

The Economics of Pharmaceutical Pricing



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Executive Summary: The Economics of Pharmaceutical Pricing¹

The price of a patented pharmaceutical drug will often decline significantly once the drug comes off-patent. Some critics erroneously see this development as a sign that price gouging must have been occurring while the pharmaceutical product was on patent. After all, if the drug can be sold at a fraction of its former cost once the drug has come off-patent, and the company is still making a profit, doesn't that prove that the price for the drug was excessive while it was on patent? The answer is no!

Sharp price declines for pharmaceutical drugs following patent expiration are an indication that the pharmaceutical market is efficiently balancing two important, but often conflicting, goals.

The first goal is to encourage a competitive market that typically includes generic competitors. A vibrant and competitive generic market ensures that affordable pharmaceuticals are widely available. Wide availability of pharmaceutical drugs, at prices that reflect the marginal costs of production, help ensure that treatments reach as many patients as possible today.

However, there is a problem that arises if generic competition is empowered as soon as a pharmaceutical product meets the Food and Drug Administration's (FDA) safety and efficacy standards. Pharmaceutical innovation is expensive (research and development (R&D) costs are estimated to be as high as \$5.5 billion per successful pharmaceutical) and fraught with failure. Production costs for a pharmaceutical, on the other hand, are relatively low once that drug has been invented and approved. This combination creates an obstacle to achieving the second goal, which is to help as many patients as possible in the future.

Patients in the future are helped by the creation of new drugs that treat illnesses tomorrow that currently have no effective treatment today. Patients in the future are also helped by the creation of new drugs that treat diseases more effectively (and with fewer adverse side effects) tomorrow than we can treat these conditions today. In short, encouraging continued pharmaceutical industry innovation today is the key to helping as many patients tomorrow.

The two goals often conflict because innovation will only continue if the innovating company is provided an opportunity to recoup its costs of capital, which cannot occur if an innovator has to immediately compete with generics that are manufactured by a company that has not incurred large R&D costs.

The current U.S. patent system, while in need of improvements, strikes a reasonable balance between these two important goals by effectively granting an innovating pharmaceutical manufacturer with 11 ½ years of market exclusivity. This market exclusivity period grants the innovating company an opportunity to cover its cost of capital. Once the innovator has had an opportunity to recover its costs of capital, the market is then opened to generic competition.

As the market for a drug transforms from market exclusivity into generic competition, the pricing structure for the drug transforms as well. During the period of market exclusivity, prices will reflect both the costs of production and the innovator's cost of capital for R&D. Once the market is opened to generic

On average, of the medicines that are successful in terms of safety and efficacy, only two in ten are profitable and return an income stream that is greater than the cost of their research and development.

competition, prices only reflect the costs of production and do not include the innovator's cost of capital. It is a reduction of the cost of capital that creates the steep price declines often observed when pharmaceuticals go off-patent.

TIME, RISK, AND OUTLAYS

The cost of capital for R&D expenditures compensate investors for the large period of time it takes to develop a new pharmaceutical product, the dollar expenditures that must be incurred to develop and test the new drug, and the risks that the investors must bear regarding whether the pharmaceutical research program will be successful.

As Benjamin Franklin famously noted to a young tradesman, “remember time is money”. With respect to the development of innovative pharmaceuticals, the easiest way to see the wisdom of Ben Franklin is to remember what an investor could do with his money had he not invested those resources into a pharmaceutical company. On average, the R&D process takes 10 to 15 years. Assuming that an investor is able to earn the average market return on his money as represented by the annual average growth rate in the S&P 500 between 1964 and 2013 (9.9 percent), then over 15 years, every \$100 invested in a pharmaceutical R&D process could have grown into approximately \$412. These opportunity costs are real, and if an investor is not compensated for these lost opportunities, adjusted for risk, then investment in pharmaceutical innovation will cease.

There are many risks associated with pharmaceutical innovation. There are the risks that the potential new drug will not be effective. Then there are risks that even if a new therapy is effective, it may not be safe. And, even if a new drug is effective and safe, and has been approved by the FDA for patient use, there is no guarantee that the pharmaceutical therapy will be commercially viable.

The California Biomedical Research Association has estimated that “only five in 5,000, or 0.10 percent, of the drugs that begin pre-clinical testing ever make it to human testing. Only one of these five is ever approved for human usage.” Of these, PhRMA, based on a study by Vernon et al, estimates that only two out of 10 marketed drugs are able to match or exceed R&D costs. These statistics illustrate that not only is failure an option, it is the expected outcome for most potential drugs. The large probability of failure underscores the large risks investors are taking when they invest their money in an innovative pharmaceutical company.

ESTIMATING THE R&D CAPITAL COSTS

Using average numbers that are indicative of the innovative pharmaceutical industry, this paper calculates a representative R&D cost of capital accounting for the time costs and the risks of failure. It should be noted that the current patent life of any particular drug is not directly linked to that specific drug's cost of capital. Nor is the patent life defined in terms of the time needed to make the necessary return on the company's cost of capital. Instead, just like with any company, pharmaceutical companies set prices so that the earnings of the entire company are sufficient to cover all costs – including the costs of capital. If this can be achieved, then the company stays in business. If

this cannot be achieved, then the company's operations will cease. The analysis here simplifies the issue for the sake of clarity. However, the fact remains that any innovator manufacturing company that cannot, on average, price in the manner described will become an unviable entity and will cease operating.

The paper estimates that the capital costs on the average R&D outlays of \$5.5 billion over 15-years, accounting for the cost of time and risks, are \$17.2 billion. These figures indicate that each patented pharmaceutical's annual cost of capital is approximately \$1.5 billion a year – a successful drug must earn \$1.5 billion in revenues each and every year just to cover the capital costs for the R&D expenditures.

Therefore, once a patent expires, and the opportunity for an innovator company to recoup its cost of capital is finished, the price structure no longer needs to attempt to recoup \$1.5 billion in annual costs. The cost reduction should be manifested in a significant price drop once generic competitors enter the market, which is precisely what happens.

According to IMS health data, the health care system saved \$65.2 billion due to patent expirations between 2007 and 2011, or \$13 billion a year. Method (2009) estimated that during the 2009 and 2011 timeframe between seven and 12 drugs came off patent each year. The IMS data, therefore, are consistent with an annual per drug savings of \$1.3 billion – similar to the estimate in this paper of \$1.5 billion.

CONCLUSION

The R&D process for innovative drugs is lengthy, requires billions of dollars in actual outlays, and is fraught with large risks. Alternatively, it is relatively inexpensive for a generic competitor to copy a new pharmaceutical product once an innovative drug has been created. Without a period of market exclusivity, the confluence of these factors creates an obstacle that would prevent branded pharmaceutical manufacturers from attracting the necessary financial resources to create new and better medications for patients. Without adequate financial resources, innovation suffers.

