The Complex Relationship Between Health Care Reform and Innovation

Darius Lakdawalla, Anup Malani, and Julian Reif

INTRODUCTION

Life expectancy has increased dramatically over the past century for individuals of all ages. For example, life expectancy at birth was 47.3 years in 1900. Today it is 78.1 years (Arias 2012). Although more difficult to measure, there is substantial evidence that the quality of life has increased also. Childhood is no longer plagued by dangerous infectious diseases such as measles, mumps and rubella. In 1980, only 5% of marathon runners were over the age of 50. Today this figure has more than doubled (Cutler 2005).

The value of this health increase is enormous. Murphy and Topel (2006) estimate that the cumulative gains in life expectancy since 1900 are worth $1.2 million (2004 dollars) to an individual alive today, with increases in longevity over the past forty years alone adding about $3.2 trillion per year to national wealth. They also offer suggestive evidence that the increase in quality of life may be as valuable as the increase in life expectancy.

Although some of this increase is attributable to changes in lifestyles (e.g., a decline in smoking), much is due to medical innovation (Cutler, Kadiyala et al. 2003; Cutler 2007; Lichtenberg 2007). Vaccines have rid us of measles, mumps and rubella. In 1950, patients who suffered a heart attack were treated with bed rest. Today, they are treated with an assortment of drugs and, if necessary, bypass surgery. Death rates for cardiovascular disease have decreased by more than 60% over the past fifty years (National Heart Lung and Blood Institute 2012).

None of this is free, of course. Health care expenditure in the United States has grown rapidly, exceeding the annual growth in GDP by 2.5% since 1960. In 2011, the United States spent about 17.9% of its GDP on health care, or about $8,700 per person (Center for Medicare and Medicaid Services 2013).

This rise has strained private and public budgets and is of central importance in the current national debate over health reform.

Convention wisdom among health economists is that the primary driver of cost growth is medical innovation.[1] Newhouse (1992) argues that innovation is the only factor that can explain the vast increase in medical costs since 1950. Similarly, Cutler (2005) argues that medical innovation, though it has generated a large increase in life expectancy, is responsible for the recent rapid growth in costs.

There is substantial heterogeneity in both the costs and benefits of different innovations, however, so one must be careful not to overgeneralize. Some innovations, like using aspirin to treat acute myocardial infraction (MI), cost almost nothing while others, like the invention of antiretrovirals for HIV/AIDS, cost $15,000 per year. Innovations that are both cheap and effective—like aspirin treatment for MI—are clearly valuable. By contrast, expensive innovations that contribute to rising costs but offer little benefit may not increase social welfare. Vertebroplasty, for example, is an expensive procedure that injects cement into the spine to stabilize vertebrae but has been shown to be ineffective (Chandra and Skinner 2012). Many innovations, of course, fall in a category in-between these two extremes. Antiretrovirals are costly but highly effective. Linkages between treatments complicate valuation. A cheap and effective diagnostic test for a disease that is treated with a cost-ineffective treatment may actually increase costs with little to no health benefit.

The ideal health care system would accomplish multiple objectives. It would provide consumers quality health care at reasonable prices. It would provide incentives for innovation that improve the

[1] Of course, there are many other contributors to cost growth. Health care is a normal good so one expects demand to increase as a country becomes wealthier. The U.S. population is aging rapidly, which means a larger portion of the population is elderly and in need of expensive medical care. The expansion of health insurance coverage to a majority of the population increases the accessibility of medical care but may also encourage inefficient spending if consumers do not face the full marginal price of their health care. Physicians may recommend treatments based on profitability rather than patient value, or may overprovide (practice "defensive medicine") in order to combat medical malpractice lawsuits. Newhouse (1992) argues that the first three factors cannot explain much of the growth in health care costs between 1950 and 1990. Mello et al. (2010) suggests medical malpractice premiums are a small percentage of total health care costs.

quality of care and thus health over time. Finally, an ideal system would insulate risk-averse individuals from either health shocks or their financial consequences. The task of health care reform is to inch our current system towards the ideal system. However, the complexity of markets for medical innovation, medical care, and financing – and the connections between them – makes it challenging to achieve all the ends of an ideal system. Some worthy objectives may counteract others, often in surprising ways.

In this chapter we examine some of the interesting and important ways in which health care reform, particularly expansion of health insurance, affects innovation. We focus on three particular linkages between insurance markets and medical innovation.

First, we examine how expansion of health insurance directly and indirectly affects the demand and supply of medical innovation. The expansion of insurance lowers the cost of financing medical care, increasing demand for that care. This demand spills over into demand for future medical innovation (Acemoglu and Linn 2004; Finkelstein 2004; Blume-Kohout and Sood 2008; de Mouzon, Dubois et al. 2011; Clemens 2012). At the same time, the expansion of insurance weakens the incentives for patients to enroll in clinical trials, making it more costly for drug and device companies to develop innovations and reducing the profits they earn from those innovations (Malani and Philipson 2013). The net effects are uncertain. Yet, because medical research in one country has value for all countries, the demand and supply effects from U.S. health care reform can have spillover impacts on the rest of the world (Lakdawalla, Goldman et al. 2009).

Second, we examine how health insurance can cure an unfortunate side effect of using patents to encourage medical innovation: high prices that make medical care unaffordable for many. Health insurance has this benefit not because it bargains down prices from medical providers but because of the way in which it separates the price that pays providers for their care and the price it charges consumers for care (Lakdawalla and Sood 2013). Providers get a high (perhaps monopoly) price consistent with their negotiating power in the market, but consumers are charged a low copayment that

may be close to or sometimes even below marginal cost. The result is both strong incentives to innovate and little deadweight loss due to under-use of medical care.

