that the worker cannot contract with multiple insurers.

[11] This assumption ensures the argument of the utility function remains positive.

wage contract to a worker of known type (n). When the worker makes an investment in health capital that the firm can or cannot observe and verify, the contract is a pair (w_0, w_n). When the firm makes an investment in health capital, the contract is a triple (w_0, w_n, h). The worker or the firm then sign a contract with the insurer. A contract is a pair (m, λ). An agent then chooses a health capital investment, h. At $t = 1$, labor is realized, and the worker receives some wage, w, which depends on realized labor. If $L = 0$, the worker receives $w = w_0$, and if $L = n$, the worker receives $w = w_n$. The worker incurs any losses, and the insurer makes any payouts. Figure 3.1 illustrates the timing of events.

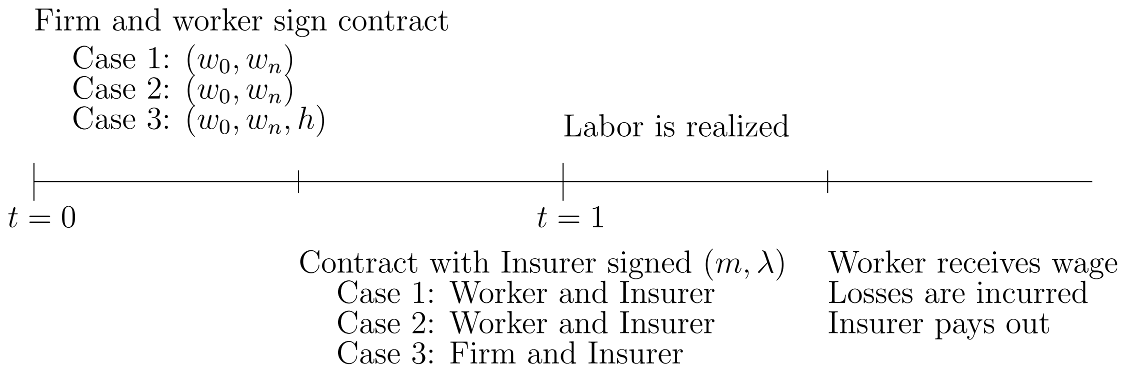

Figure 2.3: Model Timing

Nothing in the model description guarantees an interior solution exists. Hence, I impose the following assumption in order to be able to describe the optimal contracts.

Assumption 1. *The percentage change in the cost of health relative to the percentage change in the probability of the worker getting sick as the health capital investment changes is greater than one in absolute value.*

$$\eta > -1$$

2.3 Model analysis

As described above, the conventional argument based on Pauly (1968) implies that if the firm invests in the worker's health capital, we will observe higher health expenditures due to moral hazard because the worker does not bear the cost. The key assumption of my model is that the firm cannot observe the worker's health capital investment, but the firm *can* observe the health capital investment if it makes the investment. In order to understand how the level of health capital investment differs when the firm invests versus when the worker invests, as well as what drives this difference, it is necessary to solve for the optimal contract under both cases. I compare both cases to a benchmark case.

In the first case, the firm can observe and contract on the worker's human capital type n and the worker's health capital investment, h. I refer to this benchmark efficient case as the first best. In the second case, the firm cannot verify the worker's human capital investment, h, after the worker and firm sign the contract. In the third case, the firm also invests in the worker's health capital and can now observe the worker's health capital. I derive the optimal wage and health capital investment in each case. I describe and discuss characteristics of the optimal contract. I then compare firm value under the two scenarios in order to draw conclusions about how and when the firm's health capital investment affects firm value.

2.3.1 First best

In this case, all information is verifiable and contractible. The firm chooses an optimal wage and the optimal health capital investment. The worker incurs the cost of the health capital investment. The firm maximizes profits subject to the worker's participation constraint. The firm's problem is:

$$\begin{aligned} \max_{h, w_i \in \{w_0, w_n\}} \quad & E[\tilde{\pi}] = E[\tilde{g} - w_i] \\ \text{s.t.} \quad & E[U] \geq u_R \end{aligned} \tag{2.1}$$

where

$$\begin{aligned} E[U] \;=\; & p(h)u(w_n) + [1-p(h)]u(w_0) + [1-p(h)]u(s + \lambda(\ell(h)) - \ell(h)) \\ & -E_\ell[1-p(h)]\lambda(\ell(h))f(N). \end{aligned} \tag{2.2}$$

The following lemma describes the first best contract.

Lemma 1. *When human capital and health capital are verifiable and Assumption 1 holds, the firm pays a wage:*

$$w^*_{fb} = v(u_R + m(h^*_{fb}; N) - [1 - p(h^*_{fb})]u(s + \lambda(\ell(h^*_{fb})) - \ell(h^*_{fb})))$$

The worker makes a health capital investment h^*_{fb} that solves:

$$p'(h)g + \frac{1}{u'(w^*_{fb})}\{-p'(h)[u(s + \lambda - \ell) + \lambda(\ell(h))f(N)][1 + \eta]\} = 0$$

The optimal wage shows that the firm fully insures the worker by paying a constant wage regardless of the labor realization. The firm compensates the worker for his reservation utility[12] and for the cost of health capital through the premium and the expected utility cost. The optimal health capital investment just shows that the worker invests at the point where the marginal benefit of the health capital investment equals the marginal cost.

It is clear from the characterization of the first best health capital investment that Assumption 1 must hold. If the elasticity is less than negative one, then the percentage change in the cost of health is less than the percentage change in the probability of getting sick, so as the investment in health capital increases, the increase in the cost of the health capital investment is less than the reduction in the probability of getting sick. In other words, it costs less to reduce the probability of getting sick. In this case, the worker has incentive to invest more and will do so up to the point where the probability of getting sick is zero, which is not a reasonable assumption.

Because the set up of the model is intentionally general, I cannot solve for the optimal wage and health capital investment explicitly. Applying the implicit function theorem to the results of Lemma 1 enables me to state comparative statics described in the following corollary.

Corollary 1. *The wage and health capital investment are both increasing with labor productivity, α, the human capital level, n, the number of workers, N, and the size of the firm K.*

I will describe similar comparative statics in the cases to follow as well as use the results from the optimal contract to express the subsequent contract with the insurer. Given that the worker is contracting with the insurer and the firm can observe the health capital investment, the insurer knows that the health capital investment is h^*_{fb}.

Corollary 2. *The insurer will offer a contract with premium $m(h^*_{fb}; N) = E_\ell[1 - p(h^*_{fb})]\lambda(\ell(h^*_{fb}))f(N)$ and payoff $\lambda(\ell(h^*_{fb}))$.*

Note that this contract is consistent with the industry zero profit condition as stated in the description of the model above.

2.3.2 Unverifiable health capital

Firms can gauge whether or not workers have made an investment in human capital through educational attainment, previous work experience, or letters of reference. At the same time, firms are less likely to observe the (costly) actions that workers take to maintain their human capital. In other words, the worker chooses a health capital investment, h, that the firm cannot observe and verify.

The firm offers the worker a contract that induces him to choose a health capital investment that is optimal for the firm subject to maximizing the worker's utility.

[12] The reservation utility may reflect compensation for the cost of a human capital investment.

The firm's problem is:

$$\begin{aligned} \max_{w_i \in \{w_0, w_n\}} \quad & E[\tilde{\pi}] = E[\tilde{g} - w_i] \\ \text{s.t.} \quad & E[U] \geq u_R \\ & h \in \arg\max_{\hat{h}} E[U] \end{aligned} \tag{2.3}$$

where $E[U]$ is defined in Eq. (2.2). Without loss of generality, the wage in the low state is zero; that is, $w_0 = 0$.[13]

The following lemma describes the optimal contract between the worker and the firm.

Lemma 2. *When human capital is observable and health capital is not verifiable and Assumption 1 holds, the worker makes a health capital investment $h^*(w_n)$ that solves:*

$$p'(h)u(w_n) - p'(h)[u(s + \lambda - \ell) + \lambda(\ell(h))f(N)][1 + \eta] = 0$$

The firm pays a wage w_n^* to a worker with human capital $n > 0$ that solves:

$$\frac{1}{(g - w_n)} / \frac{p'(h^*)h^{*'}(w_n)}{p(h^*)} = 1$$

The worker invests in health capital up to the point where the marginal benefit equals the marginal cost. Anticipating the optimal health capital investment of the worker, the firm pays a wage so that the percentage change in revenue from increasing wages is equivalent to a percentage change in the probability the worker gets sick. Using the results of Lemma 2 yields the following corollary.

Corollary 3. *A worker's optimal health capital and wage are increasing with labor productivity, α, the human capital level, n, the number of workers, N, and the size of the firm, K.*

These comparative statics are intuitive. The worker in a high human capital or high labor productivity firm, all else equal, makes a larger investment in health capital to reduce the probability that his wages are lower due to the depreciation of his human capital. The wage and health capital investment will be lower compared to first best whenever $g > u(w_n)$. In other words, when the marginal benefit to the firm exceeds the marginal benefit to the worker, the health capital investment will be higher.

The firm that utilizes a higher human capital and the firm for which labor is

[13] This is without loss of generality because the health capital investment is decreasing with the wage in the state where the worker is sick.

more productive, all else equal, will pay higher wages.[14] Additionally, the wage is more volatile compared to the first best wage. The worker only receives a wage when he is present and productive. This wage structure is analogous to a firm that does not compensate workers with paid sick leave. Hence, the optimal contract gives the worker an incentive to invest in health capital.

Figure 2.4 illustrates how the optimal health capital investment differs from the first best case when it is not verifiable. As labor productivity, α, the human capital, n, the number of workers, N, and the size of the firm, K, increase, it is more likely that $g > u(w_n)$ so that in the first best case firms will demand a higher health capital investment. Using imprecise notation for the sake of clarity, the marginal cost to the worker of the health capital investment is $m'(h;N) - c'(h)$, but the marginal cost to the firm in the first best case $\frac{1}{u'(w^*_{fb})}[m'(h;N) - c'(h)]$. Because $u' > 0$, the marginal cost under first best is lower than for the worker.

