

*The Elasticity of Demand With Respect to Product Failures;
or Why the Market for Quack Medicines Flourished for More Than 150 Years*

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Abstract

Between 1810 and 1939, real per capita spending on patent medicines grew by a factor of 114; real per capita GDP by a factor of 5. The long-term growth and survival this industry is puzzling when juxtaposed with standard historical accounts, which typically portray patent medicines as quack medicines. This paper argues that patent medicines were distinguished from other products by an unusually low elasticity of demand with respect to product failure. While consumers in other markets stopped searching for a viable product after a few failed attempts, consumers of patent medicines kept trying different products, irrespective of the number of failed medicines they observed. The market expanded as the stock of people buying potential cures accumulated over time. Because no one was ever cured and consumers possessed a highly inelastic demand with respect to product failures, demand was unrelenting. In short, patent medicines flourished not despite their dubious medicinal qualities, but because of them. There is also evidence that genuine medical advances, such as the rise of the germ theory of disease and new therapeutic interventions, helped expand the market for quack medicines.

0. Introduction

Figure 1 plots spending on patent medicines and GDP per capita from 1810 through 1939.¹ Both series are in constant (US) dollars and are normalized to a value of 1 in 1810. Between 1810 and 1939, real per capita spending on patent medicines grew by a factor of 114; real per capita GDP by a factor of 5. Growing 22 times more than the economy as a whole over this period, individual spending on patent medicines rose from \$0.39 per year in 1810, to \$2.94 in 1860, to \$12.69 in 1889, to \$26.07 in 1919, and to \$44.89 in 1939 (2009 dollars). This is not a low base effect. Spending grew relatively quickly over the entire nineteenth century; growth slowed only after 1900. Between 1810 and 1939, Americans spent a cumulative \$158 billion (2009 dollars) on patent medicines. By 1909, out of 259 industries counted by the *Census of Manufactures*, the patent-medicine industry ranked 38th (85th percentile) based on the aggregate market value of its products. In this way, it rivaled industries such as lead refining, illuminating gas, fertilizers, agricultural implements, paint and varnish, and chemicals.

The magnitude and sustained growth of the patent medicine industry is puzzling when juxtaposed with standard historical accounts, which typically portray patent medicines as the fruits of quackery—for purposes of this paper, quackery is defined as any medical product or service that involves drugs and therapies devoid of curative power that providers nevertheless claim fully cure (not simply treat or ameliorate) diseases of various origin and effect. According to prevailing wisdom, patent medicines promised to cure everything from cancer and epilepsy, to kidney disease and tuberculosis, but left the patient no better off than before treatment, and

¹The phrase “patent medicines” is a misnomer. With a handful of unimportant exceptions, patent medicines were not patented. The phrase is used here only because it is convention; it is, for example, the label used by the U.S. Census and most historical observers to identify the industry. “Proprietary medicines” would be a more accurate descriptor.

often had deleterious long-term health consequences.² Evidence presented in section 3 supports prevailing wisdom. In light of this, it is not immediately obvious how to reconcile the data and observations presented in the opening paragraph with the sort of economic reasoning that predicts markets based on deceptive advertising and consumer misinformation would be fleeting and minor affairs. Simply put, one does not normally expect strong consumer demand for products that routinely fail to deliver on the promises made by their manufacturers, and more often than not, leave consumers worse off than they were before they purchased the product. Yet, patent medicines flourished in United States for roughly 150 years, rivaling in size industries that had much stronger claims to economic legitimacy.