The current patent system creates a period of market exclusivity that provides an innovative pharmaceutical manufacturer with an opportunity to recoup its R&D capital costs allowing the beneficial innovation process to continue. The market exclusivity period is limited, however, in order to allow competition to lower prices once a drug comes off patent.

The market results created by the patent system – higher prices while on patent, and steep price declines that occur in the market for patented drugs once its patent expires – is the efficient and expected result that balances the sometimes conflicting needs to fund the large expenses of developing new innovative drugs for tomorrow and making drugs as affordable as possible today.

Introduction

In January 1984, Apple Computer introduced the Macintosh. The price for the Macintosh computer was around \$2,500, which is the equivalent of about \$5,600 in today's dollars.² Today, top of the line Apple computers (with enormously greater capabilities) sell for one-half of the price of that original Macintosh.

Expensive prices for innovative technology products when they are first launched, followed by sharp price declines once competitors have introduced comparable products, is common. It would be difficult to assert that Apple was harming consumers by introducing new products that consumers never knew they needed to have. Nor, do people complain when competition finally arrives driving down prices making those innovative products widely available.

This patent cycle has two major benefits for patients and the health-care system. It allows investors to receive a return on their capital, incenting innovation. Afterward, the patent cycle empowers the establishment of a vibrant generic market.

The same beneficial process occurs in the innovative pharmaceutical market. Creating new pharmaceuticals is an extraordinarily expensive and risky endeavor. Unlike many inventive processes, bringing pharmaceuticals to market requires demonstrating both safety and efficacy through expensive clinical trials. When potential drugs have completed the long and arduous discovery and testing processes, and are finally ready for market, many of these new inventive drugs will create great value to their users and be commercially successful. While many medicines create great value to their users, commercial failure is also an option. As New Coke, the Ford Edsel, and the Sony Betamax all demonstrate, technological success does not guarantee commercial success. The same commercial viability hurdle also exists for innovative pharmaceutical medicines. On average, of the medicines that are successful in terms of safety and efficacy, only two in 10 are profitable and return an income stream that is greater than the cost of their research and development.³ Those medicines that are successful in terms of safety, efficacy, and commercially must cover all of the company's cost of capital.

There is a potentially crippling problem that can derail this difficult, but beneficial, development process. While the cost of inventing a new drug is expensive, the cost of producing a drug that has already been invented is relatively cheap. The existence of high invention costs but low production costs, creates a significant obstacle to the beneficial invention process.

Due to the low production costs, a pharmaceutical company that has developed an innovative drug faces potential competitors that have not expended a large amount of resources on research and development (R&D). Without having to recover R&D costs, potential competitors could create a generic drug, enter the market, and sell a generic copy of the new innovative drug at a very low price. The innovator company cannot match these low prices and recoup its extensive R&D costs. Without the ability to recoup these costs, the innovator company cannot repay its cost of capital to its investors severely diminishing (if not eliminating) the incentive for investors to engage in the risky drug invention process.

The purpose of patents is to provide the innovator company with market exclusivity to create an opportunity for the company to cover its R&D capital costs. A competitive rate of return on capital, adjusted for

risk, ensures that investors will be willing to put their money into the pharmaceutical industry, a business where failure is the norm, and a small number of medicines pay for all of the R&D.

The innovator company should not receive unlimited market exclusivity, however. After a certain period of time, a competitive environment should be encouraged. And, this occurs after a branded pharmaceutical has been on the market around 10-12 years. Typically after 11.5 years, patents for branded pharmaceuticals expire.⁴ Once the patent has expired, generic companies can copy the medicine, and use the data developed by the innovator company for free. Competition from generics typically drives prices down toward the marginal cost of production.

This patent cycle has two major benefits for patients and the healthcare system. It allows investors to receive a return on their capital, incenting innovation. Afterward, the patent cycle empowers the establishment of a vibrant generic market. This market allows for the treatment of many of the highest incidence diseases, including heart disease, depression, and even some cancers, with lower cost drugs.

It should be noted that the current patent life of any particular drug is not directly linked to that specific drug's cost of capital.

The value of this process is sometimes misconstrued by market observers. These observers will erroneously claim that the steep price declines following the end of a branded drug's patent life – the lower prices for generics entering the market or the formerly branded product lowering its price in order to compete in the generic space – are signs that prices for the branded drug while on patent were too high.

Contrary to these claims, it is efficient for prices on branded pharmaceuticals to significantly decline once the patent for pharmaceuticals expires (generic competition enters the market). Doing so is an illustration that the branded and generic pharmaceutical markets are working properly. Steep price declines following the expiration of a branded drug's patent is evidence of exactly the opposite phenomenon that some critics allege – the pharmaceutical market is effectively balancing the need for continued innovation and the desirability of a competitive market that drives down prices once an opportunity for the innovator company to recoup its costs of innovation has been provided.

This paper analyzes the dynamics of the pharmaceutical pricing process, with an emphasis on: (1) the efficient pricing mechanisms for patented pharmaceutical products; and, (2) the price transition that occurs when drugs transition from being on-patent to the time when their patents expire. The goal of the paper is to illustrate the economic theory behind the current innovative drug market structure, including the current patent system, and the evidence that this system is working for the benefit of consumers today and in the future.

It should be noted that the current patent life of any particular drug is not directly linked to that specific drug's cost of capital. Nor is the patent life defined in terms of the time needed to make the necessary return on the company's cost of capital. Instead, just like with any company, pharmaceutical companies set prices so that the earnings of the entire company are sufficient to cover all costs – including the costs of capital. If this can be achieved, then the company stays in business. If this cannot be achieved, then the company's operations will cease. The analysis here simplifies the issue for the sake of clarity. However, the fact remains that any innovator manufacturing company that cannot, on average, price in the manner described here will become an unviable entity and will cease operating.

It is also an important point to note that competition, while typically due to new generic drugs entering the market, does not need to only come from new generic products entering the market. Once the costs

of R&D have been recovered, innovator companies may choose to compete in the generic market by lowering the prices on the formerly patented products. Both the entry of new competitors into the market and the decline in the price of the formerly patented product are consistent with an efficient market.

THE DEMAND FOR BRANDED PHARMACEUTICALS

Pharmaceuticals create great value for patients. Not only is the sheer size of the market huge – the Centers for Medicare and Medicaid Services estimates that the current U.S. prescription drug market is \$262.3 billion⁵ – but the benefits for patients have been tremendous. Researchers have attributed pharmaceutical innovation to an increase in the average U.S. life expectancy of 0.75 percent to 1.00 percent per annum between 1970 and 1991.⁶ Another study found that, with respect to cancer, innovative pharmaceuticals accounted for 50 to 60 percent of the increase in survival rates between 1975 and 1995 during the first six years following diagnoses.⁷

Spending money on pharmaceutical drugs can also reduce the total amount spent on hospital or other medical costs through more effective disease management.