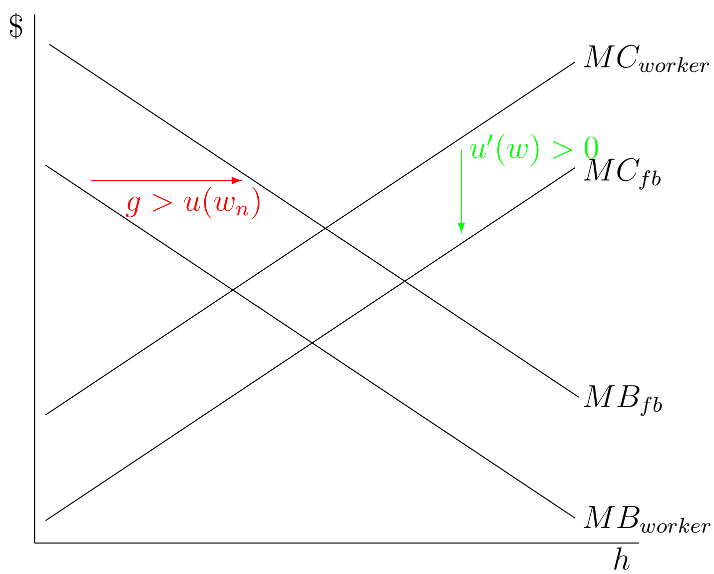

Figure 2.4: Unverifiable Health Capital. This figure shows the marginal benefit and marginal cost of health capital investment under the first best (fb) efficient case when the investment by the worker is verifiable and in the case when the investment by the worker is not verifiable. The marginal benefit is higher in the first best case because the firm gets a production externality. The marginal cost is higher when the worker's investment is not verifiable because the firm compensates the worker for bearing the risk of the uncertain labor realization.

[14]Industry may be a proxy for different types of firms. The result that wages depend on human capital, n, and labor productivity, α, is consistent with previous work showing that the worker's industry can account for observed differences in wages (Krueger and Summers (1988)).

Given that the worker is contracting with the insurer and the firm cannot verify the health capital investment, the insurer infers that the health capital investment is $h^*(w_n)$. The following corollary describes the contract using Lemma 2.

Corollary 4. *The insurer will offer a contract with premium* $m(h^*(w_n)) = E_\ell[1 - p(h^*(w_n))]\lambda(\ell; h^*(w_n))f(N)$ *and payoff* $\lambda(\ell; h^*(w_n))$.

I will elaborate more on the differences in insurance contracts below.

2.3.3 Verifiable health capital

In the United States, over 90 percent of the privately insured population receive insurance through employment (Gruber and Madrian (2002)). Further, firms often invest in worker health beyond just health insurance. Fronstin and Werntz (2004) review anecdotal evidence of six firms investing in worker health beyond just health insurance and include education and other programs. In their case study, health programs had existed for at least ten years. The next case explores when the firm invests in the worker's health capital.

The firm's objective is to maximize expected profits, which now include the cost of the health capital investment. The firm's new problem is:

$$\begin{aligned} \max_{h, w_i \in \{w_0, w_n\}} \quad & E[\tilde{\pi}] = E[\tilde{g} - w_i - E_\ell[1 - p(h)]\lambda(\ell; h)f(N)] \\ \text{s.t.} \quad & E[U] \geq u_R \end{aligned} \tag{2.4}$$

where now

$$E[U] = p(h)u(w_n) + [1 - p(h)]u(w_0) + [1 - p(h)]u(s + \lambda(\ell(h)) - \ell(h)). \tag{2.5}$$

In contrast to the case when the health capital investment is not verifiable, the worker only has to be willing to participate and no longer incurs the cost of the health capital investment. Notice how the expected utility in Eq.(2.5 differs from the expected utility used previously in Eq. (2.2). The participation constraint when the worker makes an unverifiable health capital investment includes the premium, but when the firm invests, the premium is now part of expected firm profits.

Lemma 3. *When the firm undertakes the health capital investment (rather than the worker) and Assumption 1 holds, the optimal contract is for the firm to pay a constant wage:*

$$w^*_{firm} = v\{u_R - [1 - p(h^*_{firm})]u(s + \lambda(\ell(h^*_{firm})) - \ell(h^*_{firm}))\}$$

The firm makes a health capital investment h^*_{firm} that solves:

$$p'(h)g + \frac{1}{u'(w^*_{firm})}\{-p'(h)u(s+\lambda-\ell)[1+\eta]\}$$
$$+(p'(h)\lambda(\ell(h)) - [1-p(h)]\lambda'(\ell)\ell'(h))f(N)[1-\frac{1}{u'(w^*_{firm})}] = 0$$

The optimal health capital investment just shows that the firm invests at the point where the marginal benefit of the health capital investment equals the marginal cost. As in the first best case, the optimal wage shows that the firm fully insures the worker by paying a constant wage regardless of the labor realization. This constant wage structure is analogous to a worker receiving paid sick leave, in contrast to the case when the worker invests health capital and gets a wage of zero when he is not present. The firm compensates the worker for his reservation utility and for the cost of health capital through the expected utility cost but not for the premium which the firm now incurs.

Corollary 5. *The optimal wage is increasing with labor productivity, α, the human capital, n, the number of workers, N, and the size of the firm, K. The optimal health capital is increasing with labor productivity, α, human capital, n, the number of workers, N, and the size of the firm, K.*

The comparative statics are similar to the case when the worker makes the human capital investment although the contract specifies different levels of health capital and wages.

One can see how the case when the health capital investment is not verifiable differs from the first best case in Figure 2.5. Note that if $g > u(w_n)$, so that the firm benefits from a production externality, then in the first best case firms will demand a higher health capital investment. The marginal cost to the worker of the health capital investment is $m'(h;N) - c'(h)$, but the marginal cost to the firm when the firm makes the verifiable health capital investment is $m'(h;N) - \frac{1}{u'(w^*_{firm})}c'(h)$. Because $u' > 0$, the marginal cost when the firm invests in health capital is lower than for the worker. In Figure 2.5, the marginal cost is also lower than the first best case,[15] but this depiction is not general. In fact, when wages are low, the marginal cost when the firm invests will be higher than the first best case. Because marginal utility is decreasing, however, at some point the marginal cost when the firm invests will be lower than the marginal cost in the first best case.

Given that the worker is contracting with the insurer and the firm cannot verify the health capital investment, the insurer infers that the health capital investment is h^*_{firm}.

[15] Recall that the marginal cost to the firm in the first best case $\frac{1}{u'(w^*_{fb})}[m'(h;N) - c'(h)]$.

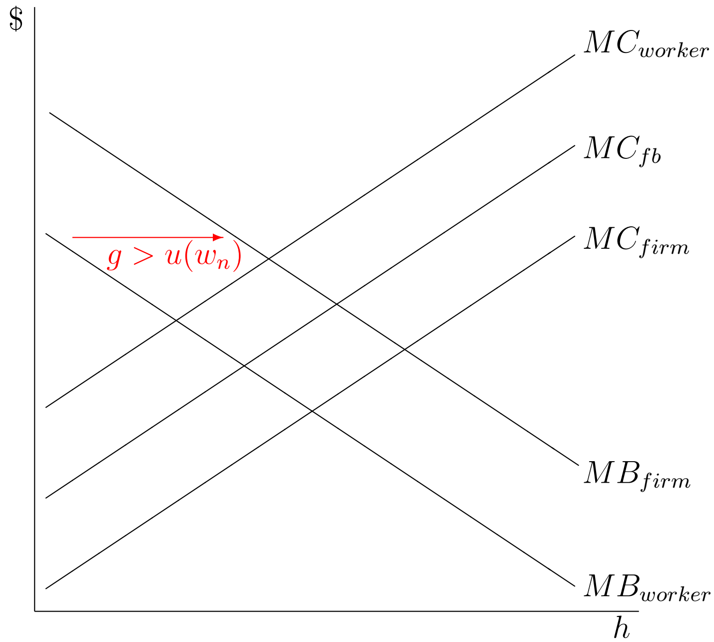

Figure 2.5: Verifiable Health Capital. This figure shows the marginal benefit and marginal cost of health capital investment under the first best (fb) efficient case when the investment by the worker is verifiable, in the case when the investment by the worker is not verifiable, and in the case where the investment is by the firm and therefore verifiable. The marginal benefit is higher when the firm invests because the firm gets a production externality. The marginal cost is lower when the firm invests because the firm no longer compensates the worker for bearing the risk of the uncertain labor realization.

Corollary 6. *The insurer will offer a contract with premium* $m(h^*_{firm}; N) = E_\ell[1 - p(h^*_{firm})]\lambda(\ell(h^*_{firm}))f(N)$ *and payoff* $\lambda(\ell(h^*_{firm}))$.

Again, I will elaborate more on the differences in the contract with the insurer following a discussion of the difference in the health capital investment levels.

One can now see how the level of health capital investment of the firm, h^*_{firm}, differs from the level of health capital investment by the individual, $h^*(w_n)$. As an example, I display this difference over human capital in the top half of Figure 2.6.[16] To explain this picture, recall that the comparative statics from the lemmata describing the optimal contracts indicate that the optimal health capital investment

[16]This figure emphasizes that human capital is an important component of what affects levels of health insurance offered by firms. In particular, tests of compensating wage differentials typically find that health insurance increases with wages, contrary to the theory, but fail to control for human capital or unobserved ability. See Currie and Madrian (1999).

is increasing with labor productivity, α, human capital, n, the number of workers, N, and the size of the firm, K. Because the worker has to bear the risk of the uncertain labor realization when the health capital investment is not verifiable, the health capital investment is costlier and the benefit of the health capital investment is lower (recall Figure 2.4). When labor productivity, human capital, and the size of the firm are low, the wage of the worker is low and subsequently marginal utility is higher. As labor productivity, human capital, and the size of the firm increase, wages also increase and marginal utility falls, so the marginal cost of the firm's investment in health capital is lower than the first best case.