Third, we examine how innovation both promotes health insurance and reduces demand for such insurance (Lakdawalla, Malani et al. 2013). It is health care, not health insurance, that reduces the negative consequences of sickness on health. Health insurance merely pays for health care, which would not exist but for innovation. Thus, innovation makes health insurance possible. Yet, if the price of health care is lowered, individuals face less financial uncertainty for sickness, reducing the demand for health insurance. Thus medical innovation, depending on how it is priced, can be a substitute for health insurance in the eyes of a risk-averse consumer.

In the conclusion we argue that the complexity and uncertainty of the relationship between insurance and innovation puts a premium on ability to experiment with alternative forms of health care reform.

I: INSURANCE EXPANSIONS AFFECTS BOTH THE QUANTITY AND NATURE OF R&D

A: Direct demand-side effects

Profits drive innovation. Firms are more likely to invest in research and development if the rewards are large. In other words, the larger the potential market, the larger the investment. Clear evidence in favor of this hypothesis comes from a counterexample: Africa. Malaria and tuberculosis kill millions of people every year in Africa, yet companies invest little in finding cures for these diseases. The reason is simple. Africa is a poor continent and cannot afford to pay much for treatment. Investing large sums of money into research for these diseases is unlikely to generate profits for firms.

The link between innovation and market size is the subject of numerous papers. Acemoglu and Linn (2004) show that a significant number of new drugs for the elderly were invented in response to the aging of the baby boomers in the United States. They estimate that a one percent increase in the

size of the potential market leads to a four percent increase in the entry of new drugs. De Mouzon et al. (2011) examine the effect of the aging population on drug innovation in a global context. They also find a significant effect of potential market size on drug entry, although their estimate is an order of magnitude smaller than the one from Acemoglu and Linn.

Whereas demographic changes like the aging of the population affect market size for elderly drugs by mechanically increasing the number of potential customers, insurance expansions, which decrease the marginal price of medical care, affect market size by increasing the quantity demanded per capita. Blume-Kohout and Sood (2009) show that the enactment of Medicare Part D is associated with a significant increase in investment in drugs for the elderly. Similarly, Finkelstein (2004) finds that public policies that encourage vaccinations induce a 2.5-fold increase in clinical trials for potential new vaccines.

These findings imply that reducing insurance payment rates, although a politically expedient way to cut costs, may have adverse long-term consequences by depressing the incentives to innovate. Medicare currently reimburses providers below the levels paid by the typical private insurer, and Medicaid reimburses at even lower rates. The Independent Payment Advisory Board (IPAB), created by the Affordable Care Act, is expected to reduce Medicare spending by $2.4 billion over the next ten years (Congressional Budget Office 2011). The ACA prohibits the IPAB from rationing care, restricting benefits, raising premiums, or changing eligibility criteria, which means that reducing payment rates is the only feasible method for reducing spending. All of these reductions are expected to reduce firm profits and investment.

Changes in market size have long-run effects not just on the United States but also on the world because innovation is a public good. Drugs invented for the U.S. market are eventually sold in foreign markets as well. It is well known that pharmaceutical firms earn substantially more revenue per capita in the United States than in Europe, where price controls lower the price paid to manufacturers (Danzon

and Furukawa 2006). Increases in spending benefit both the U.S. and Europe; conversely, American spending cuts may have adverse international effects. Lakdawalla et al. (2009) estimate that U.S. price controls that lower firm revenue by 20 percent would reduce life expectancy by 2.8 percent for *both* the U.S. and Europe in the long run. Although the cuts generate some financial savings, the authors estimate that the costs of decreased innovation significantly outweigh the fiscal benefits.

Although the effect of insurance on market size is important, Lakdawalla et al. (2013) note that this is not the only way insurance encourages innovation. They show that if consumers are risk averse then insurance also raises the value of innovation by allowing them to transfer financial resources across different health states. This generates an increase in demand that reinforces the other effects previously discussed. One way of framing this issue is to note that insurance makes consumers better off and thus serves like an increase in wealth. This encourages further use of medical technology, and consequently raises the returns earned by innovators on their discoveries.

For example, consider an individual who exists in one of two possible states, "healthy" or "sick". If she is sick then she purchases a treatment that returns her to the healthy state. For simplicity, suppose the good is priced so high that it generates no consumer surplus in the conventional sense. Even so, it is valuable to a risk-averse consumer because it allows her to purchase access to the treatment prior to knowing whether she will be sick or not. The technology makes the individual relatively better off in the "sick" state by improving health. Since financial payment for the technology is equal across states, this increases the value of the sick state overall. By the usual logic of insurance, compressing the difference between a "bad" state and a "good" state is valuable to a risk-averse consumer.

Medical insurance affects not only the amount of innovation but also the types of innovation. Policies that include catastrophic coverage (i.e., coverage for severe illnesses that require prolonged hospitalization) encourage expensive, intensive procedures like ICU technology because consumers pay

little or nothing for them. Similarly, policies with generous "first-dollar" coverage encourage investment in routine-care treatments like vaccines.