Spending money on pharmaceuticals can also reduce the total amount spent on hospital or other medical costs through more effective disease management. For instance, Shang and Goldman (2007) found that a \$1 increase in drug spending was associated with a \$2.06 reduction in Medicare spending.⁸ Stuart, Doshi and Terza (2009) found that outpatient prescription drug expenditures create “cost savings for Medicare beneficiaries” once reduced hospital costs are considered.⁹ Similarly, Santerre (2011) found that “the typical new drug slows the growth of overall medical care spending.”¹⁰

These studies illustrate branded pharmaceuticals’ value in keeping patients healthy and reducing overall healthcare costs. While these studies illustrate that pharmaceuticals can reduce overall health care spending, it is not clear that such a reduction is necessary to justify the value of the drugs. For instance, if an innovative drug had the same efficacy and costs as a surgical procedure, the option of using the drug therapy rather than surgery may create value for some patients even if no net cost savings are achieved. A similar argument can be made if the pharmaceuticals were a net addition to health care spending, but also a valuable asset in more effectively managing chronic or infectious diseases.

Ensuring that the benefits created by pharmaceuticals not only continue, but expand, requires policies that support continued innovation from pharmaceutical manufacturers. An important component of ensuring continued innovation is ensuring policies maintain an effective pricing environment.

A Review of the Theory Guiding the Current Patented Pharmaceutical Market

Prices balance the needs and desires of consumers with the costs and risks that producers must bear in order to create a product. More precisely, the market price for a good is determined by the costs to produce the next batch of those goods (the marginal cost of production) coupled with the marginal value consumers attribute to the product.

In many markets this balance is achieved relatively easily. Typically, these markets do not have high fixed costs, do not have production processes that take an exceptionally long time to complete, do not have high regulatory costs and barriers, and do not require a large amount of research and development expenditures before production can begin. Prices in such a market easily reflect an efficient balance between consumer desires and producer costs.

A QUICK HEALTH CARE ECONOMICS PRIMER AND ITS IMPACT ON PHARMACEUTICAL PRICING

Effectively pricing drugs is more complicated than the pricing decisions in most markets, however, because patients (the person demanding services) do not pay the majority of the costs. Consider that in 1960, the private sector funded over three-quarters of the nation's health care expenditures and patients paid nearly one-half of the total bill through out of pocket expenditures.¹¹ Today, the private sector pays for less than one-half of the \$2.6 trillion in health care spending (17.8 percent of GDP); and, slightly more than \$1 out of every \$10 is funded by patients through out of pocket expenditures.¹²

Further distorting the health care payment system is the fact that most Americans do not have health insurance as the term is traditionally understood, they have "first dollar coverage". Insurance is a tool for managing risk. In exchange for periodic payments from a customer, an insurance company provides protection against a large but uncertain potential cost (a risk).

Take disability insurance. A potential risk for many families is the possibility that the primary (or one of the dual-income earners) might suffer an accident that prevents him or her from working for a prolonged period of time. In such a case, a family could face potential financial ruin. To protect against this risk, many income earners purchase disability insurance. In return for annual (or quarterly/monthly) payments, the insurance company pays a pre-determined amount of money to the income earner, should an unfortunate accident or disabling illness occur.

Health insurance does not work this way. Instead of covering only true health risks (the costs associated with broken arms, major surgeries, or covering the cost of care for chronic diseases), health insurance pays the costs for routine health events that are not risks in the true sense of the word. An analogous

Instead of covering only true health risks (the costs associated with broken arms, major surgeries, or covering the cost of care for chronic diseases), health insurance pays the costs for routine health events that are not risks in the true sense of the word.

situation would be for a disability insurance plan to pay an individual's disability claims for missing work due to a cold. The basic principles of risk and insurance have been distorted. The expected result from this distortion is diminished quality and increased prices.

A catastrophic health insurance plan that focused solely on major risks would not cover routine health costs such as wellness doctor visits or the costs related to the common cold. Instead, patients would cover the costs of routine expenditures and health insurance companies would cover the costs of true health risks. Premiums would then be priced to fully cover the costs for policyholders that face true

health risks such as being afflicted with expensive chronic diseases – in other words, health insurance would actually *be insurance*.

The health insurance market resembles a system of pre-paid health care services that, in stark contrast to a typical market transaction, entails a complex system that must coordinate across many different groups including doctors, payers, regulators, licensing boards, lawyers, pharmaceutical manufacturers, and patients.

With respect to prices for innovative pharmaceuticals, under such an insurance system, health insurance companies could focus on the cost of treating patients effectively and pay for the most effective course of treatment – be it surgery, other treatment procedures, or pharmaceuticals. The cost of drugs would then properly be judged against the costs incurred and medical benefits gained versus the same trade-off for alternative procedures. This is the way health insurance markets should work.

Of course, the health insurance market does not function like a true insurance market. Instead the health insurance market resembles a system of pre-paid health care services that, in stark contrast to a typical market transaction, entails a

complex system that must coordinate across many different groups including doctors, payers, regulators, licensing boards, lawyers, pharmaceutical manufacturers, and patients. Along with many other adverse consequences, such as skyrocketing health care inflation, the current health insurance system creates a less responsive medical pricing system. And, this applies to the prices for pharmaceuticals as well – particularly innovative drugs on patent.

This less responsive pricing system explains a number of anomalous outcomes. For instance, in some cases several patented products will compete against one another in the same market – the market for cholesterol medication, for instance. Often the list prices for these drugs will actually increase as the number of competitors increases – the opposite of what should be occurring when competition is increasing. This occurs due to the complexity of the pharmaceutical pricing system. List prices are not the actual prices paid. In fact, as competition increases, the discounts payers receive often increase making the actual list price a less important economic measure. Growth (or declines) in list prices are not meaningful because few people (if anyone) actually pay the list price of a drug. Often, the prices paid on drugs in markets with growing patented competition are declining as one would expect with increased competition. Due to the vast complex payment negotiation process (with both private payers and public payers), coupled with the web of regulations, tracking changes in list prices reveals little practical information.