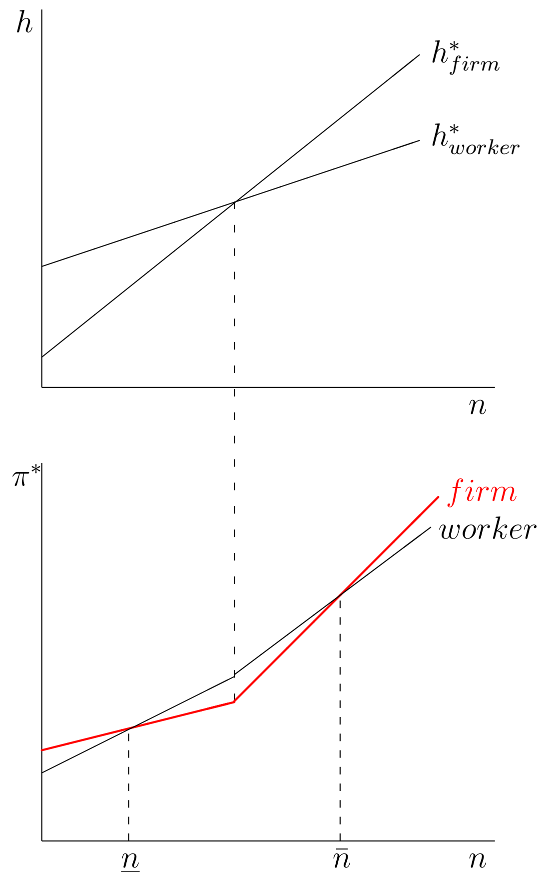

Figure 2.6: Health Capital Investment Levels. The top panel of this figure shows how the optimal health capital investment changes with one of the parameters of the firm, human capital (n), when the worker invests in health capital and when the firm invests. The bottom panel of this figure shows how maximized firm profits change with human capital (n) when the worker invests in health capital and when the firm invests.

This fact explains why at some level of the parameters of the firm, the optimal health capital investment of the firm exceeds that of the first best case. In other words, when labor productivity, human capital, and the size of the firm are low, the distortion in the optimal level of health capital investment is positive so that the worker invests more. When labor productivity, human capital, and the size of the firm are high, the distortion is negative, so that the worker invests less in health capital.

2.3.4 Investment decision

Given the optimal contracts in the case where the worker invests in unverifiable health capital and the firm invests in verifiable health capital, one can describe when the firm offers a contract that includes a firm-sponsored health capital investment. To do so, we need to examine the difference in expected firm profits. When the worker invests in health capital, firm profits are:

$$\pi^*_{worker} = p(h^*_{worker})[g - w^*_n].$$

When the firm invests in health capital, firm profits are:

$$\pi^*_{firm} = p(h^*_{firm})g - w^*_{firm} - m(h^*_{firm}; N).$$

We can see how these profits change with the parameters of the revenue function: labor productivity, α, human capital, n, firm size, K, and number of workers, N. Figure 2.6 shows the changes for human capital. Below the point $\underline{n}$ and above the point $\overline{n}$, firm profits are higher when the firm invests in health capital. For all levels of human capital between these two points, however, firm profits are higher when the worker invests in health capital. The following lemma describes the relative difference in profits for the parameters.

Lemma 4. *For each parameter of firm revenue, there are three investment regions. For intermediate parameter values, firm profits are higher when the worker invests in health capital. Otherwise, for parameter values outside the intermediate region, firm profits are higher when the firm invests in health capital.*

Similarly to Lemma 4, it is possible to see how profits change with the parameters of the firm. In particular, there exists some $\underline{g}$ below which the firm finds it optimal to invest in health capital. For now, I will rule out this region in the analysis that follows. There exists some $\overline{g}$ that serves as a threshold for when the firm is better off investing in the worker's health capital. The following proposition makes this more precise.

Proposition 1. *For all firms with parameters such that revenue is high enough, that is, $g > \overline{g}$, the firm invests in the health capital of the worker. The firm offers a contract with a constant wage w^*_{firm} and pays a premium $m(h^*_{firm}; N)$.*

In other words, the firm will invest in the worker's health capital whenever the expected profits in the case of the firm investing exceed the expected profits in the case of the worker investing. Figure 2.7 shows a simple example of when it is optimal for the firm to offer a contract with an explicit health capital investment that depends on labor productivity, human capital, and the number of persons at the firm. In this figure, firms with higher levels of labor productivity or higher levels of human capital invest in the health capital of the worker. As the number of workers increases, the firm benefit from the production externality tapers off, but the effect of the loading fee in the insurance premium remains. As the number of workers increases, the premium decreases (because $f'(N) < 0$), which implies that for a firm with a given labor productivity, human capital, and size, the threshold at which the firm invests in the workers health capital is decreasing. This example uses labor productivity and human capital for illustrative purposes, but a similar relation holds for the size of the firm as well.

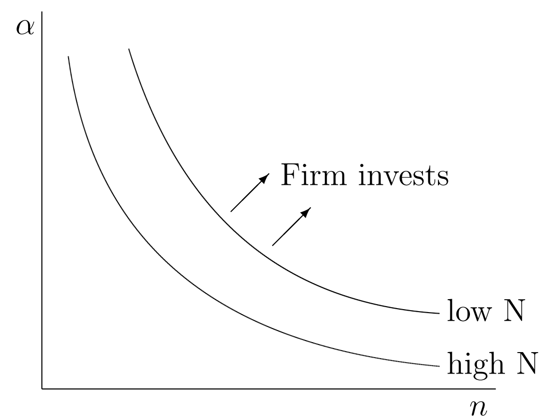

Figure 2.7: Investment Threshold. This figure shows that firms will choose to invest in worker health capital for higher levels of labor productivity, α, and human capital, n. The threshold that delineates the combination of parameters for which it is optimal for the firm to invest is decreasing with the number of workers, N, at the firm because the loading fee decreases with the number of workers.

2.3.5 Insurance contract

One can now also see how the insurance contract differs when the firm chooses the optimal health capital investment, h^*_{firm}, compared to the optimal investment choice by the individual, $h^*(w_n)$. I focus on these two cases because they are observable. The insurer offers a contract which is a pair (m, λ) that specifies the premium and the payout. I describe each component in more detail.

In order to say something about how the premiums differ, I impose the following assumption.

Assumption 2. *The percentage change in the payout relative to the percentage change in the probability of getting sick is greater than negative one.*

$$\frac{d\lambda(\ell(h))/dh}{\lambda(\ell(h))} / \frac{d(1-p(h))/dh}{1-p(h)} > -1$$

If this payout probability elasticity is greater than negative one, then the premium is increasing in the health capital investment. In other words, if the percentage change in the payout is greater relative to the percentage change in the probability of getting sick, then the premium is decreasing with the health capital investment because the expected payout is decreasing.[17]

If Assumption 2 holds, then because the optimal health capital investment of the firm is higher than the optimal health capital investment of the individual, in the absence of a loading fee, $f(N)$, the premium under the firm investment is higher. Including the loading fee, however, implies that as the number of workers increases, the premium for a worker could be lower even though the health capital investment is higher.

Finally, the contract specifies a payout λ, which is a function of the verifiable loss, $\ell(h)$. One can interpret the derivative of the payout as a complement to the coinsurance that increases with the loss, $\lambda'(\ell) > 0$.[18] Furthermore, if $\lambda'(\ell)$ is constant over some range, then it is possible to say how the optimal health capital investment changes with the coinsurance (at least locally).

Lemma 5. *For a small enough loading fee, the optimal health capital investment increases with the portion of the loss covered by the insurer.*

As the portion of the loss that the insurer covers increases, the optimal health capital investment increases. Because the marginal payout is analogous to the complement of the coinsurance, another way of stating this result is that if the loading fee is low enough, then the optimal health capital investment of the firm and the worker are decreasing as the coinsurance increases. Conversely, if the loading fee was large, the health capital investment would decrease with the portion of the loss covered by the insurer because the fee is proportional to the payout.

The following proposition describes how the sensitivity of the health capital investment to the coinsurance depends on whether the worker or the firm invests in health capital.

[17] One possible extension is for Assumption 2 to hold over some range of h so that increasing health capital investment leads to a lower premium in some cases, analogous to sponsored wellness programs.

[18] For example, $\lambda(\ell; h) = \theta\ell(h)$, where $0 \leq \theta \leq 1$, and the worker is responsible for the portion the insurer does not cover.

Proposition 2. *The coinsurance reduces the optimal health capital investment more when the firm invests in health capital rather than the worker.*

In other words, if the insurer requires the insured to pay for at least some of the loss out of pocket, the insured will invest less in health capital, but the reduction due to the coinsurance is less when the worker invests. Alternatively, if this condition holds, then as the insurer increases the payout, the firm increases the optimal health capital investment at a higher rate than the worker because the firm benefits relatively more by capturing the production externality.

Proposition 2 holds as long as the indirect effect of a change in the coinsurance rate on the first order conditions in Lemma 2 and Lemma 3 are small relative to the direct effect. If we let SOC denote the respective second order conditions for health capital investment from the firm's optimization problem, it must be the case that $\frac{-f(N)+u'(s+\lambda-\ell)}{SOC_h} < \frac{-f(N)+\frac{u'(s+\lambda-\ell)}{u'(w^*_{firm})}}{SOC_h^{firm}}$. To see when this is true, recall that the wage when the firm invests in health capital is higher and so the marginal utility will be lower. Additionally, note that the loading fee, $f(N)$, is larger when the individual invests in health capital because the number of persons covered on the individual market is essentially one.