This paper explains why the market for quack medicines was so robust. The analysis proceeds in three parts. First, a simple model is constructed. The model suggests that patent medicines are distinguished from other products by what might be called an unusually low elasticity of demand with respect to product failure. While consumers in more typical markets stop searching for a viable product after a few failed attempts, consumers of patent medicines kept experimenting with different products, irrespective of the number of failed medicines they tried or observed others trying. What drove market expansion in this context was that the stock of people buying potential cures accumulated over time. Because no one was ever cured and consumers possessed a highly inelastic demand with respect to product failures, demand was unrelenting. Put another way, patent medicines proliferated and flourished not despite their dubious medicinal qualities, but because of them. If the typical medicine had been as effective in its realm as the typical agricultural implement or unit of illuminating gas had been in theirs, people would have been cured, search would have been reduced, and spending would have

²For modern historians who portray patent medicines as quack medicines, see for example: Holbrook (1959); Young (1961); Anderson (2000); and Jameson (1961). For direct first-hand observations by historical actors, see for example: Prescott (1882); Osborne (1904); Brashford (1911); and Fosbroke (1842).

been curtailed.

The second part of the paper uses the model to rationalize the market's history and development, including the following observations: that the number of medicines proliferated and grew increasingly bizarre with time; that specific brands of medicine of dubious value had product lives of 100 years or more; that prices did not rise over time; that manufacturers advertised heavily; that advertising was fraudulent and misleading; that older, more established firms advertised as much as, or even more, than new entrants; that a fairly competitive market existed despite large investments in advertising and product differentiation; and that the market was robust to competition from honest medical providers and finite increases in the stock of medical knowledge. The paper also considers a series of alternative explanations for these historical patterns, including the possibility that historians are mistaken in their characterization of patent medicines as quack medicines, and that the products had some medicinal value; the possibility that, because some patent medicines contained morphine, opium, and alcohol, their persistence was the result of addiction or a social convention that would have otherwise discouraged drinking alcohol or taking drugs; and the possibility that with sufficiently large elasticities, changes in relative prices, the effectiveness of physician care, and consumer income might account for the rapid growth of patent medicines.

The third part of the paper explores why the market for quack medicines was robust to two changes: growing competition from legitimate physicians, who became increasingly effective and productive between 1800 and 1950; and the rise of the germ theory of disease, a scientific breakthrough that transformed medical understanding regarding the pathogenesis of infectious diseases. Ideally, competition from legitimate physicians, even if they were relatively high priced, would have given consumers a viable alternative to quack medicines. In addition, as documented below, legitimate physicians, even if they could not cure many ailments, were honest, telling their patients that certain afflictions were incurable. Ordinary practitioners

recognized that for many diseases some things might be done to ameliorate the pain, or treat observable symptoms, but also understood that the underlying pathology was beyond the reach of nineteenth-century medicine. By the same token, the rise of the germ theory not only led to the eradication of a whole range of diseases, it also should have made patients more knowledgeable and thereby more discriminating in their health-care choices. Yet contrary to this otherwise intuitive reasoning, there is only weak evidence to suggest that these medical innovations posed significant obstacles to the growth of the patent medicine industry. This result is consistent with the model. As explained below, the model suggests honest, high-quality providers of medical services would have been at a competitive disadvantage relative to quack providers, and that finite increases in knowledge on the part of consumers would not have been sufficient to drive demand for quack medicines to zero.

The survival of quack medicines in the face of improvements in medical knowledge and physician efficacy and productivity is compelling on at least two levels. First, it illustrates how scientific advances do not necessarily translate into improved consumer knowledge. Second, it suggests mechanisms through which quack medicines can not only withstand innovations that make legitimate physicians more effective in their (genuine) battle against disease, but could actually benefit from such innovations. These mechanisms are simple. For example, the germ theory gave rise to a series of public health initiatives that helped eradicate infectious diseases such as typhoid fever, diphtheria, infantile diarrhea, and measles. At least in the United States, the near eradication of these diseases shifted the age distribution upward; the average age of the population rose. Because older individuals had more long-term chronic health problems than younger ones and most quack medicines were marketed as cures for chronic diseases, and because infectious diseases killed relatively quickly before the sick had a chance to search out (and purchase) all possible cures, demand for quack medicines rose as a consequence of the germ theory. This finding implies that quack medicines can grow more prevalent as the

median age of the population rises, as it now is in most countries.