PRICING IN THE DISTORTED HEALTH CARE MARKET

Despite the problems inherent in the health care industry, basic market forces still exist in the pharmaceutical market. Pharmaceutical manufacturers engage in an intense competition with one another, as well as with companies in other industries, to attract sufficient financial resources (investment) to fund their R&D efforts. Investors will only choose to allocate their money to a pharmaceutical manufacturer if they believe they will earn an adequate return on their investment, which includes compensation for the greater risks associated with the pharmaceutical industry. Pharmaceutical manufacturers earn a return by negotiating prices with payers (who are negotiating on behalf of their patients) that are high enough to cover the manufacturers' costs. The actual prices paid generally reflect the balance between the pharmaceutical manufacturers' costs, the benefits to patients that the medicines can create, and the benefits to patients that the alternative therapies can create.

The innovator pharmaceutical manufacturers' costs include the production and R&D costs. The costs facing potential manufacturers that did not develop the drug therapy are unencumbered by the large research and development costs that the innovating drug company has spent.¹³ A non-innovator drug manufacturer who wanted to compete against an innovator drug manufacturer could sell the new drug at the marginal cost of production and earn a competitive rate of return on their operations. The innovator company – the company whose investment created the new drug therapy – cannot profitably compete at these prices. The competitive market price is only high enough to provide an adequate rate of return on the production costs. The competitive market price is not high enough to cover the hundreds of millions of dollars in research and development costs (and in some instances even more) that the innovator firm has sunk into the project.

Without the ability to recover its sunk costs, including a competitive profit, drug manufacturers would no longer support research programs to develop new innovative drug therapies – any firm that attempted to invest sufficient resources into developing new therapies would soon find itself financially bankrupt. The producer of an innovative drug, consequently, must be able to recoup its large financial research and development investment by charging prices higher than the marginal costs of production.

Recognizing this problem, the U.S. patent system provides the developers of innovative drugs exclusivity rights. Empowering the innovator drug company with exclusivity rights for a predetermined period provides the drug company with the opportunity to recoup the large R&D costs by charging prices that are higher than the prices charged by a firm that only incurred production costs – or exclusivity prices.¹⁴ It is the ability to charge exclusivity prices that creates the opportunity for the innovative drug manufacturer to recoup both the cost of production and the research and development costs. But, this creates a new problem.

Enabling higher prices while a drug is on patent is crucially important – it allows the investors who risked a large sum of money on developing an innovative drug, long before the drug's success was ensured, to recover the costs of development.

As taught in every economics 101 course, prices above the marginal costs of production reduce the total benefits that consumers can receive. For this reason, it is desirable to empower a competitive environment where different versions of a drug compete to provide greater value and benefits for consumers. For this reason, an innovator drug manufacturer's exclusivity period is limited. The innovative drugs come "off patent" after around 10-12 years on the market. Once off-patent, generic companies introduce inexpensive copies and the average price of the drug declines closer to the marginal cost.

Enabling higher prices while a drug is on patent is crucially important – it allows the investors who risked a large sum of money on developing an innovative drug, long before the drug's success was ensured, to recover the costs of development.¹⁵ Ensuring that the manufacturers are able to cover their cost of capital ensures a healthy innovative drug market, and encourages continued research into new innovative drug therapies. The exclusivity part of the pricing process exists to encourage the process of developing new medicines that address untreated diseases or address diseases more effectively (or with fewer side effects) than the current therapies.

Ensuring a competitive generic drug market after the patent expires ensures that the benefits from innovation are able to help as many people as possible. Once off-patent, the now lower-priced drug reflects the marginal costs of production. Importantly, like many industries, manufacturers gain efficiencies over time that can lower their marginal costs of production, and, therefore, lower prices charged to consumers, even further.

It is, therefore, an integral part of an efficient pharmaceutical market that following patent expiration, significant price declines occur. These price declines are consistent with the incremental production costs (excluding development costs) and enhance drug affordability and availability.

The combination of patent protection and significant price drops when drugs go "off patent" creates an optimal balance between drug affordability and new developments of innovative drugs. The dual needs for continued innovation and affordable pharmaceutical drugs is the reason why large and discrete price changes for pharmaceutical drugs coming off patent should be expected and desired. The following section provides a detailed review of the average R&D costs and the necessary coverage of these costs, illustrating that this theoretically desired outcome is, in fact, the case in the current pharmaceutical market.

The Costs of Innovation: Time, Outlays, and Risk

Properly accounting for research and development costs requires investors to be compensated for the length of time it takes to develop a new innovative drug, the large dollar outlays required to be invested in the drug development process, and the large risks involved in trying to successfully develop a new drug.

TIME

Developing a new branded drug takes a long time. According to the California Biomedical Research Association, it takes, on average, 12 years.¹⁶ The Pharmaceutical Research Manufacturers Association (PhRMA) estimates that the drug development process takes 10 to 15 years.¹⁷ This includes the time needed to discover the drug as well as the time needed to comply with the Food and Drug Administration's safety and effectiveness standards. The safety and effectiveness standards typically include pre-clinical trials, clinical trials, submitting proprietary manufacturing data, as well as paying for both the direct costs of these tests and any relevant government fees.

Outside of the direct outlays that must be recouped (discussed in the next sub-section), this time has a cost. The easiest way to see the cost of this time is to examine the opportunity investors lose by committing their money into the pharmaceutical research process as opposed to other possible investments. The alternative investment opportunity could be putting their money in a start-up internet company; perhaps the alternative investment opportunity is putting their money in a less risky asset such as an electric utility; or, perhaps both. If we use the broader market as the potential alternative investment opportunity, then it is possible to quantify the lost investment opportunity that potential investors forgo by investing their money in the risky pharmaceutical research process. Between 1964 and 2013 the average annual return of the S&P 500 was 9.9 percent.¹⁸ Investors, consequently, can earn a return of 9.9 percent on their money if they just invest in the *market* instead of investing their savings into the pharmaceutical research process.¹⁹

With an opportunity cost of 9.9 percent, then a \$100 investment could have grown into \$257 if the money was invested in the broader market instead of being invested in a pharmaceutical company that is developing a drug that required 10 years of R&D time. If the drug required 15 years of R&D time, then the \$100 investment could have grown into \$412 (see Table 1).

According to the California Biomedical Research Association, “only five in 5,000, or 0.10%, of the drugs that begin pre-clinical testing ever make it to human testing. Only one of these five is ever approved for human usage.”

TABLE 1
OPPORTUNITY COST DURING DRUG R&D DEVELOPMENT PROCESS
(BASED ON AVERAGE GROWTH IN S&P 500, BASED ON \$100 INVESTMENT)

Initial Investment	\$100.00
<i>Annual growth in investment over R&D timeframe</i>	
Year 1	\$109.89
Year 2	\$120.76
Year 3	\$132.71
Year 4	\$145.84
Year 5	\$160.27
Year 6	\$176.12
Year 7	\$193.55
Year 8	\$212.69
Year 9	\$233.73
Year 10	\$256.86
Year 11	\$282.27
Year 12	\$310.19
Year 13	\$340.88
Year 14	\$374.60
Year 15	\$411.65

Of course, the precise amount of time that it will take to develop the drug is unknown *a priori*. A prudent assumption for the investor is, consequently, to assume the longer R&D timeframe given the large opportunity cost should the necessary time for the R&D process be on the longer-side.