2.4 Welfare discussion

Now that I have derived the optimal contract in the case where the worker invests in his health capital and in the case where the firm invests in the worker's health capital as well as when it is optimal for the firm to offer one of these contracts, I will discuss the welfare implications. It is clear from Figure 4 that there is a nonmonotonic relation for the firm's investment decision. Because empirically we do not observe firms investing at low levels of human capital and labor productivity, I rule out that case.[19] I will focus on the case below $\overline{g}$ where it is optimal, from the firm's vantage point, for the worker to invest and the case above $\overline{g}$ where it is optimal for the firm to invest. In addition to discussing the welfare of the contracts, I will also address the moral hazard welfare loss proposed to arise from insurance due to Pauly (1968).

In the case where the worker invests in unverifiable health capital, the contract is the standard result from Holmström (1979). The equilibrium is constrained Pareto efficient. The firm cannot observe and verify the health capital investment of the worker, and the firm offers a contract that gives the worker an incentive to invest in costly health capital. This contract only pays a wage when the worker is present and productive. This contract is analogous to a labor contract in which the worker

[19] It may be possible to rule this case out for two reasons. One explanation is that firms do not operate at low levels of human capital and labor productivity because it is not profitable. Alternatively, firms do not make a significant health capital investment in these regions because charity care and government programs such as Medicaid are more likely to serve these groups.

does not receive paid sick leave. The worker bears the risk of the uncertain labor realization, and so the firm has to compensate him for taking on this extra risk. As a result, this solution is inferior to the first best case.

In the case where the firm invests in health capital, the optimal health capital investment is higher. Because the ratio of marginal utilities is constant in every state, the equilibrium is Pareto efficient following the Borch (1962) rule. At higher levels of human capital and labor productivity, it is less costly for the firm to make the health capital investment and pay a constant wage than compensate the worker for the uncertain labor realization.[20] There is a tradeoff between wages and health insurance relative to the first best contract. The constant wage that the worker receives in first best includes compensation for the premium that the worker would purchase on his own. The wage that the worker receives when the firm invests in health capital obviously does not include this compensation. One would not expect to see this tradeoff empirically, however, since it is only possible to observe the cases where the worker invests in unverifiable health capital or the firm invests.[21] Given the optimal contracts in this model, one would expect to see firms with higher wages offer health insurance because the wage includes compensation for human capital. It is also worth pointing out that the higher level of health capital investment comes from a model without taxes.

Furthermore, in both cases, the insurance premium is set by a zero profit condition. The insurer rationally anticipates the level of health capital demanded by the worker or the firm, depending on which party contracts with the insurer. Hence, the insurer will charge a premium consistent with the higher level of health capital investment demanded by the firm.

Given the discussion of welfare under each optimal contract, I can now comment on the presence of the Pauly (1968) moral hazard welfare loss. Empirically, we observe $h^*_{firm} > h^*_{worker}$, so that a worker utilizes more medical care if the firm makes the investment rather than the worker. But there is no moral hazard welfare loss for four reasons. First, the firm takes advantage of a production externality. Second, the firm does not have to compensate the worker for bearing the risk of the uncertain labor realization. Third, the probability of loss is now endogenous. Fourth, the insurer sets premiums based on the anticipated level of health capital investment. In sum, the outcome of the optimal contract between the worker and the firm drives the higher level of health capital investment of the firm rather than ex post inefficiencies.

[20]Note this effect is larger if the cost of the health capital investment depends on human capital. There is evidence that higher health status and education are correlated (Currie and Madrian (1999)).

[21]On extension of the model is for the firm to pay a portion ϕ of the premium m and the worker to pay $1 - \phi$. This contract would still allow the firm to verify the health capital investment by contracting with the insurer, but it would be more realistic. The same basic results of the model will hold.

2.5 Conclusion

I present a simple model of health capital investment. Investment in health capital increases the probability that a worker is present and productive. In the labor literature, health benefits are a part of employee compensation, but in my model risk drives the health capital investment decision. Using the moral hazard framework of Holmström (1979), the firm is risk neutral and the worker is risk averse. The worker of the firm can invest in health capital by contracting with an insurance company. I derive the optimal contract between the firm and the worker in each case.

When the worker invests in health capital, which the firm cannot verify, the firm has to compensate the worker for bearing the risk of an uncertain labor realization. When the firm invests in the worker's health capital, the firm contracts with the insurer and can verify that the worker invests in health capital. The firm gets a production externality when investing in the worker's health capital. The optimal level of health capital investment is increasing in labor productivity and human capital. I derive a health capital investment threshold that depends on labor productivity, human capital, the number of workers, and the size of the firm. At higher levels of these parameters, the firm is better off investing in the worker's health capital. The cost of compensating the worker for bearing risk is higher than the cost of the health capital investment.

The model yields several predictions about wages. The model predicts that wages are more volatile in firms that do not invest in health capital. There is not necessarily a tradeoff between wages and health insurance, and the model predicts that firms that invest in health capital will have higher wages once controlling for human capital and labor productivity.

The model also yields predictions about the level of health capital investment. When the firm invests in health capital rather than the worker, the optimal health capital investment is higher. This result contrasts with the implication of Pauly (1968). Under Pauly (1968), when a worker purchases health insurance, the amount of medical care utilized will be inefficient ex post because the price the worker faces is zero, and so when firms provide health insurance, workers will consume more than what is optimal creating a moral hazard welfare loss due to the worker's change in behavior. The results of my model show that although empirically we may observe firms investing more in health capital, there is no moral hazard welfare loss because this level of investment is optimal for firms. The result arises from the addition that the probability of getting sick is endogenous and the insurer sets the premium by rationally anticipating the health capital investment of the worker or the firm. The firm invests more because of the production externality and not having to compensate the worker for bearing risk.

Finally, the model has results for the nature of insurance contracts. In particular, when premiums are increasing in the level of health capital investment, the premium when the firm invests will be higher than when the worker invests. If insurers impose loading fees that depend on the number of workers, however, the premium may be lower when the firm invests. Additionally, under certain conditions the optimal health capital investment declines as the coinsurance rate increases, but this decline is faster if the firm invests in health capital.

While the model captures the health capital investment decision in a simple framework and yields several results that we observe empirically or can test, there are several possible extensions. First, as noted above, the firm could make the health capital investment by only paying a fraction of the premium instead of the the whole premium and the worker would pay the remaining amount. Second, the model could include taxes and examine the subsequent effect on the health capital investment decision. Modifying the model to include taxes and the number of employees will amplify the effect that the marginal cost of the health capital investment is lower when the firm makes the investment, but it is interesting that even without these additions, the moral hazard welfare loss is at least smaller or even nonexistent. Third, although this model captures shorter term health capital investments, employment tenure is generally longer. Allowing for a dynamic contract could yield more testable outcomes at the expense of complicating the model. Finally, it would be interesting to evaluate two policy proposals in the context of my model. In particular, I would like to explore how the optimal contracts change as well as when and by how much the firm invests in health capital if a law requires all firms to provide insurance or if a law requires all individuals to purchase insurance.

2.6 Appendix

Proof of Lemma 4.

Proof. The maximized profit in each case is equivalent at $\underline{\alpha}$ and $\overline{\alpha}$ with $\underline{\alpha} < \overline{\alpha}$; $\underline{n}$ and $\overline{n}$ with $\underline{n} < \overline{n}$; $\underline{n}$ and $\overline{K}$ with $\underline{K} < \overline{K}$; and $\underline{N}$ and $\overline{N}$ with $\underline{N} < \overline{N}$. The lemma states that firm profits are higher when the firm invests in health capital for all $\alpha < \underline{\alpha}$ or for all $\alpha > \overline{\alpha}$. Firm profits are higher when the worker invests in health capital for all $\underline{\alpha} < \alpha < \overline{\alpha}$. Firm profits are higher when the firm invests in health capital for all $n < \underline{n}$ and for all $n > \overline{n}$. Firm profits are higher when the worker invests in health capital for all $\underline{n} < n < \overline{n}$. Firm profits are higher when the firm invests in health capital for all $K < \underline{K}$ and for all $K > \overline{K}$. Firm profits are higher when the worker invests in health capital for all $\underline{K} < K < \overline{K}$. Firm profits are higher when the firm invests in health capital for all $N < \underline{N}$ and for all $N > \overline{N}$. Firm profits are higher when the worker invests in health capital for all $\underline{N} < N < \overline{N}$.

Using the envelope theorem, we have the following comparative statics for profits under the optimal wage and health capital investment contracts:

$\frac{\partial \pi^*_{worker}}{\partial \alpha} = p(h^*_{worker})\frac{\partial g}{\partial \alpha}$, $\frac{\partial \pi^*_{worker}}{\partial n} = p(h^*_{worker})\frac{\partial g}{\partial n}$, $\frac{\partial \pi^*_{worker}}{\partial N} = p(h^*_{worker})\frac{\partial g}{\partial N} - E_\ell[1 - p(h^*_{worker})]\lambda(\ell; h^*_{worker})f'(N)$, $\frac{\partial \pi^*_{worker}}{\partial K} = p(h^*_{worker})\frac{\partial g}{\partial K}$, $\frac{\partial \pi^*_{firm}}{\partial \alpha} = p(h^*_{firm})\frac{\partial g}{\partial \alpha}$, $\frac{\partial \pi^*_{firm}}{\partial n} = p(h^*_{firm})\frac{\partial g}{\partial n}$, $\frac{\partial \pi^*_{firm}}{\partial N} = p(h^*_{firm})\frac{\partial g}{\partial N} - E_\ell[1 - p(h^*_{firm})]\lambda(\ell; h^*_{firm})f'(N)$, $\frac{\partial \pi^*_{firm}}{\partial K} = p(h^*_{firm})\frac{\partial g}{\partial K}$. Define $\Delta p \equiv p(h^*_{firm}) - p(h^*_{worker})$. Then $\frac{\partial \pi^*_{firm}}{\partial \alpha} > \frac{\partial \pi^*_{worker}}{\partial \alpha}$, $\frac{\partial \pi^*_{firm}}{\partial n} > \frac{\partial \pi^*_{worker}}{\partial n}$, and $\frac{\partial \pi^*_{firm}}{\partial K} > \frac{\partial \pi^*_{worker}}{\partial K}$ whenever $\Delta p > 0$. Furthermore, $\frac{\partial \pi^*_{firm}}{\partial N} > \frac{\partial \pi^*_{worker}}{\partial N}$ whenever $\Delta p > \frac{\partial m/\partial N}{\partial g/\partial N}$. □

Chapter 3

Labor Risk Management and Firm Financing and Investment

3.1 Introduction

Firms use financial products to hedge business risks stemming from foreign currency fluctuations, interest rate changes, commodity price changes, or property damage. This list is not exhaustive, but it does represent examples that are now standard in introductory finance texts.[1] In this paper I explore when and how firms use health insurance to hedge human capital risk. Additionally, I examine the effect of different health benefit choices on firm financing and investment.