1. A Rudimentary Model of the Patent Medicine Industry

1. *The Basic Set-Up*

Ex post, it is clear that the market for patent medicines was a mistake; consumers spent a lot of money doggedly pursuing cures that did not exist. But hindsight is always 20/20. The relevant question is whether an exhaustive search for an effective medicine could have been rationalized *ex ante*, and the answer to that question is yes. In a world where the value of a cure was high, the cost of trying and experimenting with various medicines was relatively low, and medical knowledge was limited—even on the part of the most accomplished physicians and scientists—it might well have made good sense to thoroughly and unrelentingly explore the efficacy of otherwise bogus medicines. Furthermore, the notion of a class of goods or services with a very low elasticity of demand with respect to product failures does not preclude consumer learning. Imagine that patients lower their expectations that a particular medicine works as they observe the medicine failing to generate a cure in an increasing number of cases. As long as the price of the medicine is sufficiently low and the value of a cure remains high, patients might rationally decide to purchase the medicine even as the number of failed cures rises and the probability that the medicine is efficacious approaches zero asymptotically.

Consider some patient, i , who is afflicted with a chronic disease. The patient searches for a cure to the disease in sequential periods, trying one new medicine, m , per period. The patient only exits the market if an effective medicine is found (and cures i) or if additional tries are deemed uneconomical. There is no random recovery, and unbeknownst to i , no cure exists. Nor does the patient know that all of the medicines are fundamentally the same product only with different names, promotional strategies, wrappers, and packages. As explained below, most patent medicines contained the same basic set of benign ingredients: alcohol,

sugar, and some vegetable matter. The expected net benefit of medicine m to person i is,

$$(1) \quad E(b_m) = (\pi_m)V - p_m,$$

where, π_m is the probability that m would affect a cure; V is the value of a cure in monetary units, and is constant across all medicines and patients; and p_m is the price of m , where $p_m > 0$. Consumer i purchases the medicine if $E(b_m) \geq 0$.

The most important element of equation (1) is π_m , the patient's ex ante assessment of the efficacy of m . The patient formulates this probability assessment based on his or her knowledge of general medical and scientific principals, and by observing the how various patent medicines have worked in earlier periods for i and for other patients. More precisely,

$$(2) \quad \pi_m = 1/(\kappa + f),$$

where, κ is i 's stock of knowledge, with higher numbers indicating greater knowledge and 1 indicating complete ignorance so that $\kappa \geq 1$; and f is the frequency with which i observes m and various other medicines failing to cure patients in earlier periods. For the moment, it is assumed that because patent medicines were devoid of curative power and therapeutic value, the patient observes nothing but failures; this assumption is dropped later in the analysis. The idea here is that the patient's belief in the efficacy of m would be reduced more after observing patent medicines fail 100 times out of 100 tries than by observing medicines fail 2 times out of 2 tries. A shortcoming of this approach is that f weights all failures identically. For example, if i observes medicine m failing to cure patient j ($j \neq i$), he or she treats that failure the same as medicine $m-1$ failing to cure patient j . Recall that i tries one medicine per period, and has no direct experience of m when he or she first purchases it.

Given this functional form, π_m approaches zero asymptotically and the only agents to set π_m equal to zero (the correct assessment) are those with either infinite knowledge ($\kappa = \infty$) or infinite experience ($f = \infty$). Because patient i 's willingness to pay for one unit of m is the product ($\pi_m \times V$), willingness-to-pay (WTP) behaves identically. Figure 2 illustrates the case where