From a pricing perspective, the key takeaway is that unless the income stream generated from the innovative R&D process is large enough to compensate the investors for the lost investment opportunity, then investors will choose to allocate their resources elsewhere. Importantly, these returns do not yet account for risk, which is discussed more fully below.

OUTLAYS

Estimates of the actual dollar outlays (the direct expenditure costs) vary. On the lower end, the development of a new patented pharmaceutical can cost \$1.3 billion – including the expenditures on the drugs that were unsuccessful.²⁰ Adams and Brantner (2006) estimated that the cost of drug development was, on average \$868 million; but the range of estimates varied widely from \$500 million up to \$2.0 billion.²¹

In a recent analysis for *Forbes*, Herper (2013) estimates these costs to be much higher.²² Herper found that the total R&D cost per drug could be between \$5.5 billion and \$5.9 billion. Specifically,

Using data from the Innothink Center for Research in Biomedical Innovation, I tabulated the number of brand new drugs launched by 98 publicly-traded biotechnology and drug companies over the past decade. Then, using FactSet Systems, I tallied each company’s research and

development spending over the ten years preceding their most recent drug approval. Then I divided the second number by the first.²³

It is noteworthy that Herper's results illustrate the large impact on costs created by drug failures. Based on his methodology, Herper found that companies that launched only one drug had an average (specifically median) cost of \$351 million compared to an average cost of \$5.5 billion for companies that had eight to 13 drugs approved. The difference in costs is due to how failures are taken into account. As Herper describes, "For every small company that succeeds, there are many more that fail. A big pharmaceutical company carries that weight of failure, with both its successes and its failures on the books."²⁴ The true cost of capital for a pharmaceutical company includes the costs of failures, of course. Consequently, based on Herper's analysis, the total cost for developing one successful drug is \$5.5 billion.

In order for drug development to continue, branded drug manufacturers must be able to recoup their research and development costs including a competitive return on their investment. The competitive return on investment incorporates the opportunity costs discussed in the previous sub-section, adjusted for the additional risks.

RISK

Risk for the innovative pharmaceutical market encompasses both the risks inherent in successfully developing a drug even after sufficient resources have been allocated to the endeavor, and the risks inherent in the commercial success of a new drug once its efficacy has been illustrated. The simplest way to visualize the risks inherent in the drug development process is to examine the pharmaceutical industry's drug development success rate.

According to the California Biomedical Research Association, "only five in 5,000, or 0.10 percent, of the drugs that begin pre-clinical testing ever make it to human testing. Only one of these five is ever approved for human usage."²⁵ DiMasi et al (2010) estimate that the success rate for drugs entering clinical trials is 19 percent, confirming the California Biomedical Research Association's estimates for the clinical success rate.²⁶ And, even those studies that find a higher success rate show most drug research programs are unsuccessful. For instance, Baines (2004) estimated that the overall chance of failure in the drug development process, accounting for the discovery phase, pre-clinical phase, phase I, phase II, and phase III trials, is 98.4 percent.²⁷

Once a drug has been approved by the FDA, the companies still must secure a place for the new medication in the marketplace. Therefore, even the one in 25,000 drugs that is approved for human use (based on the California Biomedical Research Association estimate) is not ensured commercial success. Instead, these are the drugs that have the potential to cover the manufacturer's cost of capital. Whether the drug will actually cover these costs depends upon the medical marketplace. PhRMA reports that "only 2 of 10 marketed drugs return revenues that match or exceed R&D costs."²⁸

There is, consequently, a great deal riding on those "2 out of 10" marketed drugs that are able to match or exceed R&D costs. These drugs must cover the extensive capital costs for all of the failed drugs, which required \$5.5 billion in total outlays and took 10 to 15 years to bring to market. Given these realities, it should be expected that the cost of an innovative drug covering the cost of capital on R&D will be significantly higher than the cost of a generic drug (or the innovative drug off patent) that must only cover the costs of production.²⁹

An Estimate of the Annual and Monthly R&D Capital Costs for an Innovative Drug

The following numerical analysis provides a sense of the R&D capital costs that need to be covered by the creator of a new innovative drug. The analysis is a simplification of the actual pricing structure and only examines the R&D costs that must be passed through to the payer of the innovative drug – no marketing, sales, or other production costs are considered. The analysis does not fully account for the expected commercial failure rate as well, which further increases the financial pressures on those drugs that are both medically and commercially viable. Last, the R&D process does not stop once a drug is for sale on the market. Continuous testing and patient monitoring is conducted, and all of these costs may not be fully accounted for either.

The analysis illustrates the significant impact on price created by expensive R&D costs and the long drug development process. The takeaway from the analysis is that steep price declines are a sign of efficiency when drugs move from the patented competitive space to the generic competitive space. Two discrete pricing environments, where the price of a patented product is high and then significantly lower, are desirable ensuring a vibrant pharmaceutical market for patients in the long-run and the short-run.

As mentioned earlier, the total R&D costs to create one marketable innovative drug is \$5.5 billion, including the costs of failures, based on the Herper (2013) analysis. While the \$5.5 billion is the estimate consistent with the actual expenditures of the pharmaceutical companies, to provide a range of scenarios, in addition to the estimated R&D costs of \$5.5 billion, the estimated cost range from Adams and Branter (2006), which varied from \$500 million to \$2.0 billion, is also examined. The time required to develop the drug is assumed to be 15 years.

The entire R&D budget is not spent all in the first year, of course, but spread over the entire R&D timeframe. For simplicity, it is assumed that the total payments are evenly spread out over the entire 15-year timeframe. Using the \$5.5 billion cost as the example, this implies that each and every year over the 15-year timeframe the company spends \$366.7 million on research and development. Table 2 provides a detailed breakdown of these three estimated R&D costs.