Firms use human capital in production. Human capital is a risky asset. In particular, workers can get sick. If firms have agreed to bear some of that risk, they absorb shocks associated with bad outcomes. The firm's role as an insurer may have an effect on other firm objectives. Firms can hedge this risk using insurance.

To understand a firm's hedging decision over human capital, I adapt the model of Froot et al. (1993). I describe how internal funds are uncertain because when workers get sick, firms make a payment to compensate workers for their loss. Firms can either bear the entire risk of this loss by paying out of assets or they can contract with an insurer and shift the risk outside of the firm. The firm has an opportunity to invest in a project and must raise external funds in excess of assets in place. Because firm value is concave and external finance is costly, firms benefit from hedging their human capital risk. I modify Froot et al. (1993) by considering the opportunity cost from hedging with insurance. With an opportunity cost to insurance, firms prefer to hedge only part of the risk.

I explore the predictions of the model regarding the types of firms that are more likely to hedge and the effect that cash flows have on investment for firms that hedge. Through a Freedom of Information Act request, I obtain data on health insurance

[1] See, for example, Berk and DeMarzo (2006) or Brealey et al. (2007).

funding and benefit arrangements from IRS Form 5500, which most firms must file if they offer benefits, and match these data to firm level data from Compustat from 1992 to 2005. In logit regressions of the hedging choice on proxies for concavity and costly external finance, I find evidence that smaller firms and firms with more investment opportunities are more likely to fully hedge. The results also indicate that firms facing a convex tax schedule are more likely to hedge. Additionally, I find that partial hedging does indeed decrease the effect that cash flow has on firm investment. This result is consistent with the Froot et al. (1993) framework, which suggests that hedging should mitigate this sensitivity.

The health hedging decision is a natural laboratory for exploring risk management because firms cannot use it for speculation, it is possible to distinguish full and partial hedging, and a large cross section of firms already engage in this practice. Furthermore, to my knowledge no previous research has looked at firms' health insurance decisions and the effect on firm operations, which is important because firms have choices that are most naturally analyzed from a finance perspective. Basically firms are deciding whether or not to bear the risk or pay to shift risk outside the firm.

I place the health insurance decision into the framework of Froot et al. (1993). In their model, firms with a concave investment opportunity face costly external finance. Initial wealth is uncertain, and firms have an incentive to hedge to reduce this uncertainty. I observe that labor is an input in firm production, and labor is either present and productive or not. Firms hedge human capital risk by purchasing health insurance. If the firm does not hedge, then when labor is "sick," the firm faces a health payment, and a firm may pay this amount out of its general assets. Benefits managers refer to this arrangement as "unfunded." In risk management terms, the firm is unhedged. Alternatively, firms can contract with an insurance company, in which case firms pay expected medical costs regardless of the worker's health. In risk management terms, the firm is hedged. Finally, the firm can choose to partially insure and pay partially out of the general assets of the firm. This arrangement is an example of a partial hedge.

Given this description of uncertain initial assets in place and the existing choices firms have to manage their risky human capital, it is appropriate to use the Froot et al. (1993) framework, which gives conditions under which it is optimal for the firm to hedge some part of the risk while leaving the rest exposed. In my use of the Froot et al. (1993) model, firms partially hedge when there is an opportunity cost to buying insurance. Without this opportunity cost, however, firms will still find it optimal to hedge as long as firm value is concave or external finance is costly. In light of this result, I explore how firm characteristics related to this concavity and costly external finance affect the hedging choice of the firm following Nance et al. (1993). In addition to exploring how firm characteristics affect the firm's hedging choice, I also explore how the hedging choice affects investment cash flow sensitivity.

Surveys of managers indicate firms hedge exposure to risk. Explanations of why firms may want to hedge include managerial risk aversion (Stulz (1984)), the convexity of firm value (Smith and Stulz (1985)), the costs of external finance, which give firms an incentive to use internal funds to pursue investment opportunities (Froot et al. (1993)), and earnings management (DeMarzo and Duffie (1995)). Although surveys of managers indicate hedging is important, the resources that firms devote to hedging are small relative to other firm expenditures and operations (Guay and Kothari (2003)). There is evidence that hedging can alleviate the sensitivity of investment to cash flow (Deshmukh and Vogt (2005)).

Although the previous literature focuses almost exclusively on standard financial products, there are many advantages to examining how firms hedge human capital risk. One advantage of looking at the health insurance decision is that one can observe how firms approach risk management using an asset that is clearly for hedging purposes rather than trading or speculative purposes.[2] Vickery (2008) shows how one can use a hedging framework to understand how small firms choose between fixed and variable rate loans.

Another advantage of the labor risk approach is that it captures a large cross section of firms from many different industries. Past research on hedging details case studies of particular firms or focuses on firms in narrow industries such as gold (Tufano (1996)), oil and gas (Jin and Jorion (2006)), or other commodities. In the past, research has relied on surveys of managers (Nance et al. (1993)) or special data sets (Deshmukh and Vogt (2005)). I use IRS Form 5500 data to get information on how firms manage health insurance. Since any firm covering more than 100 employees must file this form in order to receive the tax benefits of offering health insurance, I capture all firms with a welfare benefit program.

Additionally, the amount that firms spend on health insurance is fairly large. Insurance expenditures are on average 1% of assets and 3% of cash flows (and about 10% of cash flows for service industry firms). Although previous research has not explored how the choice of hedging affects firm value, Holland (2010a) shows that the level of health insurance expenditures does not affect firm value in an investment context, indicating that firms are in equilibrium with respect to health capital investment.

The rest of the paper proceeds as follows. In the next section, I draw on Froot et al. (1993) to show how a firm chooses the optimal human capital hedge with a choice between insurance contracts. In Section 3, I describe the data and outline my empirical strategy. In Section 4, I discuss empirical results. Section 5 concludes.

[2]While economists have traditionally asserted that firms use health insurance to compensate workers, it has been hard to show empirically that workers trade off wages for health insurance (Currie and Madrian (1999), Morrisey (2001)).

3.2 Model description

3.2.1 Model setup

Consider the following two period model of a firm. The firm has some assets in place, A, and has an investment opportunity that uses labor, L, and investment, I, to generate cash flows, $f(I, L)$. The production function f is increasing and concave so that $\frac{\partial f}{\partial I} > 0$ and $\frac{\partial^2 f}{\partial I^2} < 0$. I assume that human capital is valuable to the firm, so L is fixed. Labor receives a wage w. The net present value of the project is $f(I, L) - I - wL$.

The labor input is a random variable that depends on a verifiable human capital investment, n. An agent who has made a human capital investment can produce a maximum level of labor of $n > 0$. The probability that the labor realization is $n > 0$ is p, and with complementary probability it is zero; that is, $Pr(L = n) = p$ and $Pr(L = 0) = 1 - p$. The uncertainty of the labor realization reflects two possible states. Either the labor and hence the human capital is present and productive so that the realization of labor is $n > 0$. Or the worker is "sick," in which case the labor realization is $n = 0$.

The firm has to compensate labor for the loss.[3] The firm pays some amount h^s in the event that the labor realization is zero. That is, the firm makes a "self-funded" health payment when the worker is sick. This health payment comes out of the general assets of the firm. Hence, internal funds are uncertain. The firm's internal wealth, A, is a random variable. In particular, $A = d$ with probability p, and $A = d - h^s$ with complementary probability $1 - p$.

Instead of financing the health payment itself, the firm has the option of insuring this risk. In particular, the firm can pay h^i upfront to an insurance company. The insurance is the actually fair premium which is the expected payout or $h^i = (1-p)h^s$. The firm's internal wealth, $A = d - h^i$, is now constant across states.

If the firm makes the payment to the insurance company to hedge the labor risk, there is some opportunity cost, $G(\cdot)$, which is increasing in the amount of money forgone to the insurance company so that $G' > 0$. This opportunity cost could arise from various sources. For instance, the firm may be better at investing its funds than the insurance company. Another reason is that when firms choose not to hedge at all, they are exempt from many of the requirements of insurance companies under the ERISA exemptions.[4]

Finally, the firm also has the option of partially hedging its risk. For example, the share that the insurer pays in the event that labor is sick is α, and the share that the firm pays is $1 - \alpha$. In both states, the firm pays αh^i. If there is a shock to labor so that $L = 0$, the firm must pay $(1 - \alpha)h^s$ for labor to recover to $L = n$. If the firm

[3] In other words, the firm agrees to compensate him for any loss associated with a pre-specified health event.

[4] See Rosenbloom (2005) Chapter 43 for more details on these issues.

pays for labor to recover, then the internal funds are now $A = d - \alpha h^i - (1-\alpha)h^s$. If there is no shock to labor, then the internal funds are $A = d - \alpha h^i$. In both states, if the firm hedges, the opportunity cost is $G(\alpha h^i)$.