Fee-for-service (FFS) is the dominant payment schedule used by insurers in the United States. Understanding how insurance has affected innovation requires understanding the incentive effects of FFS, which reimburses providers for each service they perform. It is widely blamed for increasing health care costs by providing incentives for physicians to provide more treatments regardless of the final value to the patient. Cutler (2005) argues that it also encourages the development of intensive procedures like heart bypasses that create generous reimbursements for providers and manufacturers. Some of these procedures are valuable but others are ineffective for at least some patients. Physicians will generally use the procedures irrespective of their cost so long as they provide at least a marginal health improvement for some patients.

B: Indirect effects through subject markets

The previous section described how insurance expansions increase innovation by increasing the market size or increasing the value of innovation. In other words, insurance expansions increase the demand for innovation. Health insurance also has a second, subtler effect on innovation through the market for human subjects.

Drug regulators require that drug and device manufacturers conduct clinical trials to demonstrate their products are safe and effective before allowing these manufacturers to sell their products. The medical product market is unique in that potential participants in these clinical trials are also potential consumers of already-approved, competing products. Moreover, patients who participate in clinical trials cannot also consume a competing product.

Malani and Philipson's (2013) insight is that, when deciding whether to enroll in a clinical trial, patients compare the benefits and costs of enrolling in a trial to the benefits and costs of consuming an already-approved product – also called conventional care. The merits of the trial are the expected

medical benefits from the experimental treatment (and perhaps free medical care). The merits of the approved-products are the health benefits of conventional care net of the costs of purchasing conventional care. Anything that improves the merits of conventional care lowers the incentive of patients to enroll in trials. Malani and Philipson call this the "subject market effect."

The authors provide evidence for this effect by examining clinical trial recruitment before and after the regulatory approval of highly active antiretroviral therapy (HAART), a treatment for AIDS. As soon as it was approved HAART became the conventional treatment for AIDS because it was so effective at reversing that disease.[2] Because HAART constituted a dramatic improvement in the quality of conventional care, it reduced HIV-positive patients' incentives to enroll in clinical trials.[3] Figure 1 shows that this innovative treatment, which became available in 1996, is associated with a steep decline in the fraction of HIV positive patients that enrolled in clinical trials for new AIDS treatments. The authors estimate that HAART reduced participation by 50-75% and that this reduction was primarily driven by exits from existing trials rather than a reduction in the demand for new participants

[2] HAART did not cure HIV. It reduced the replication of the HIV virus so that patients did not experience a full collapse of their immune system, a fatal condition known as AIDS.

[3] Improvements in the quality of conventional care do not always reduce enrollment in all clinical trials. Medical innovation in one market may positively affect innovation in another market. For example, innovation in the treatment of heart disease will result in a larger population facing co-morbid risks such as Alzheimer's disease. This increases both the demand for Alzheimer's research and the supply of available clinical trial participants for that research. As a result, while innovation may be self-limiting within a disease, it may increase the returns to innovation in other diseases.