consumers attach a monetary value of 500 to an effective cure, and have minimum knowledge ($\kappa = 1$). See the line labeled “first example”; ignore the other plots for the time being. The first failure cuts i 's WTP in half to 250; the second failure cuts it to 167; the third to 125, with the absolute reduction in WTP becoming progressively smaller with each observed failure. That WTP decreases at a decreasing rate with respect to failures suggests it is possible to have a market that persists in the face of millions of failures, so long as the producers can manufacture and distribute m at a price at or below the WTP . At $f = 3,000$, for example, producers would need to set p_m at or below .167 to induce consumer i to purchase m . Compare this set up to one where even the least knowledgeable consumer discovers that m does not work after a finite number of observed failures:

$$(3) \quad \pi_m = (W - \kappa - f)/(W - \kappa).$$

Setting $W = 6$ and $\kappa = 1$, patient i would conclude that m is not efficacious after observing only five failures to cure, and would quickly refuse to purchase any medicine with a non-zero price.

Equation (2) seems a more appropriate set up than (3) for any class of products or services where it is prohibitively expensive for consumers to know and learn, with complete certitude, that the good would not or does not function as promised. As explained in section 1.b, the case for π_m approaching but never reaching zero becomes even more plausible if one allows manufacturers to invest in advertising and brand development strategies that effectively mislead consumers and obfuscate the incidence of product failures.³ There is also a historical rationale for embracing equation (2). For any finite κ , equation (2) is predicated on the idea that consumers before 1950 did not know enough about disease and human physiology to reject quack medicines out of hand. Instead, they had to discover medicinal value through

³While theory suggests that such strategies are unprofitable (e.g., Kihlstrom and Riordan 1984; Milgrom and Roberts 1986), they can be profit-maximizing when consumer demand is not sufficiently responsive to product failures.

experimentation and first hand observation. Their experimenting took the form of purchasing and ingesting a series of medicines until they found one that worked. This is not a strong a claim. Arriving at cures through experimentation, without the aid of any theoretical guides, was common practice among physicians for more than a thousand years. From the ancient Greeks through the early 1800s, a branch of medicine known as empiricism ignored discoveries in human physiology and the etiology of disease, and instead studied only how drugs affected the sick (Horton 1891; Stancell 1896, pp. 144-45). To assume that consumers adopted the same crude empiricism that physicians had used for centuries does not require a Herculean leap.⁴

Consistent with equation (2) as well are the views of historical actors who portrayed the market for patent medicines as a market for chance; a market in which consumers were fully aware that the probability of finding an effective medicine was very low; and a market in which consumers repeatedly purchased medicines that they were nearly certain did not work.

Consider the following quotation from an article by Albert Prescott (1881, p. 154), a Professor of Chemistry at the University of Michigan:

Just as men driven to straits will put their last pittance into the lottery instead of the savings bank, or as men find in their natures a temptation to venture their prospects at the gaming table, or as harassed persons in critical times turn to the fortune teller, so, with the better excuse of bodily prostration and nervous restlessness, against his own judgement, and suffering with a glimmering apprehension of the wholly unscrupulous character of the human harpies who practice on his credulity, the sick man tries one game of chance among the unknown remedies, and tries again, one more, and tries one after another. But mark you, here is a difference: the lottery wheel, the gaming table, and the fortune teller are fully outlawed by the common intelligence of the times, and their victims are few, but on the other hand the miracle-promising panaceas are not fully discarded by the current thought of the people, and their victims are very many.

Three aspects of this quotation merit comment. The first is how Prescott likens the search for

⁴A small literature in health economics indicates that similar exercises in self-medication are rife in the developing world today (e.g., Chang and Trivedi 2003; Hjortsberg 2003).

an effective patent medicine to a game chance. The second is how he describes both the game of chance and the unrelenting quest for a cure as the result of desperation. The third is how he describes patients returning repeatedly to medicines of dubious efficacy, trying one failed medicine “after another.”