TABLE 2
BREAKDOWN OF ANNUAL R&D EXPENDITURES
(ALTERNATIVE TOTAL COST SCENARIOS BASED ON CONSTANT R&D SPENDING AND 15 YEAR DEVELOPMENT PERIOD)

Year	\$500 Million R&D Costs	\$2.0 Billion R&D Costs	\$5.5 Billion R&D Costs
1	\$33.33	\$133.33	\$366.67
2	\$33.33	\$133.33	\$366.67
3	\$33.33	\$133.33	\$366.67
4	\$33.33	\$133.33	\$366.67
5	\$33.33	\$133.33	\$366.67
6	\$33.33	\$133.33	\$366.67
7	\$33.33	\$133.33	\$366.67
8	\$33.33	\$133.33	\$366.67
9	\$33.33	\$133.33	\$366.67
10	\$33.33	\$133.33	\$366.67
11	\$33.33	\$133.33	\$366.67
12	\$33.33	\$133.33	\$366.67
13	\$33.33	\$133.33	\$366.67
14	\$33.33	\$133.33	\$366.67
15	\$33.33	\$133.33	\$366.67
Total Expenditures	\$500.00	\$2,000.00	\$5,500.00

The R&D budget is spent over time, therefore, the time value of money must be taken into account. Due to the time value of money, \$366.7 million spent in the 15th year of the R&D program does not have the same value as the \$366.7 million spent in the first year of the R&D program. The easiest way to see this is to imagine one investor who is funding the entire R&D program. That investor needs \$366.7 million to fund the first year’s research efforts. That initial first year investment will not see any earnings until the innovative drug has been approved for use – in this case after 15 years. Alternatively, the investor could have put the funds that were used in the first year in an interest earning asset and earn income on that money. If that investor earned the average return on the S&P 500 between 1964 and 2014 (a 9.9 percent return), then he would have earned \$36.3 million on the money required to fund the first year of the R&D process. In year 2, the investor could have earned 9.9 percent on the original \$366.7 million, plus an additional 9.9 percent on the \$36.3 million earned in year 1.

These lost potential earnings continue to compound throughout the entire 15 year R&D process. The same logic applies to the next tranche of capital that is required to fund the R&D expenditures in year 2, except in this case there are only 14 years of potential earnings that are foregone. Repeating this process for all 15 years of the R&D program estimates the future value of the \$5.5 billion in R&D expenses. Estimating the future value is crucial because this future value represents the actual capital costs that must be repaid by the innovative pharmaceutical company during the life of its patent.

One key assumption in this calculation is the capital costs (or rate of return) used for the analysis. The example above used the average return of the S&P 500 to illustrate the concept, however, the average equity returns are not necessarily representative of the pharmaceutical industry’s actual cost of capital. Based on data calculated by the NYU Stern School of Business, the weighted average cost of capital (WACC) for the pharmaceutical industry is estimated to be 8.33 percent.³⁰ The pharmaceutical industry’s WACC is higher than the average WACC of 6.94 percent, which is a reflection of the greater risks involved in the development of innovative pharmaceuticals.

Using the NYU Stern School’s estimated WACC of 8.33 percent, the estimated capital costs of the \$5.5 billion R&D budget at the end of the R&D process is \$11.1 billion, the estimated capital costs of the \$2.0 billion R&D budget at the end of the R&D process is \$4.0 billion, and the estimated capital costs of the \$500 million R&D budget at the end of the R&D process is \$1.0 billion, see Table 3.

TABLE 3
TOTAL COST OF CAPITAL AT THE END OF THE R&D PROCESS
(ALTERNATIVE TOTAL COST SCENARIOS BASED ON 8.33 PERCENT WACC AND 15-YEAR DEVELOPMENT PERIOD)

	(in millions)		
	\$500 Million R&D Expenditures	\$2.0 Billion R&D Expenditures	\$5.5 Billion in R&D Expenditures
Total capital costs to be repaid	\$1,006.39	\$4,025.56	\$11,070.29

The innovative manufacturer must repay all of these capital costs during the time period that the innovative drug will have market exclusivity – the effective life of the patent. According to Lichtenberg and Duffos (2009) “the average period of marketing under patent protection after enactment of the Hatch-Waxman Act and the Uruguay Round Agreements Act of 1994 is about 11.5 years.”³¹

Based on this effective patent life, the innovative drug manufacturer has 11.5 years, or 138 months, to pay for its R&D capital costs. The entire capital costs, however, are not paid out all at once. Instead, because these costs are priced into the patented drug’s price. They are paid down slowly over time. Therefore, just like with any fixed payment scheme (i.e. a home mortgage) capital costs are also accruing while the innovative pharmaceutical company is paying down the previously accrued capital costs. Table 4 estimates the total capital costs that would have accrued across the three scenarios assuming the 8.33 percent WACC and the estimated 11 ½ year effective patent life. As shown in Table 4, the total capital costs for a \$5.5 billion R&D budget is estimated to be \$17.2 billion, the total capital costs of the \$2.0 billion R&D budget is estimated to be \$6.2 billion, and the total capital costs of the \$500 million R&D budget is estimated to be \$1.6 billion.

TABLE 4
TOTAL COST OF CAPITAL
(ALTERNATIVE TOTAL COST SCENARIOS BASED ON 8.33 PERCENT WACC, 15-YEAR DEVELOPMENT PERIOD, AND
11 ½ YEAR EFFECTIVE PATENT LIFE)

	(in millions)		
	\$500 Million R&D Expenditures	\$2.0 Billion R&D Expenditures	\$5.5 Billion in R&D Expenditures
Total capital costs to be repaid	\$1,567.80	\$6,271.19	\$17,245.76

The actual R&D costs that must be recovered per patient depends upon the size of the population that can benefit from the new innovative drug and the share of those who are prescribed the medication. As Table 5 demonstrates, the actual R&D costs of capital can be sizable. Based on the \$5.5 billion R&D costs, the assumptions described above, and a population of 500,000 patients, the monthly per patient costs necessary just to cover the R&D capital costs are approximately \$250, or the per patient R&D costs add nearly \$3,000 to the cost of the drug per year. If the number of patients taking the medication are above the orphan drug cut-off level (approximately 200,000 patients) then the monthly per patient costs necessary just to cover the R&D capital costs are approximately \$625, or nearly \$7,500 of R&D costs per patient per year.