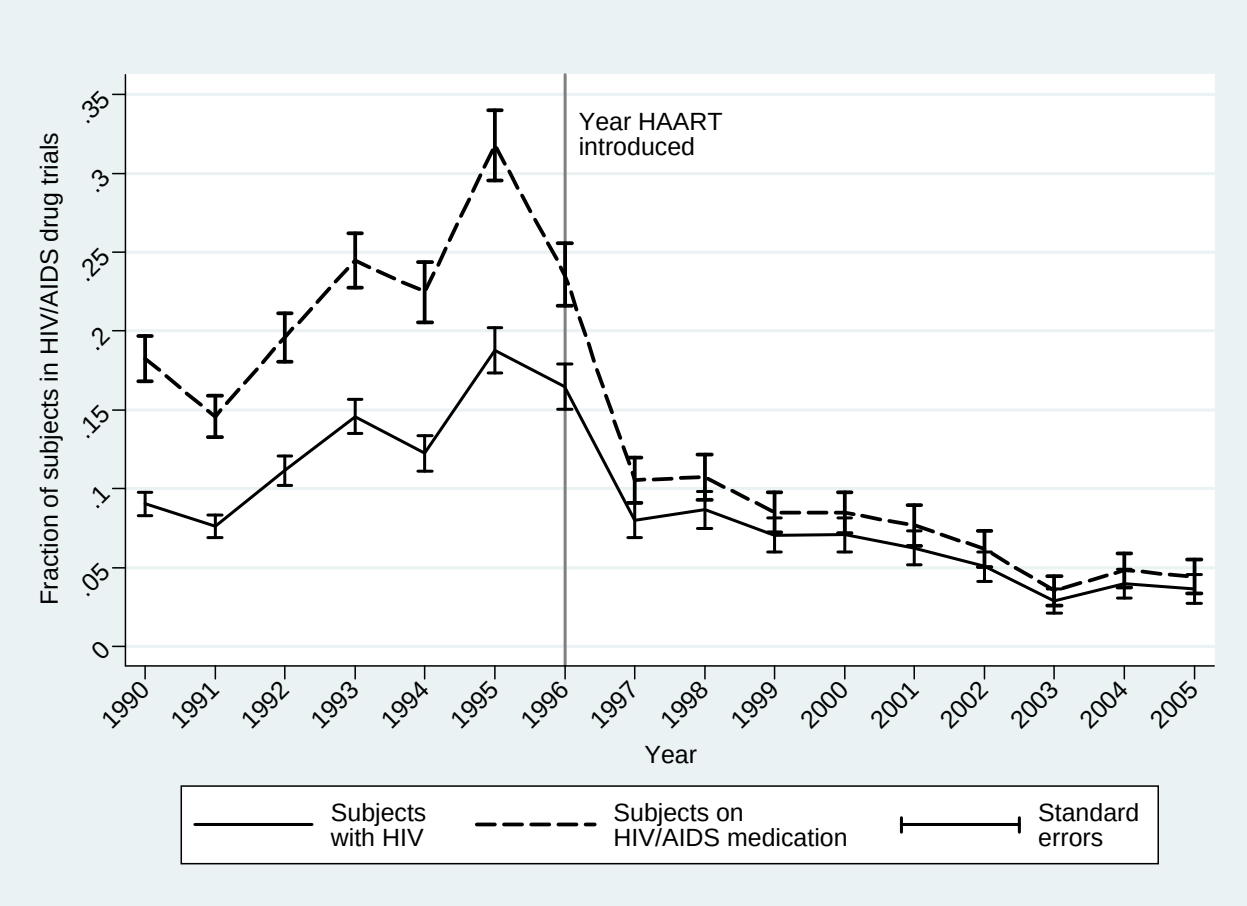

Figure 1. Introduction of HAART reduces the rate of trial participation, by category of HIV patient. Notes: Data are from Multicenter Aids Cohort Study as described in Malani and Philipson (2013). Subjects with HIV are subjects in MACS with HIV. Subjects on HIV/AIDS medication are MACS subjects with HIV and on some medication to control HIV/AIDS.

Health insurance expansions can also reduce enrollment rates in clinical trials. Health insurance reduces the cost of purchasing the already-approved product because it charges patients a copay for that product rather than its full price. In this manner, health insurance makes already-approved products relatively more attractive than enrolling in a trial. Therefore, health insurance expansions reduce enrollment in clinical trials.[4]

This reduction in enrollment rates due to health insurance increases the time required to complete a clinical trial. Statistical considerations such as power and confidence require trials to enroll a

[4] Using the same logic, price controls also reduce enrollment rates in clinical trials.

given number of patients. In the U.S., the Food and Drug Administration imposes such requirements when companies file for required approval to conduct clinical trials, during the so-called Investigational New Drug application process. The lower the enrollment rate per year, the more years are required to enroll a given number of patients.

The resulting delay in trials has two effects on innovation. First, the delay increases the opportunity cost of clinical trials. The delay ties up money that could be used for alternative investments or increases the repayment required for money borrowed to conduct trials. Because drug companies face a high cost of capital (Scherer 2010), this increases the cost of clinical trials. DiMasi et al. (2003) estimate that opportunity costs are a substantial driver of the costs of clinical trials. In this manner, delays in clinical trials increase the cost of innovation, reducing the supply of such innovation.

Second, delays in completing a trial reduce the potential profits a company can earn from a medical product even if it is approved. Patents on medical products have a fixed duration, 20 years. Because drug companies typically obtain patents prior to conducting clinical trials and because they cannot sell drugs until trials are completed and drug are approved, the time required to conduct clinical trials reduces the amount of time the companies have to sell drugs under the patent. This reduction in the so-called "effective patent life" reduces the expected profits from drugs. This demand-side effect reduces companies' incentives to conduct medical R&D.

To summarize, due to the subject market effect, health insurance expansions can reduce medical innovation in two ways. First, they increase the cost of trials of innovation, which operates like an inward shift in the supply curve for innovation. Second, they reduce the expected profits from any innovation and operate like an inward shift in the demand for innovation. These two changes both tend to reduce the amount of medical innovation in the economy.[5]

[5] Philipson and Malani note that the subject market effect, by itself, does not demonstrate inefficiency in the market for medical innovation. Just as an increase in demand due to aging may efficiently improve the quantity

These two changes do not imply that health insurance on net reduces innovation. The net effect depends on the combined effect of these two negative changes and the positive change discussed in the previous section. That positive effect was an outward shift in demand due to the prospect of additional quantity sales after a medical product is tested and approved for sale. It is possible that innovation could fall or rise. The important point is that the conventional wisdom that health insurance increases demand for innovation paints an incomplete picture of the effect of insurance on the amount of innovation because it neglects the subject market effects of insurance.

II: INSURANCE EXPANSIONS REDUCE THE COST OF MEDICAL INNOVATION

A primary method by which our legal system encourages innovation is by granting patents to innovators. A company that invents a new product is given a patent that bars any other company from producing that new product. The patent enables its holder to sell the new product at supracompetitive prices, earning correspondingly high profits. The prospect of these profits is what encouraged the company to invest in the research & development (R&D) that generated the product. Without this R&D, no consumers would have enjoyed the product. Economists call this the dynamic efficiency from the patent.

However, the high prices enabled by a patent also preclude some consumers from purchasing the new product after it is invented. Among those excluded by the patent are consumers who were willing to pay the marginal cost of the new product, but not the supracompetitive price that patent holder charges. The loss borne by these consumers is what economists call the static inefficiency. For

---

of innovation, reductions in the supply of innovation due to health insurance or improvements in the quality of conventional care may efficiently reduce the quantity of innovation. Better health insurance or conventional care may represent increases in the real opportunity costs for patients to enroll in clinical trials. The only feature of the subject market that suggests adjustments in that market may yield inefficient levels of innovation is the fact that ethical rules governing clinical trials generally cap the amount that companies can pay patients to enroll in their clinical trials. Just as rent control can lead to inefficiencies in the allocation of housing, these ethical wage controls can lead to inefficiencies in the allocation of patients to trials.

most products, the duration of a patent is thought to tradeoff the dynamic efficiency from longer duration with the static inefficiency from duration (Nordhaus 1969).[6]

In the healthcare context, however, Lakdawalla and Sood (2009) show that health insurance can provide a way out of this tradeoff by decoupling the price that consumers pay from the price that innovators receive. Insurance does not charge beneficiaries the full cost of a drug, but rather a copay.[7] This copay is not substantially different from the marginal cost of the drug. Yet, insurance may reimburse innovators at a rate close to the price that the latter would like to charge under their patent. Thus, health insurance is able to increase welfare by increasing drug consumption without reducing incentives for innovation.