1.b. The Elasticity Parameter, η , and the Origins of Fraudulent and Misleading Advertising

It is useful at this stage to add a parameter to equation (2) that defines the elasticity of demand with respect to observed product failures. In this regard, the elasticity parameter, η , determines the rate at which consumers lower the expected probability of success, as well as their willingness-to-pay, in response to failures. Introducing η modifies equation (2) as follows:

$$(4) \quad \pi_m = 1/(\kappa + (\eta^{\eta})),$$

where $\eta > 0$. Consumer priors and willingness-to-pay become more (inelastic) elastic with respect to observed failures as η (approaches zero) increases. Setting $\kappa = 1$, figure 2 illustrates the relationship between willingness-to-pay and product failures for four different values of η : .05, .5, 1, and 2. Assume for the moment that all of the medicines on the market are produced by a single manufacturer. If so, one might think of η as defining the penalty the manufacturer incurs for selling consumers medicines that do not work: the more bogus medicines the producer sells, the more he must discount his price to induce other consumers to buy his product; η specifies the magnitude of those discounts. Larger η 's imply larger discounts; smaller η 's, smaller discounts.

Because the penalty for misleading consumers rises as η rises, one expects more fraudulent and misleading advertising in markets where demand is inelastic with respect to failures than in those where demand is elastic. More formally, let A indicate the level of fraudulent and misleading advertising in any given industry or market:

$$(5) \quad A = a(\eta),$$

and $a_{\eta} < 0$. For purposes of this paper, it assumed that the advertising operates the same way

random recoveries do in Spiegel (2006): advertising creates false positives, sending consumers misleading signals about the efficacy of patent medicines. Historically, these signals came in three varieties. First, marketers published long and largely fictitious letters testifying to the efficacy of the medicine. These testimonials gave consumers the impression that more people were recovering from the product than actually were. Second, the medicines themselves often contained herbal laxatives, cathartics, relaxants, or stimulants. These ingredients, while they did not actually cure anyone, generated physiological changes that patients sometimes misconstrued as improvement or even recovery. Laxatives and cathartics were common, for example, in medicines that promised to purge the blood of disease-causing toxins. Third, producers can invest in re-branding. By convincing i that medicine m' is a wholly new and original product, distinct from all those products that he or she has observed fail on prior occasions, producers would have induced i to disregard those failures and discount m' less than otherwise.

These observations suggest a second modification to equation (2). Let ε indicate the number of positive signals consumer i receives through misleading advertising so that,

$$(6) \quad \varepsilon = e(A),$$

where, $e_A > 0$, and $e_{AA} < 0$. The negative second derivative reflects the possibility that with excessive amounts of advertising, consumers eventually come to recognize advertising for what it is (empty promises), and begin ignoring it. These positive signals have the potential to nullify the effects of both knowledge and observed product failures so that equations (2) and (4) can be rewritten as follows:

$$(7) \quad \pi_m = 1/(\kappa + (f^i) - \varepsilon),$$

where, $0 \leq \varepsilon \leq (\kappa + (f^i) - 1)$. When ε reaches the upper bound (i.e., $\varepsilon = (\kappa + (f^i) - 1)$), the cumulative impact of the misleading signals is to trump experience and knowledge, and the consumer assigns a probability of 1 to medicine m working as promised. Allowing for (false)

positive signals creates a second avenue through which η can influence the formation of expectations regarding curative and therapeutic efficacy. To see this, note that equation (7) can be rewritten as:

$$(8) \quad \pi_m = 1/(\kappa + (f') - s(\eta)),$$

where, $s(\eta) = e(a(\eta))$, $s_\eta < 0$, and $s_{\eta\eta} > 0$.