3.2.2 Adaptation of Froot, Scharfstein, and Stein (1993)

I adapt the model of Froot et al. (1993) to find the firm's optimal hedging decision. The firm has internal funds A and raises external capital $I - A$ to fund the project. The cost of raising funds externally is $C(\cdot)$. Assume that this cost is increasing in the amount the firms borrows, so that $C' > 0$. For simplicity, there is no discounting, so investors demand a return of zero. The value of the firm is then $V(A) = \max_I f(I, L) - I - wL - C(I - A) - G(\alpha h^i)$. Given the assumption that the production opportunity is concave and the cost of external finance is increasing in the amount borrowed, firm value is concave.

Following the analysis in Froot et al. (1993), the firm will prefer to hedge its uncertain first period income given a concave production function due to Jensen's inequality. Figure 3.1 illustrates the timing of events. At $t = 0$, the firm chooses the optimal labor hedge. At $t = 1$, the firm chooses the optimal investment, taking assets in place as given. At $t = 2$, the cash flows from the investment opportunity accrue.

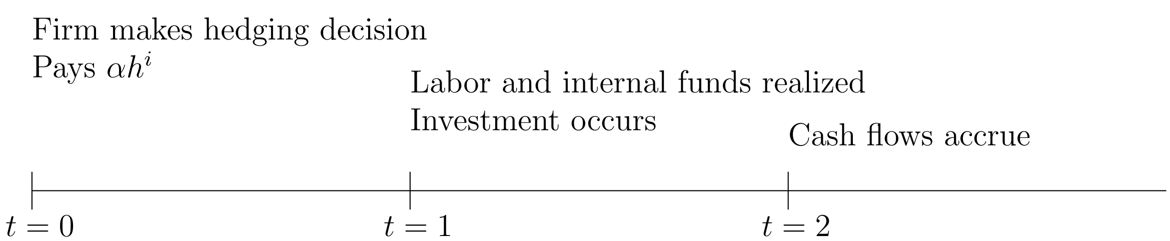

Figure 3.1: Model Timing

To find the optimal investment and hedging strategy, I solve the model backwards. At time t=1, the firm solves for optimal investment given internal funds. The firm's problem is:

$$\max_I f(I, L) - I - wL - C(I - A) - G(\alpha h^i), \tag{3.1}$$

which yields some optimal investment, I^*. The value of the firm is then $V(A) = f(I^*, L) - I^* - wL - C(I^* - A) - G(\alpha h^i)$.

The firm now finds the optimal hedge. At $t = 0$, the firm's problem is:

$$\max_\alpha E[V(A)]. \tag{3.2}$$

The first order condition is:

$$E[V'(A)\frac{dA}{d\alpha}] = 0. \tag{3.3}$$

Assuming that the opportunity cost is linear and the cost of external finance is globally convex, I can simplify the the above expression using a first order Taylor series approximation around $\alpha = 0$. The optimal hedge ratio is:

$$\alpha^* = 1 - \frac{G'(0)h^i}{E[V_{AA}]}. \tag{3.4}$$

As long as there is a positive and increasing opportunity cost to insuring workers, firms will prefer to partially hedge the labor risk.

3.3 Data and empirical predictions

Data on welfare benefits, including medical and dental benefits, is available from the IRS Form 5500, which all benefit plans with over 100 participants need to file every year.[5] This data is available by request from the Department of Labor. The filing requirements will limit the sample to larger firms, but the number of firms and the choice between hedging and not hedging are large relative to previous research.

I construct the sample by starting with the universe of Compustat firms between 1992 and 2005 and merging with any welfare benefit plan for which the benefit code indicates a health, dental, or vision plan.[6] Firms on average file two welfare plans, and welfare plans are aggregated at the firm level. Table 3.1 shows summary statistics for firms in the sample. The second column describes how I construct these variables. The third column reports the mean, and the fourth column shows the standard deviation. The fifth column shows the number of firm year observations for which the variable is available.

Panel A of Table 3.1 shows variables relevant to predicting the hedging decision. The model implies that firms with a concave production function or costly external finance are more likely to hedge. Costly external finance is very general in the framework above.[7] Smaller firms may find external finance more costly because they are more likely to face future credit constraints (Vickery (2008)) or because the costs of financial distress are lower for larger firms (Warner (1977)). If firms hedge because

[5]In some cases welfare plans with fewer than 100 participants are also required to file, but those plans are excluded from the current analysis.

[6]In general, welfare benefit plans can include "medical, dental, life insurance, apprenticeship and training, scholarship funds, severance pay, and disability" according the the Form 5500 Instructions. Some plans in the sample include more than one of the health benefits in addition to other welfare benefits such as life insurance or disability, for example.

[7]Froot et al. (1993) show how the costs arise from the costly state verification model of Gale and Hellwig (1985) and Townsend (1979), and Vickery (2008) illustrates how these costs arise in a moral hazard framework where both the borrower and lender are constrained.

external finance is costly, as the model predicts, then firms with lower free cash flows are also more likely to hedge. Firms with debt face the underinvestment problem (Myers (1977)) because bondholders capture all of the gains from investment opportunities. Firms with more investment opportunities or more debt may be more likely to hedge. I use research and development expenses as a proxy for investment opportunities following Nance et al. (1993). Convertible debt or preferred stock may mitigate the underinvestment problem and reduce some of the costs of external finance.

Froot et al. (1993) note that the concave production function arises naturally from decreasing returns to scale or a progressive corporate tax system. I focus on progressive taxation. Following Nance et al. (1993), the presence of investment tax credits or tax loss carry forwards indicate that firms may face convex tax schedules that either cause or intensify concave firm value due to taxes.

Panel B of Table 3.1 shows variables used in exploring the implications of the hedging decision for finance and investment. I follow Rauh (2006) in my construction of these variables. Capital expenditures, cash flow, and Tobin's Q are all Winsorized at the 1st and 99th percentile. The firms in this sample have lower cash flow and higher Tobin's Q relative to the summary statistics in Rauh (2006).

Table 3.2 shows summary statistics for variables of interest in the empirical tests of the hedging decision by type of benefit arrangement.[8] This research focuses on firms that use insurance, firms that pay out of general assets, also called unfunded, and firms that use a combination of the two arrangements. In terms of risk management, these benefit arrangements correspond to firms that fully hedge, firms that do not hedge, and firms that partially hedge, respectively. Under each benefit arrangement type, there are two columns. The first column reports summary statistics for firms that use the respective benefit arrangement for at least one plan. Firms may use another arrangement for other plans in this case. The second column shows summary statistics for firms that exclusively use the stated benefit arrangement. The bottom rows of Table 3.2 show the number of firm year observations that use these benefit arrangements and the number of firm year observations for which at least one of these plans is subject to a collective bargaining agreement.

The summary statistics in Table 3.2 suggest that larger firms are more likely to be unhedged or partially hedged. Firms with higher levels of research and development are more likely to fully hedge. The summary statistics for debt levels are ambiguous. Fully hedged firms have lower leverage ratios but higher interest coverage ratios compared to firms that are not fully hedge. Firms with more tax loss carry forwards are more likely to use insurance or a combination of insurance and unfunded, corresponding to fully or partially hedging, respectively. Fully hedged firms have lower capital intensity and lower free cash flows. Only a small number of firms have unfunded health benefit plans, either in combination with other types of funding or exclusively

[8] I use the benefit arrangement for the hedge decision because this data corresponds most closely to the adapted model. An alternative for the hedge decision is the funding arrangement, but the results are very similar since firms generally use the same funding and benefit arrangement.

unfunded. Most firm year observations are for plans that are partially insured and partially unfunded. Most firms with plans subject to collective bargaining agreements have partially funded benefit arrangements, but this is no clear trend. The results in this table are merely suggestive, however, and I next describe a test of how these variables affect the firm's hedging decision.

There are two main empirical predictions. The first addresses what kinds of firms hedge. The model predicts that firms are more likely to hedge if external finance is costly or if firm value is concave. I use size, research and development, free cash flows, debt, interest coverage ratio, convertible debt, and preferred stock as proxies for costly external finance. I use tax loss carry forwards and investment tax credits as indicators of whether firm value is concave. The regression framework is:

$$\begin{aligned} Pr(hedgechoice) = \Phi(&\text{size, R\&D, free cash flows, debt,} \\ &\text{tax loss carry forwards, investment tax credits, } \epsilon). \end{aligned} \tag{3.5}$$

The empirical strategy is to run limited dependent variable regressions to explore what kinds of firms are more likely to choose to hedge labor risk, partially hedge, or not hedge at all. I use a logistic regression.

The second empirical prediction addresses how hedging can mitigate investment cash flow sensitivities. In the absence of opportunity costs in Eq. (3.4), the firm that faces a concave production function or costly external finance prefers to fully hedge. When there is an opportunity cost, however, the firm is better off implementing a partial hedging strategy. This partial hedge should mitigate the sensitivity of investment to cash flow. The empirical strategy is to run investment cash flow sensitivity regressions to see if firms that hedge or partially hedge have less sensitivity. The regression of interest is:

$$I_{i,t} = \beta CF_{i,t} + \gamma Q_{i,t} + \theta_t + c_i + \eta_{i,t} \tag{3.6}$$

where $I_{i,t}$ is investment for firm i at time t, $CF_{i,t}$ is firm cash flows, $Q_{i,t}$ is a proxy for investment opportunities, θ_t is a year specific intercept term, c_i is a firm level fixed effect that captures unobserved heterogeneity, and $\eta_{i,t}$ is an error term. Previous research has employed some variation of this regression.[9] Firms that partially hedge should have a lower β. Deshmukh and Vogt (2005) employ this same strategy when testing the Froot et al. (1993) model in the context of conventional financial hedging tools.

[9] See, for example, Fazzari et al. (1988), Kaplan and Zingales (1997), Lamont (1997), and Rauh (2006).

3.4 Results

In this section I present and discuss results of the empirical predictions described above. I begin with the firm's decision to hedge its labor risk. I then examine the implications of this decision on the firm's investment cash flow sensitivity.