This finding contrasts with the common intuition that insurance leads to inefficiency due to over-consumption of health care, i.e., ex post moral hazard. According to this intuition, health insurance does not charge consumers the full price of care, but rather a (low) copay. This price reduction leads beneficiaries to consume more care than they would at full price. Because beneficiaries consume even when their willingness to pay is less than full price of care, ordinarily we would say the extra consumption is inefficient. But in the case of medical products covered by patent, the full price is "too high" relative to the social optimum as a result of market power due to the patent. However, unlike in traditional goods markets, health insurance provides a way out of this dilemma in the context of health care consumption. Specifically, it is efficient for health insurers to charge ex post copayments to

[6] The dynamic efficiency and static inefficiency are not the only benefits and cost of the patent system. For example, there is some cost associated with multiple companies investing in R&D to develop a given product. Since only one company obtains the patent, the investments of other companies are, in hindsight, a waste (Loury 1979). Another example is that, because a patent does not allow the holder to expropriate all the social surplus from the new product, it gives suboptimal incentives for innovation (Lakdawalla, Goldman et al. 2009).

[7] The beneficiary will typically have to pay a deductible, but that is not specific to a given treatment. After paying the deductible, the beneficiary is only responsible for the copay, up until her annual or lifetime limits kick in. The recently-enacted Patient Protection and Affordable Care Act bars such limits in the health insurance plans to which it applies (Healthcare.gov 2013).

consumers that approximate the efficient price for the treatment, even when monopolistic health care providers are receiving much higher prices upstream.[8]

The effect of insurance on deadweight loss can be tested empirically by examining what happens to quantity sold when a drug's patent expires. Theoretically, drugs that are well-insured ought to exhibit lower deadweight loss due to patent monopolies. Therefore, patent expirations should have more modest effects on such drugs, compared to their less well-insured counterparts. **Error! Reference source not found.** uses data from Lakdawalla and Sood (2013) to provide support for this hypothesis. It reveals that quantity sold increases for drugs that are not well insured, but changes negligibly for drugs covered by insurance. (Drugs not covered by insurance tend to be expensive, with prices far above marginal cost.) The results are consistent with the hypothesis that insurance limits deadweight loss from monopoly.

Table 1. Effect of patent expiration on drug quantity and branded drug revenue by insurance penetration. Source: Data from Lakdawalla and Sood (2013).

Insurance Penetration Percentile	Insurer Share of Spending	Effect of Patent Expiration On:	
		Quantity	Branded Revenue
25th percentile	41%	+11%	-22%
Median	57%	+5.3%	-30%
75th percentile	78%	-1.9%	-40%

A health insurance contract that charges an upfront premium and a (low) ex post out-of-pocket cost resembles a two-part tariff that is often used by monopolists to eliminate deadweight loss. An example illustrates the analogy. Consider a monopolist that produces health care and provides health insurance. By charging its customers a co-payment equal to social marginal cost, this monopolist can

[8] In theory, if the copay is less than social marginal cost even for patented products, then beneficiaries may over-consume care relative to the social optimum. In the context of the conventional pharmaceutical market, this is unlikely to be the case, because marginal cost is so low (Caves et al. 1991). As a result, health insurance is almost certainly welfare improving in the pharmaceutical context.

ensure that consumers use care efficiently and derive the maximum possible gross consumer surplus. The monopolist then profits from this strategy by charging a premium equal to this gross consumer surplus. Here, consumers are willing to participate in the health insurance market, utilization occurs at the efficient level, and the firm earns profits equal to gross consumer surplus. While this simple example featured a single firm producing both healthcare and insurance, its logic can be shown to extend to the real-world case in which separate firms provide healthcare and insurance (Lakdawalla and Sood 2013). This is the usual logic through which two-part pricing generates maximum profits and first-best utilization (Oi 1971).

The analogy to two-part pricing suggests that a by-product of the way in which health insurance solves the problem of static inefficiency from medical product patents is that health insurance premiums must rise. If insurance companies are charging beneficiaries a low price, but paying providers a high price, the difference must be extracted via the premium charged to beneficiaries. This suggests that health insurance may just transfer static inefficiency from the medical product market to the health insurance market.

There are three reasons to suspect the static inefficiency in the insurance market is small. First, patented (or branded) drugs are a minor component of health expenditures and thus health insurance premiums. Total drug expenditures, including both branded and generic drugs, are approximately 10% of overall national health expenditures (U.S. Census Bureau 2012, p. 102 Table 136). Moreover, roughly 70% of all drug purchases are generic drugs (Hemphill and Sampat 2011). Therefore, branded drugs costs are a small driver of health insurance premiums. Second, the tax code subsidizes the purchase of employer-sponsored health insurance. It allows employers to expense their contributions to premiums and employees to deduct their contributions to premiums from taxable income. This proportional subsidy reduces the extent to which consumers bear the cost of higher insurance premiums (Gruber and Lettau 2004). Thus, higher premiums due to medical product patents are unlikely to reduce the

consumption of insurance much. Not surprisingly, a survey of the empirical literature reveals that "demand for health insurance is, in general, price inelastic" (Liu and Chollet 2006). Third, the recently-enacted Patient Protection and Affordable Care Act (ACA) virtually eliminates static inefficiency in the health insurance market. The ACA includes a so-called individual mandate that requires nearly all persons to buy health insurance (26 U.S.C. § 5000A). To ease the burden of this mandate, the ACA provides premium tax credits to individuals below 400% of the federal poverty level and expands Medicaid coverage for individuals too poor to afford health insurance.[9]