TABLE 5
ALTERNATIVE MONTHLY R&D COST OF CAPITAL PER PATIENT
(ALTERNATIVE TOTAL COST SCENARIOS)

	Monthly Cost in Dollars		
# of Patients Taking the Medication (in millions)	\$500 Million R&D Costs	\$2.0 Billion R&D Costs	\$5.5 Billion in R&D Costs
0.200	\$56.80	\$227.22	\$624.85
0.500	\$22.72	\$90.89	\$249.94
1.000	\$11.36	\$45.44	\$124.97
1.500	\$7.57	\$30.30	\$83.31
2.000	\$5.68	\$22.72	\$62.48
2.500	\$4.54	\$18.18	\$49.99
3.000	\$3.79	\$15.15	\$41.66
3.500	\$3.25	\$12.98	\$35.71
4.000	\$2.84	\$11.36	\$31.24
4.500	\$2.52	\$10.10	\$27.77
5.000	\$2.27	\$9.09	\$24.99

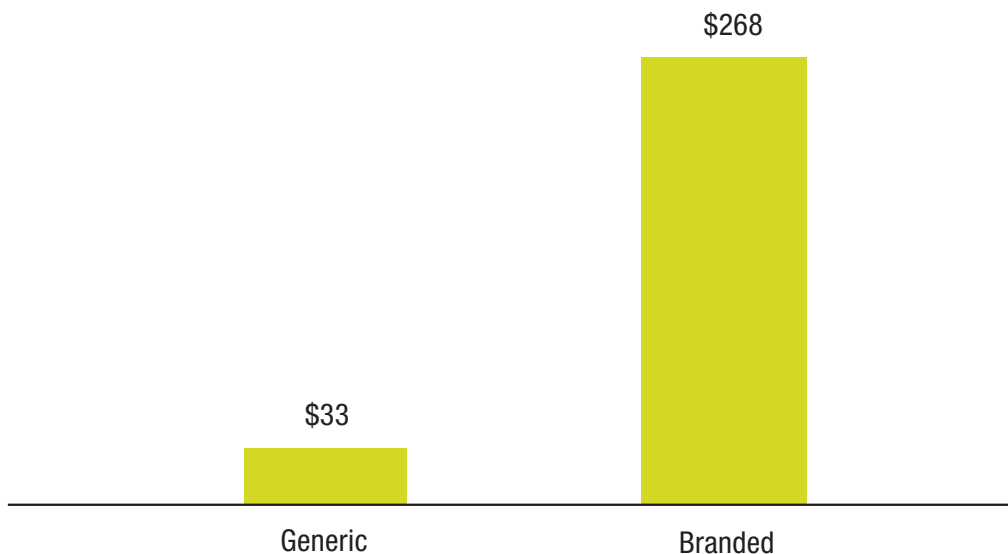
In aggregate, the total R&D capital costs that must be recouped based on a \$5.5 billion in R&D costs, based on these assumptions, would equal approximately \$125 million a month or \$1.5 billion a year over the 11 ½ years the branded drug is on patent, see Table 6. For perspective, according to IMS health data, the health care system saved \$65.2 billion due to patent expirations between 2007 and 2011, or \$13.0 billion a year.³² These reductions are consistent with the illustrative analysis presented here – particularly the estimated R&D costs associated with Herper (2013).³³

TABLE 6
ALTERNATIVE MONTHLY AND ANNUAL R&D COST OF CAPITAL
(ALTERNATIVE TOTAL COST SCENARIOS)

	(in millions)		
	\$500 Million R&D Costs	\$2.0 Billion R&D Costs	\$5.5 Billion in R&D Costs
Monthly capital costs	\$11.36	\$45.44	\$124.97
Annual capital costs	\$136.33	\$545.32	\$1,499.63

These results are also consistent with the average price for generic prescriptions in 2011 according to the Health Care Cost Institute (HCCI). According to HCCI, the average price for a generic prescription was \$33, or \$235 cheaper than the average price for a branded prescription in 2011, or \$268, see Figure 1.³⁴

FIGURE 1
AVERAGE PRESCRIPTION COSTS



(2011, Source: HCCI)

These dollar costs do not take into account the additional R&D expenses that the innovating pharmaceutical company will have to spend on safety and clinical trials after the drug has been approved (and is selling in the marketplace on patent). These expenditures are spent to better understand the therapy's possible uses; or the mechanisms that make the therapy work, particularly for certain patient sub-groups (e.g., how the drugs work for diabetic patients).

These results illustrate that once the R&D cost of capital has been covered, significant reductions in prices for generics (or for the patented product should it choose to compete in the generic space) are possible. It is important to note that these values are only illustrative. Actual prices will vary (sometimes significantly) due to different actual capital costs than those assumed here.

Conclusion

Branded pharmaceutical products require an exceptionally lengthy development period, billions of dollars in actual outlays, and are subject to large risks. Copying an innovative product once it has been created, on the other hand, is relatively inexpensive. The combination of these factors creates a major obstacle for the pharmaceutical industry. These problems are further compounded by the inefficient health care regulations that distort pricing signals across the health care sector.

Despite these inefficiencies, innovative pharmaceutical manufacturers must be able to attract the necessary financial resources from investors to create new and better medications for patients. The current patent system, with all of its flaws, establishes a system that enables this process to occur.

The patent system provides a period of market exclusivity that grants an innovator company the opportunity to recoup its R&D costs of capital. By giving the innovating company the chance to recoup its costs of capital, the industry is able to attract investment that funds innovations that will improve patients' outcomes in the future. However, because a competitive market that includes generic products reduces prices and benefits patients today, an innovator company's market exclusivity period is limited.

This study presented the theory and key data illustrating that the market results created by the patent system – higher prices while on patent, and steep price declines that occur in the market for patented drugs once its patent expires – is the efficient and desired result. This market result balances the sometimes conflicting needs to fund the large expenses of developing new innovative drugs and making drugs as affordable as possible.

Endnotes

1 Citations for all numbers and references can be found in the main body of the text.

2 The price of the Apple Macintosh in 1984 is from: <http://oldcomputers.net/macintosh.html>; the value is converted to today's dollars using the annual CPI data from the Bureau of Labor Statistics, <http://www.bls.gov/cpi/>.

3 Vernon, JA, Golec, JH, Dimasi, JA. (2010) "Drug development costs when financial risk is measured using the Fama-French Three Factor Model" *Health Econ*; 19(8):1002-1005.

4 Lichtenberg, Frank R. and Duflos, Gautier (2009) "Time Release: The Effect of Patent Expiration on U.S. Drug Prices, Marketing, and Utilization by the Public", Center for Medical Progress at the Manhattan Institute, October.

5 "National Health Expenditure Projections; 2012-2022" Centers for Medicare and Medicaid Services; <http://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/National-HealthExpendData/NationalHealthAccountsProjected.html>.

6 These figures imply that the average life expectancy (in years) increased by 0.75% to 1.00% per year during this time period. See: Lichtenberg, Frank R. (1998) "Pharmaceutical Innovation, Mortality Reduction, and Economic Growth" *NBER Working Paper No. 6569* May, accessed April 16, 2014.

7 Lichtenberg, Frank R. (2004) "The Expanding Pharmaceutical Arsenal in the War on Cancer" *NBER Working Paper No. 10328* February, accessed April 16, 2014.

8 Shang, Baoping and Goldman, Dana P. (2007) "Prescription Drug Coverage and Elderly Medicare Spending" *NBER Working Paper 13358*, September; <http://www.nber.org/papers/w13358>.