3.4.1 Hedging decision

The model described above predicts that a firm's decision to fully hedge labor risk, partially hedge labor risk, or not hedge labor risk depends on costly external finance or on the concavity of the production function, which may come through a progressive tax system. In this section I discuss results from an estimation of Eq. (3.5). The dependent variable in each regression depends on the benefit arrangement. For example, when the firm fully hedges with insurance, Eq. (3.5) models the probability that the hedge choice is to fully hedge.

Table 3.3 reports results from the logit estimation when at least one of the benefit arrangements is insured, unfunded, or partially insured and partially unfunded. The first two columns indicate firms that fully insure or fully hedge labor risk. The coefficient on size is negative and significant, indicating that smaller firms are more likely to fully hedge. The coefficient on research and development is positive, so firms with higher levels of research and development expenditures, and thus higher investment opportunities, are more likely to fully hedge. The coefficient on investment tax credit is positive and significant, which is consistent with the hypothesis that firms with concave value are more likely to hedge. The second specification includes free cash flow, capital intensity, and a collectively bargained dummy. The coefficient on free cash flow is negative and significant, which is consistent with the hypothesis that firms that face costly external finance are less likely to hedge with higher free cash flows.

The third and fourth columns of Table 3.3 show firms that are unfunded or unhedged. Most of the coefficients are not statistically significant, which may be due to the low number of observations for unfunded plans as shown in Table 3.2. The results here for firms that do not hedge labor risk are the converse of results for firms that fully hedge as one would expect. Large firms are more likely to remain unhedged. Interestingly, in the second specification, firms that have benefit plans that are subject to collective bargaining agreements are more likely to remain unhedged.

The fifth and sixth columns indicate firms that partially hedge. These firms have benefit arrangements that are partially insured and partially funded from general assets, which is a partial hedge. The coefficient on size is positive and significant, indicating the larger firms that might face less costly external finance may still hedge. The coefficient on research and development is also negative and significant, suggesting that firms with fewer investment opportunities are more likely to partially hedge. The coefficient on investment tax credit is negative and significant, which is consistent with the hypothesis that firms with concave value functions are less likely to leave assets in place unhedged.

Thus far the results examine the choice of a particulary hedging strategy relative to any other hedging hedging decision, but because in each case the converse includes more than one alternative, the conclusions are informative but not precise. To better test the hedging hypothesis, the last two columns of Table 3.3 show the probability of fully hedging exclusively. Once again, the coefficient on size is negative and significant and the coefficient on research and development expenditures is positive and significant. To interpret the coefficients, one can exponentiate the result to find the odds ratio. For example, if the size of the firm increases by one unit, or about $400 million at the sample average, the odds of fully hedging relative to not fully hedging decreases by 0.8. Increasing research and development expenditures by one unit increases the odds of fully hedging by 10.8.

In the second specification, there is evidence that firms with more debt are less likely to fully hedge, which is inconsistent with the hypothesis that firms facing costly external finance are more likely to hedge – as long as debt is a proxy for costly external finance. This contradictory finding, however, is fairly weak. Finally, the coefficient on free cash flow is again negative and significant.

In sum, results from the logit estimation of Eq. (3.5) are generally consistent with the predictions from the above model adapted from Froot et al. (1993). Firms that are smaller and have more investment opportunities as measured by research and development expenditures are more likely to fully hedge their labor risk. These variables serve as proxies for the costly external finance of the model. There is some additional evidence that firms facing a convex tax schedule are also more likely to fully hedge labor risk.

Up to this point, the results arise from an exploration of firms binary hedging decisions. Inevitably in these coarse cuts, some information is lost. In effect, all previous studies that have looked at firms that hedge are grouping full and partial hedging into one category, but one of the unique features of this data set is that it is possible to more carefully examine firms choices between full, partial, and no hedging. To explore this decision, I employ a multinomial logit which is used for unordered choices. Table 3.4 shows results for the choice of no hedging, partially hedging, and fully hedging labor risk using the same explanatory variables outlined above. In each specification the base case is partial hedging, the left column shows full hedging and the right column shows no hedging. In each case, the coefficients are log odds ratios relative to the base case.

In the first specification, the coefficient on size is negative and significant in both cases. Relative to firms that partially hedge, firms that fully hedge are larger, again indicating that smaller firms are more likely to fully hedge. Firms that fully hedge, however, are also larger, which is not consistent with the hypothesis that firms that find external finance more costly hedge. Firms that spend more on research and development and hence have more investment opportunities are more likely to fully hedge relative to partially hedging firms, but there is no relationship between research and development and no hedging. In both cases, the coefficient on investment tax credit, a proxy for whether firm value is convex, is positive and statistically significant. This result is consistent for firms that fully hedge, but it is puzzling for firms that do not hedge relative to firms that partially hedge because it appears that firms that do not hedge have concave production functions.

The second specification includes free cash flow, capital intensity, and a collective bargaining dummy. Results from the first specification are robust to the inclusion of these new variables. Relative to firms that partially hedge, firms with lower free cash flow are more likely to fully hedge, which is consistent with the hypothesis that firms facing costly external finance are more likely to fully hedge.

Overall the results in Table 3.4 indicate that firms that face costly external finance and have concave production functions fully hedge. The results for firms that do not hedge relative to firms that partially do not conform with traditional hypotheses for hedging. In short, why firms choose to remain unhedged versus partially hedge is still a bit of a puzzle. These results do show that one has to interpret with caution other papers that can only examine no hedging versus partial and fully hedged firms grouped together.

3.4.2 Investment sensitivity

I now turn to the model's implication for the role of hedging in the firm's financing and investment decision. In short, the model implies that for firms that face costs to external finance, hedging should mitigate the affect of cash flow on investment. Furthermore, the version of the model presented above indicates that when firms face an opportunity cost as well, firms are better off by partially hedging. I explore these predictions by estimating Eq. (3.6) for firms that fully hedge ($\alpha = 1$), for firms that remain unhedged ($\alpha = 0$), and for firms that partially hedge ($0 < \alpha < 1$).

Table 3.5 shows results from estimating Eq. (3.6). The first column shows estimates for firms using full hedging; that is, the insurance only benefit arrangement. The second column shows estimates for firms using either partial hedging or not hedging at all. In both cases, the coefficient on cash flow is positive and significant. The magnitudes are comparable to other studies that find evidence of sensitivity of investment to cash flow. Comparing the coefficient on cash flow in each regression reveals that the effect of cash flow on investment is lower for firms that partially hedge labor risk. A full hedge can mitigate investment cash flow sensitivities, which is consistent with the model.

While the results in the first two columns suggest that the effect of cash flow on investment is lower for firms that fully hedge, they do not indicate if these results are statistically significant. The third column of Table 3.5 shows estimates from estimating a version of Eq. (3.6) that includes a dummy variable that equals one if firms fully hedge interacted with the cash flow variable. The results confirm the findings from Table 3.5. The coefficient on cash flow is positive and significant, but the coefficient on cash flow interacted with an indicator for firms that fully hedge is negative and statistically significant. In short, firms that fully hedge labor risk reduce the sensitivity of investment to cash flow by 2.5%.

Finally, the last column of Table 3.5 reports the investment sensitivity for firms that both partially hedge and fully hedge relative to firms that do not hedge at all by interacting the cash flow variable with relevant hedging indicators. The coefficient on cash flow is positive and statistically significant and larger in magnitude than when unhedged firms were grouped together with partially unhedged firms. The coefficient on cash flow interacted with the partial hedging indicator is negative and statistically significant, the coefficient on cash flow interacted with the full hedging indicator is negative and statistically significant and larger in absolute value, suggesting that firms that fully hedge have even lower investment cash flow sensitivity.

As a robustness check, Table 3.6 shows results when I limit the sample to firms that have data for at least five years following Lewellen and Lewellen (2009) who claim that the problems with time series data and avoid problems due to survivorship that might affect regressions with firm level fixed effects.[10] I choose to always include firm level fixed effects rather than use a Fama and MacBeth (1973) procedure because cash flow is of course an endogenous variable and, while certainly not eliminating the endogeneity, including fixed effects might be one way to mitigate this problem barring good instruments. The results in Table 3.6 are qualitatively very similar to the results reported in the main regressions examining the effect of firms' labor risk hedging strategy on investment cash flow sensitivities. In sum, a partial hedge as well as fully hedging can mitigate investment cash flow sensitivities, which is consistent with the model.

3.5 Conclusion

The purpose of this research is to explore how firms hedge human capital risk using health insurance options. Firms can essentially choose to fully hedge using insurance, remain unhedged by relying on the general assets of the firm, or partially hedge using some combination of these two benefit arrangements. I adapted the model of Froot et al. (1993) to account for the firm's human capital risk and show that if external finance is costly or if the production function is concave, then firms will want to hedge. Additionally, I show that if there is an opportunity cost to using full insurance, then firms are better off by partially hedging. Using IRS Form 5500 data, which all firms must file to receive tax advantages from providing welfare benefits, I test two main predictions of the model. First, firms that find external finance costly

[10] Additionally, Angrist and Pischke (2009) note that differences in coefficient estimates when regressions include fixed effects may be due to sample selection issues rather than unobserved heterogeneity.

and firms facing a convex tax schedule are more likely to hedge. Second, investment by firms that partially hedge is less sensitive to cash flow. Empirical tests confirm both of these hypotheses.

This paper contributes to existing research on risk management in several ways. It examines management of human capital risk rather than conventional financial risks like commodities, interest rates, or foreign exchange. This examination is important because firms already devote significant resources to health benefit plans and because corporate finance research, with some exceptions, has not fully focused on firms' decisions over human capital. The firm's hedging decision over health insurance is also unique because it is for hedging purposes only and does not have a speculative component. Finally, this research sheds light not just on the firm's decision to hedge, but whether the firm decides to leave some of the risk unhedged. Previous research has not explored this distinction.

Table 3.1: **Summary statistics for firm characteristics.**

The table shows summary statistics for firm characteristics. Observations are firm-year observations. The sample is from 1992 to 2005. Financial data is from Compustat. Welfare benefit plan data is from IRS Form 5500.