III: THE EFFECT OF INNOVATION ON DEMAND FOR HEALTH INSURANCE

Thus far we have focused on how health insurance affects the amount of innovation and the cost of using patents to spur innovation. In this section we turn the tables and focus on how innovation affects health insurance. Ostensibly this discussion is less relevant to health care reform, which in the U.S. typically focuses on expansion of health insurance. However, health care policy could focus on promoting innovation rather than insurance. In this section, we consider the benefits of this alternative policy strategy.

Conventional analysis of new medical technologies often treats these technologies – or more precisely the need to pay for these technologies and their high prices – as sources of financial risk. This view leads naturally to the conclusion that health care reform should focus on providing insurance to reduce financial risk. In a recent working paper, Lakdawalla, Malani and Reif (2013) explain that this view misses the forest for the trees. They argue that therapeutic medical innovation in particular plays a

[9] Of course the pre-ACA tax subsidy for the purchase of health insurance and the ACA's new premium tax credits and Medicaid expansion may increase government expenditures on health care. But for the same reasons that branded drug expenditures are likely to have only nominal effects on insurance premiums, they are likely to have negligible effects on government expenditures. Moreover, the effects on government expenditures are smaller since the government shares only a portion of the cost of health insurance premiums. Finally, the welfare effects depend on how the government finances those additional expenditures. If the government cuts other less efficient expenditures, the causal effect of higher insurance premiums on welfare may be zero or even negative.

fundamental role in reducing health risks, as important as health insurance, if not more.[10] As a result, innovation may be as important a policy goal as health insurance.

To make their point, the authors explain how therapeutic medical innovations are more valuable to risk-averse individuals than they are to risk-neutral individuals, i.e., more valuable to individuals who value insurance than to those who do not. To be sure, medical treatments have value to risk-neutral individuals, value that also accrues to risk-averse individuals. *After they fall ill* (or *ex post*), all individuals have some willingness to pay for medical treatment. If that treatment is offered at a price below that willingness to pay, economists say the individual has earned a consumer surplus. This is a benefit enjoyed regardless of risk preference. The value that a risk neutral individual obtains from a medical treatment *prior to falling ill* (or *ex ante*) is the same as the value they obtain after they fall ill, albeit discounted by the probability of falling ill. However, the value that the risk-averse individual obtains from that treatment *ex ante* is greater than the value she obtains from it *ex post* discounted by the probability of falling ill. The reason is that the risk-averse individual dislikes risk more than a risk-neutral individual does. Therapeutic medical treatments have particular value to her because they address that risk in two ways.

First, risks to life and health are fundamentally physical – not financial – and it is medical technology – not health insurance – that directly reduces these physical risks. Health insurance merely pays for medical treatment. Indeed, in the absence of medical technology, health insurance can do nothing to reduce risks or life and health. Once a medical treatment is developed, however, individuals face only the risk of having to pay for treatment, a risk for which they can buy market insurance. Another way to put this is that medical innovation converts uninsurable health risks into insurable

[10] The authors do not extend their analysis to preventative medical innovations or to diagnostic medical innovations, though they intend to explore these other innovations in future work.

financial risks. Lakdawalla et al. (2013) call this the market-insurability value of innovation to risk averse individuals.

Second, if medical treatment is sold at a value below willingness to pay, it reduces the magnitude of risk faced by individuals. Instead of facing a high health risk, individuals face a *smaller* financial risk. In the terminology of Ehrlich and Becker (1972), innovation therefore functions as a form of self-insurance. The authors call this the self-insurance value of innovation.

A simple example can explain these two additional sources of value from innovation. Imagine the plight of an HIV-negative individual prior to the introduction of HAART. To make our calculations easy, suppose that, without HAART, an individual who gets HIV progresses to AIDS in five years and dies; with HAART, that individual lives 25 years at full health with HIV and then dies; and individuals do not discount the future. If the value of a life year is $100,000, then the HIV negative individual confronts a health shock of $2 million (20 years x $100,000). Before HAART, the individual has no value for health insurance coverage for HIV treatment even if she is risk averse: there is no treatment for her to purchase with health insurance. Once HAART comes along, however, health insurance has value. Even if HAART is priced at $100,000 per year,[11] the risk-averse individual can use insurance to spread that cost out over HIV and non-HIV states. This is the market insurability value of HAART to the HIV-negative risk-averse individual.

Moreover, if HAART is sold – as it actually is – for $15,000 per year, then HAART reduces a $100,000 annual financial shock by $85,000 (Steinbrook 2001). This is the self-insurance value of HAART. This reduces the amount of insurance a risk-averse person has to buy; if the insurance load were 10%, then the innovation would provide $8,500 of additional value to the risk-averse consumer. At this price, we can also compare the value of HAART to health insurance. A risk-averse individual obtains value from

[11] We assume the HIV-positive individuals begins HAART five years after diagnosis with HIV, when her viral load rises such that she is at risk for AIDS.