9 Stuart, Bruce C, Doshi, Jalpa A, and Terza, Joseph V (2009) "Assessing the Impact of Drug Use on Hospital Costs" *Health Services Research*, February, 44(1): 128-144; <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2669633/>.

10 Santerre, Rexford E. (2011) "National and International Tests of the New Drug Cost Offset Theory", *Southern Economic Journal*: April 2011, Vol. 77, No. 4, pp. 1033-1043.

11 Source: Centers for Medicare & Medicaid Services, Office of the Actuary: Data from the National Health Statistics Group.

12 Source: Centers for Medicare & Medicaid Services, Office of the Actuary: Data from the National Health Statistics Group.

13 These costs are referred to as sunk costs in the economics literature.

14 Typically the effective exclusivity period is around 10-12 years currently.

15 It is important to note that not all medicines will be able to cover their cost of capital – as in any market, failure is an option. As noted earlier, only 2 out of 10 medicines are profitable. However, as an entity, a drug manufacturer must cover the company-wide cost of capital, otherwise the company will eventually go out of business.

16 “Fact Sheet: New Drug Development Process” *California Biomedical Research Association*; <http://ca-biomed.org/pdf/media-kit/fact-sheets/CBRADrugDevelop.pdf>.

17 “2013 Profile” *PhRMA*; <http://www.phrma.org/sites/default/files/pdf/PhRMA%20Profile%202013.pdf>. PhRMA cites the following studies to substantiate the 10-15 year development time estimate: PAREXEL International. “PAREXEL Biopharmaceutical R&D Statistical Sourcebook 2010/2011.” Waltham, MA: *PAREXEL International*, 2010; M. Dickson and J.P. Gagnon. “Key Factors in the Rising Cost of New Drug Discovery and Development.” *Nature Reviews Drug Discovery* 2004; 3(5): 417-429; J.A. DiMasi, R.W. Hansen, and H.G. Grabowski. “The Price of Innovation: New Estimates of Drug Development Costs.” *Journal of Health Economics* 2003; 22(2): 151-185.

18 Damodaran, Aswath (2014) “Annual Returns on Stock, T.Bonds and T.Bills: 1928 – Current” *NYU Stern School of Business*; Updated January 5, 2014; http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/histretSP.html.

19 The 9.9 percent figure is the average annual return on the S&P500, which includes some pharmaceutical companies. The precise alternative investment figure would exclude the impact of the pharmaceutical companies on the return of the S&P 500. However, the unadjusted figure provides a good approximation of the necessary competitive returns.

20 DiMasi Joseph A. and Grabowski, Henry G. “The Cost of Biopharmaceutical R&D: Is Biotech Different?” *Managerial and Decision Economics*, Vol. 28, Nos. 4-5 (June-August 2007), pp. 469-497; (2013) “2013 Profile: Biopharmaceutical Research Industry” *PhRMA* July.

21 Adams, Christopher P. and Brantner, Van V. (2006) “Estimating The Cost Of New Drug Development: Is It Really \$802 Million?” *Health Affairs*, 25, no.2, 420-428; <http://content.healthaffairs.org/content/25/2/420.full.pdf+html>.

22 Herper, Matthew (2013) “The Cost of Creating a New Drug Now \$5 Billion, Pushing Big Pharma to Change” *Forbes.com*, August 11; <http://www.forbes.com/sites/matthewherper/2013/08/11/how-the-staggering-cost-of-inventing-new-drugs-is-shaping-the-future-of-medicine/>.

23 Herper, Matthew (2013) “The Cost of Creating a New Drug Now \$5 Billion, Pushing Big Pharma to Change” *Forbes.com*, August 11; <http://www.forbes.com/sites/matthewherper/2013/08/11/how-the-staggering-cost-of-inventing-new-drugs-is-shaping-the-future-of-medicine/>.

24 Herper, Matthew (2013) “The Cost of Creating a New Drug Now \$5 Billion, Pushing Big Pharma to Change” *Forbes.com*, August 11; <http://www.forbes.com/sites/matthewherper/2013/08/11/how-the-staggering-cost-of-inventing-new-drugs-is-shaping-the-future-of-medicine/>.

25 “Fact Sheet: New Drug Development Process” *California Biomedical Research Association*; <http://ca-biomed.org/pdf/media-kit/fact-sheets/CBRADrugDevelop.pdf>.

26 DiMasi, JA, Feldman, L, Seckler, A, and Wilson, A (2010) “Trends in Risks Associated with New Drug Development: Success Rates for Investigational Drugs” *Clinical Pharmacology & Therapeutics* Vol. 87 No. 3 March.

27 Baines, William (2004) “Failure rates in drug discovery and development: will we ever get better?” *Drug Discovery World*, Fall.

28 “2013 Profile” *PhRMA*; <http://www.phrma.org/sites/default/files/pdf/PhRMA%20Profile%202013.pdf>. PhRMA cites the following study to substantiate the 2 in 10 marketed drugs claim: J.A. Vernon, J.H. Golec, and J.A. DiMasi. “Drug Development Costs When Financial Risk Is Measured Using the Fama-French Three-Factor Model.” *Health Economics* 2010; 19(8): 1002–1005.

29 While not considered here, the costs can be even greater than what is described here. If each drug that successfully completes the safety and efficacy trials costs \$5.5 billion, but only 1 out of 5 of these drugs is commercially viable, then the actual R&D capital costs that need to be recovered could be a multiple of the \$5.5 billion.

30 “Cost of Capital by Sector” *NYU Stern School of Business*, Updated January 2014; http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/wacc.htm.

31 Lichtenberg, Frank R. and Duflos, Gautier (2009) “Time Release: The Effect of Patent Expiration on U.S. Drug Prices, Marketing, and Utilization by the Public” Center for Medical Progress at the Manhattan Institute, October.

32 (2012) “The Use of Medicines in the United States: Review of 2011” *IMS Institute for Healthcare Informatics*, April; http://www.environmentalhealthnews.org/ehs/news/2013/pdf-links/IHII_Medicines_in_US_Report_2011-1.pdf.

33 According to Method (2009) an average of 7 and 12 drugs came off patent each year between 2009 and 2011; see: Method, Kathy (2009) “Going, going, gone” *Drug Topics*, August; <http://drugtopics.modernmedicine.com/drug-topics/news/modernmedicine/modern-medicine-feature-articles/going-going-gone?id=&sk=&date=&pageID=2>. Using an average of 10 drugs expiring per year, the IMS data would imply a per drug savings of \$1.3 billion a year.

34 (2012) “Spending on Prescriptions in 2011: Findings from HCCTI’s Health Care Cost and Utilization Report: 2011” *Health Care Cost Institute*, Issue Brief #4, September.

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