Variable	Description	Mean	Standard Deviation	Observations
Panel A: Hedging Decision				
Size	Log of market value of equity	5.523	2.169	39,456
Research and Development	Research and development expenses scaled by total assets	0.048	0.111	39,593
Leverage	Long-term debt scaled by book value of equity	0.652	26.683	39,489
Interest Coverage	Interest expense scaled by income before extraordinary items	0.830	76.812	36,801
Convertible Debt	Convertible debt and preferred stock scaled by total assets	0.030	0.124	39,183
Preferred Stock	Preferred stock scaled total assets	0.013	0.097	39,591
Tax Loss Carry Forwards	Unused net operating loss carry forward scaled by total assets	0.358	5.032	25,653
Investment Tax Credit	Investment tax credit scaled by total assets	0.001	0.010	24,634
Free Cash Flow	Operating profits scaled by total assets	0.087	0.184	39,589
Capital Intensity	Capital stock scaled by total assets	0.279	0.226	39,338
Panel B: Investment-Cash Flow				
Capital Expenditures	Capital expenditures scaled by total assets at t-1	0.065	0.067	39,593
Cash Flow	Income before extraordinary items plus depreciation and amortization scaled by total assets at t-1	0.058	0.157	39,593
Tobins Q	(Total assets - book value of equity - deferred taxes + market value of equity)/(Total assets at t-1)	1.918	1.395	39,593

Table 3.2: **Summary statistics for firm characteristics by benefit arrangement.**

The table shows summary statistics for firm characteristics. For each variable, the first row shows the mean, and the second row shows the standard deviation. For each benefit arrangement, the first column shows summary statistics for all firms in which at least one plan uses that benefit arrangement. The second column shows summary statistics for firms that exclusively use that benefit arrangement. The bottom row reports the number of firm year observations for which at least one plan using that benefit arrangement is subject to a collective bargaining agreement. The sample is from 1992 to 2005.

	Funding Arrangement					
	Unfunded		Insurance		Partial	
Size	5.940	5.423	4.986	4.856	5.783	5.741
	2.329	1.881	1.976	1.867	1.925	1.908
Research and Development	0.026	0.027	0.048	0.050	0.028	0.028
	0.054	0.057	0.098	0.099	0.060	0.060
Leverage	0.583	0.484	0.139	0.109	0.569	0.564
	2.903	3.221	15.292	15.633	6.772	6.861
Interest Coverage	0.027	0.032	0.043	0.044	0.032	0.033
	0.076	0.081	0.188	0.191	0.104	0.105
Convertible Debt	0.009	0.010	0.019	0.020	0.011	0.012
	0.054	0.058	0.140	0.143	0.093	0.095
Preferred Stock	0.304	0.307	0.228	0.226	0.275	0.273
	0.249	0.260	0.209	0.208	0.218	0.219
Tax Loss Carry Forwards	0.150	0.170	0.415	0.431	0.192	0.197
	0.465	0.504	1.454	1.483	0.869	0.880
Investment Tax Credit	0.002	0.002	0.002	0.002	0.0005	0.0005
	0.017	0.019	0.021	0.021	0.002	0.002
Free Cash Flow	0.121	0.119	0.077	0.074	0.125	0.124
	0.096	0.102	0.187	0.190	0.122	0.123
Capital Intensity	0.925	0.924	0.134	0.096	0.568	0.565
	5.617	6.179	7.981	8.134	9.368	9.491
Number of Observations	320	253	1,843	1,763	2,631	2,562
Collectively Bargained	51	17	111	62	184	151

Table 3.3: **Hedging Decision.**
This table shows results from a logit regression. The dependent variable is the firm's labor hedge choice. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively. The sample is from 1992 to 2005.

	Benefit Arrangement							
	Insurance		Unfunded		Partial		Full Hedge	
Size	-0.207***	-0.196***	0.094***	0.082***	0.113***	0.104***	-0.229***	-0.219***
	(0.016)	(0.017)	(0.030)	(0.031)	(0.014)	(0.015)	(0.017)	(0.018)
Research and Development	3.254***	2.316***	-1.548	-1.041	-1.637***	-1.304***	3.199***	2.386***
	(0.460)	(0.476)	(1.052)	(1.074)	(0.451)	(0.476)	(0.475)	(0.491)
Leverage	-0.003	-0.003	0.001	0.001	0.003	0.003	-0.003	-0.003
	(0.003)	(0.003)	(0.006)	(0.007)	(0.004)	(0.004)	(0.003)	(0.003)
Interest Coverage	-0.003	-0.007	0.004	0.006	0.002	0.005	-0.004	-0.008***
	(0.003)	(0.004)	(0.005)	(0.005)	(0.003)	(0.004)	(0.003)	(0.004)
Convertible Debt	0.234	0.146	-0.249	-0.165	0.240	0.302	0.173	0.091
	(0.287)	(0.285)	(0.686)	(0.687)	(0.285)	(0.292)	(0.293)	(0.293)
Preferred Stock	-0.141	-0.100	-0.071	-0.122	-0.331	-0.349	-0.022	-0.004
	(0.366)	(0.360)	(0.952)	(0.952)	(0.373)	(0.385)	(0.370)	(0.368)
Tax Loss Carry Forwards	0.039	0.007	-0.076	-0.105	-0.027	0.005	0.025	-0.004
	(0.035)	(0.034)	(0.109)	(0.118)	(0.033)	(0.033)	(0.035)	(0.035)
Investment Tax Credit	10.517*	8.982	2.075	1.366	-22.424**	-20.880**	8.485	7.359
	(6.272)	(6.011)	(2.487)	(2.488)	(9.269)	(9.270)	(5.729)	(5.274)
Free Cash Flow		-0.769***		-0.499		0.848***		-0.651**
		(0.252)		(0.540)		(0.244)		(0.260)
Capital Intensity		-0.988***		0.545**		0.072		-0.809***
		(0.151)		(0.256)		(0.131)		(0.158)
Collectively Bargained		0.061		0.820***		-0.256**		-0.328**
		(0.122)		(0.167)		(0.109)		(0.157)
Pseudo R^2	0.05	0.06	0.01	0.02	0.02	0.02	0.05	0.06
Number of Observations	5,288	5,246	5,288	5,246	5,288	5,246	4,615	4,578

Table 3.4: **Hedging Decision: Multinomial Logit.**

This table shows results from a multinomial logit regression. The dependent variable is the firm's labor hedge choice. The base case is partially hedged. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively. The sample is from 1992 to 2005.

	(1)		(2)	
	Full	No	Full	No
Size	-0.238***	-0.104***	-0.229***	-0.101***
	(0.018)	(0.036)	(0.018)	(0.038)
Research and Development	2.849***	-0.610	2.108***	-0.084
	(0.496)	(1.208)	(0.514)	(1.230)
Leverage	-0.003	-0.002	-0.003	-0.001
	(0.003)	(0.006)	(0.003)	(0.007)
Interest Coverage	-0.004	0.002	-0.007	0.003
	(0.004)	(0.005)	(0.004)	(0.006)
Convertible Debt	0.136	0.179	0.061	0.193
	(0.301)	(0.736)	(0.301)	(0.745)
Preferred Stock	-0.016	-0.523	-0.005	-0.578
	(0.376)	(1.128)	(0.375)	(1.130)
Tax Loss Carry Forwards	0.019	-0.118	-0.009	-0.129
	(0.035)	(0.128)	(0.035)	(0.133)
Investment Tax Credit	28.184***	28.892***	26.158**	26.589**
	(10.226)	(10.495)	(10.130)	(10.403)
Free Cash Flow			-0.652**	-0.334
			(0.265)	(0.613)
Capital Intensity			-0.746***	0.654**
			(0.160)	(0.285)
Collectively Bargained			-0.310*	0.103
			(0.159)	(0.268)
R^2	0.04		0.05	
Number of Observations	4,615		4,578	

Table 3.5: **Investment Cash Flow Sensitivity.**
This table shows results from a regression of investment on cash flows by type of labor hedge. For each benefit arrangement, the first column shows summary statistics for all firms in which at least one plan uses that benefit arrangement. The second column shows summary statistics for firms that exclusively use that benefit arrangement. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively. The sample is from 1992 to 2005.

	Full Hedge	No/Partial Hedge	All Firms	
Cash Flow	0.032***	0.069***	0.066***	0.114***
	(0.007)	(0.007)	(0.006)	(0.013)
Cash Flow * Hedge			-0.025***	
			(0.007)	
Cash Flow * Partial Hedge				-0.053***
				(0.013)
Cash Flow * Full Hedge				-0.073***
				(0.013)
Tobin's Q	0.009***	0.011***	0.009***	0.010***
	(0.001)	(0.001)	(0.000)	(0.000)
Adjusted R^2	0.12	0.17	0.16	0.16
Number of Observations	4,667	6,840	11,507	13,010

Table 3.6: **Investment Cash Flow Sensitivity - At Least 5 Years of Data.** This table shows results from a regression of investment on cash flows by type of labor hedge. For each funding arrangement, the first column shows summary statistics for all firms in which at least one plan uses that funding arrangement. The second column shows summary statistics for firms that exclusively use that funding arrangement. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively. The sample is from 1992 to 2005.

	Full Hedge	No/Partial Hedge	All Firms	
Cash Flow	0.036***	0.069***	0.068***	0.113***
	(0.007)	(0.007)	(0.006)	(0.013)
Cash Flow * Hedge			-0.024***	
			(0.008)	
Cash Flow * Partial Hedge				-0.051***
				(0.013)
Cash Flow * Full Hedge				-0.070***
				(0.014)
Tobin's Q	0.009***	0.011***	0.010***	0.010***
	(0.001)	(0.001)	(0.000)	(0.000)
Adjusted R^2	0.12	0.17	0.16	0.17
Number of Observations	4,031	6,147	10,178	11,576

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