HAART because it reduces the cost of the HIV shock by $35,000. By contrast, insurance coverage for HAART only smooths out a $15,000 shock. The ratio – 85/15 or 566% – yields the relative value of risk reduction from innovation and smoothing from health insurance in this (cooked up) example.

Lakdawalla et al. estimate the market-insurability and self-insurance value of medical innovation using data on 1,257 medical treatments from Tufts University's Cost-Effectiveness Analysis Registry (CEAR). They report results for a hypothetical individual with a constant-relative risk aversion utility function

$$u(w+h) = \frac{1}{1-\gamma}(w+h)^{1-\gamma}$$

where w is wealth used for non-health consumption and h is health. The parameter $\gamma \geq 0$ measures the degree of risk aversion. A $\gamma = 0$ implies risk neutrality while a γ approaching infinity implies infinite risk aversion. As Table 2 illustrates, they find that, for a plausible range of risk aversion parameters, the median market-insurability value of insurance is 65-1061% of the *ex post* consumer surplus from innovation and the median self-insurance value of insurance is 9-169 % of the *ex post* consumer surplus from innovation. This implies that medical innovation may have significantly more value to a risk-averse person than a risk-neutral one.

Table 2. Estimates of the market-insurability and self-insurance value of innovation, by level of risk aversion.

	Surplus			Self-insurance value			Market-insurance value		
Gamma	P10	Median	P90	P10	Median	P90	P10	Median	P90
0.5	$0.11	$2.42	$44.39	$0.00	$0.21	$6.19	$0.00	$1.58	$24.57
1.1	$0.11	$2.42	$44.39	$0.01	$0.51	$16.15	$0.00	$3.67	$62.04
1.7	$0.11	$2.42	$44.39	$0.01	$0.85	$29.64	$0.00	$6.11	$105.96
3	$0.11	$2.42	$44.39	$0.02	$1.81	$69.21	$0.00	$11.99	$235.34
5	$0.11	$2.42	$44.39	$0.04	$4.09	$194.13	$0.01	$25.67	$602.90

Notes: Table is from Lakdawalla, Malani & Reif (2013). P10 and P90 indicate 10th and 90th percentile, respectively.

The additional value that new medical treatments offer to risk-averse individuals (relative to risk neutral individuals) also illustrates the complicated relationship between medical innovation and health

insurance. One the one hand, the market-insurability value of medical innovation suggests that innovation and health insurance are complements. Medical innovation makes health insurance more valuable. Policies that neglect or reduce the amount of medical innovation may thereby reduce the potential value of health insurance, even public health insurance. On the other hand, the self-insurance value of medical innovation suggests that innovation and insurance are substitutes. The lower is the price of medical innovation, the more that innovation provides self insurance and the less need there is for market health insurance. Thus, lower prices for medical innovations are a substitute for health insurance.

One might be tempted to suggest that this logic suggests price controls are a (cheap) substitute for health insurance expansions. To some extent this is true. Given the innovations currently on the market, price controls increase the self-insurance from those innovations. However, price controls also reduce the potential profits to innovators and thereby discourage future innovation. In the long run, price controls may just shift self-insurance from the future period to the present, and perhaps even reduce total self-insurance value from a present-value perspective. Moreover, price controls forego future market-insurability value from the future innovation that they deter. Given the relative magnitude of the estimates of market-insurability and self-insurance value in Table 2, this second cost could dwarf the short-run self-insurance value from price controls.

Conclusion

We have argued that the relationship between innovation and health reform involves a wide variety of causal relationships. The complexity of this relationship makes it hard to predict with great certainty what the effects of new policies, like the Affordable Care Act, are likely to be. Local experimentation, whereby different areas implement different reforms, could provide valuable data on

the effectiveness of different reforms. Successful reforms can then be adopted gradually by different localities or eventually implemented by a centralized authority.

The creation of Accountable Care Organizations by the Affordable Care Act is a partial step in this direction. These organizations are allowed to experiment with different methods of caring for patients, although they are subject to certain quality requirements, such as reducing hospital readmissions. The ACA encourages companies to reduce costs by allowing them to keep some of the savings they generate. Success could create a system where providers are rewarded for quality rather than quantity.

To be sure, there are significant risks with a decentralized approach. States that experiment with more generous public programs, for instance, risk attracting migrants in search of these subsidies. The result can be strategic interaction across states, which end up competing to keep unattractive migrants out, rather than to construct efficient health policy. Evidence in the welfare recipiency context suggests this is an important dynamic (Gelbach 2004). This problem becomes even more acute at the level of small areas or localities. If a city, for instance, began to impose community-rating requirements, healthy people might flee to the suburbs, while only the sickest consumers would remain.

Finally, decentralized health policy that involves cost-sharing between the federal and state governments create additional problems. States have an incentive to foist expenditures onto the federal government, and vice-versa. A good example is the interaction between federally funded Medicare and Medicaid programs that involve partial state funding. States have little incentive to prevent acute illness in elderly residents of long-term care institutions. Acutely ill long-term care patients get admitted to hospitals, where they become Medicare's financial liability. While they remain in long-term care facilities, on the other hand, they are at least in part the responsibility of the state.

On balance, there are good reasons to promote decentralization in health care policy, but the practical aspects of decentralizing policy frequently lead to wasteful conflicts between states, and

between state and federal governments. The latter dynamic would disappear in a system where state governments had complete control, and fully internalized the costs of public health insurance schemes. The former effect could be solved by state-level policies that promoted efficiency and tended to draw productive firms and citizens into successful states.

References

Acemoglu, D. and J. Linn (2004). "Market Size in Innovation: Theory and Evidence from the Pharmaceutical Industry." The Quarterly Journal of Economics **119**(3): 1049-1090.

Arias, E. (2012). "United States Life Tables, 2008." National Vital Statistics Reports **61**(3): 1-64.

Blume-Kohout, M. E. and N. Sood (2008). The impact of Medicare Part D on pharmaceutical R&D, National Bureau of Economic Research.

Caves, R. E., M. D. Whinston, et al. (1991). "Patent expiration, entry, and competition in the US pharmaceutical industry." Brookings papers on economic activity. Microeconomics **1991**: 1-66.

Center for Medicare and Medicaid Services, U. S. D. o. H. a. H. S. (2013). "National Health Expenditure Data: Historical." Retrieved March 25, 2013, 2013, from http://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/NationalHealthExpendData/NationalHealthAccountsHistorical.html.

Chandra, A. and J. Skinner (2012). "Technology Growth and Expenditure Growth in Health Care." Journal of Economic Literature **50**(3): 645-680.

Clemens, J. (2012). "The Effect of US Health Insurance Expansions on Medical Innovation."

Congressional Budget Office (2011). Scoring of Proposed Changes to the Independent Payment Advisory Board Mechanism (May 13, 2011).

Cutler, D. M. (2005). Your money or your life: strong medicine for America's health care system, Oxford University Press, USA.

Cutler, D. M. (2007). "The lifetime costs and benefits of medical technology." Journal of Health Economics **26**(6): 1081-1100.

Cutler, D. M., S. Kadiyala, et al. (2003). The return to biomedical research: Treatment and behavioral effects. Measuring the Gains from Medical Research, Citeseer.

Danzon, P. M. and M. F. Furukawa (2006). "Prices and availability of biopharmaceuticals: An international comparison." Health Affairs **25**(5): 1353-1362.

de Mouzon, O., P. Dubois, et al. (2011). Market Size and Pharmaceutical Innovation, CEPR Discussion Papers.

DiMasi, J. A., R. W. Hansen, et al. (2003). "The price of innovation: new estimates of drug development costs." Journal of Health Economics **22**(2): 151-185.

Finkelstein, A. (2004). "Static and dynamic effects of health policy: Evidence from the vaccine industry." The Quarterly Journal of Economics **119**(2): 527-564.

Gelbach, Jonah B. (2004). "Migration, the Life Cycle, and State Benefits: How Low Is the Bottom?" Journal of Political Economy **112**(5): 1091-1130.

Gruber, J. and M. Lettau (2004). "How elastic is the firm's demand for health insurance?" Journal of public economics **88**(7): 1273-1293.

Healthcare.gov. (2013). "Lifetime & Annual Limits." Retrieved March 25, 2013, 2013, from http://www.healthcare.gov/law/features/costs/limits/index.html.

Hemphill, C. S. and B. N. Sampat (2011). "When Do Generics Challenge Drug Patents?" Journal of Empirical Legal Studies **8**(4): 613-649.

Lakdawalla, D., A. Malani, et al. (2013). Therapeutic Medical Innovation and Health Insurance.

Lakdawalla, D. and N. Sood (2009). "Innovation and the welfare effects of public drug insurance." Journal of public economics **93**(3-4): 541-548.

Lakdawalla, D. and N. Sood (2013). "Health insurance as a two-part pricing contract." Journal of Public Economics.

Lakdawalla, D. N., D. P. Goldman, et al. (2009). "U.S. pharmaceutical policy in a global marketplace." Health Affairs **28**(1): w138-150.

Lichtenberg, F. R. (2007). "The Impact of New Drugs on US Longevity and Medical Expenditure, 1990-2003: Evidence from Longitudinal, Disease-Level Data." THE AMERICAN ECONOMIC REVIEW **97**(2): 438-443.

Liu, S. and D. Chollet (2006) "Price and Income Elasticity of the Demand for Health Insurance and Health Care Services: A Critical Review of the Literature." Mathematic Policy Research Ref. No. 6203-042.

Loury, G. C. (1979). "Market structure and innovation." The Quarterly Journal of Economics: 395-410.

Malani, A. and T. J. Philipson (2013). The Economics of Medical R&D: The Subject Market Effect.

Murphy, K. M. and R. H. Topel (2006). "The Value of Health and Longevity." Journal of Political Economy **114**(5).

National Heart Lung and Blood Institute, N. I. f. H. (2012). Morbidity & Mortality: 2012 Chart Book on Cardiovascular, Lung, and Blood Diseases.

Newhouse, J. P. (1992). "Medical Care Costs: How Much Welfare Loss?" The Journal of Economic Perspectives **6**(3): 3-21.

Nordhaus, W. (1969). "Invention, Growth and Welfare." Cambridge, MA: MIT Press.

Oi, W. Y. (1971). "A Disneyland Dilemma: Two-part Tariffs for a Mickey Mouse Monopoly." Quarterly Journal of Economics **85**: 77-96.

Scherer, F. M. (2010). Chapter 12 - Pharmaceutical Innovation. Handbook of the Economics of Innovation. H. H. Bronwyn and R. Nathan, North-Holland. **Volume 1:** 539-574.

Steinbrook, R. (2001). "Providing Antiretroviral Therapy for HIV Infection." New England Journal of Medicine **344** (11): 844-846.

U.S. Census Bureau (2012). Statistical Abstract of the United States: 2012