1.c. η , Spending Growth, and the Emergence of Long-Term Brands

A surprising characteristic of markets with a very low elasticity of demand with respect to product failure is that growth in spending can be higher in situations where the product does not work as promised than in those where it functions properly. Consider a population of 4 people, each of whom survives 4 periods. In each period, one of those individuals experiences some sort of a morbidity shock that prompts them to enter the market for patent medicines. Once shocked, the patient searches for an efficacious product, purchasing one brand of medicine per period and stopping only if a cure is found. Assume that demand is perfectly inelastic with respect to product failures so that each patient keeps trying different medicines, regardless of how many failures are observed. Assume also that the price, p , is constant over time and across medicines. If so, total spending would grow fourfold over the four periods, with patient 1 purchasing one unit in the first period, patients 1 and 2 both purchasing one unit in the second period, and so on. On the other hand, if the medicines cured people, spending would be constant because the number of people searching for a cure would not accumulate over time. One patient per period would enter, buy a medicine, experience a cure, and exit the market.⁵

It is easy to imagine patients regularly trying new and emerging medicines in a tenacious search for an effective cure. It is much harder to understand why patients would continually cycle through old and demonstrably ineffective brands of medicines, medicines that

⁵Presumably, the price of an effective medicine would be higher than the price of bogus medicines. But this only raises the price level; it does not effect the growth rate in spending.

had already failed to cure thousands of other people. But as documented below in section 3, there were many brands of patent medicines that had product life cycles of more than 100 years. One possible explanation for the long-term survival of specific brands is a natural extension of the η -construct built above. Thus far, it has been assumed that patient i is considering purchasing m for the first time. Accordingly, the preceding discussion has considered patient i 's demand for medicine m in relation to the failures i observes among other patient's using m , the failures among other patient's using various medicines not- m , and the failures experienced by i with various medicines not- m . But to explain the emergence and persistence of specific brands of medicine, it is necessary to drop the assumption that i has never purchased m before, and consider situations where i might continue to use m despite the fact it has failed to cure i on multiple occasions in the past.

To generate long-term brands, one does not need patients using the same medicine for extended periods of time. If persistence on the part of i signals to other patients that the medicine m might be working only a little persistence is required; suppose each patient uses m across two or three periods rather than abandoning it after just one. A well-designed quack medicine could generate such short-term persistence. As already mentioned, patent medicines often contained herbal components that induced noticeable physiological changes such as drowsiness or increased regularity. Although these changes did nothing to ameliorate the underlying condition, they might have given the patient the inaccurate impression that the medicine was working and that all that was required was little more time for it to affect a full-blown cure. Along the same lines, cancer cures often contained powerful corrosive and caustic agents that burned away the patient's skin with repeated use. While such medicines undermined the long-term chances of survival, for a short time their corrosive properties gave patients the false sense that the medicine was eating away at the underlying malignancy and it is entirely possible that victims of this sort deception perished before ever realizing that they

had been taken (Barnesby 1910, p. 87; Bashford 1911).

Assume that patent medicine advertising generate three types of signals, depending on the source of the signal: the medicine might be improving the patient's condition (maybe); the medicine is not improving the patient's condition (no cure); and the patient is cured (cure). Because the medicine possesses no genuine curative power, advertisers can only signal "cure" by publishing fraudulent testimonials in newspaper ads. They can, however, signal "maybe" with genuine patients by putting the correct mix of ingredients in their medicines. No assumption is made about which signal is more effective, though one might imagine situations where a "maybe" from a close friend or relative means more than a miracle cure testified by some unknown individual in a newspaper ad. Whatever the relative effectiveness of printed testimonials and communication with friends and relativeness, a medicine that generates lots of maybes would have an advantage over other medicines that are less able to deceive patients. Most consumers would eventually learn that while the medicine in question made them sleepy or more regular, it was doing nothing to cure their cancer or kidney disease. But in the meantime, their repeated use of the product would have signaled maybe to many other potential customers. This process explains why most patent medicines did not simply contain water or some other cheap, inert substance: to generate anything more than a one-shot purchase by the patient, producers had to square their products with consumers' preconceived notions about how a medicine should look, taste, and smell, and the products had to generate physiological changes to get consumers to think they were working.

2. What Would a Market With a Low η Have Looked Like?

The central proposition of this paper is that market for patent medicines was characterized by a consumer demand function that was highly inelastic with respect to product failures. The discussion above suggests that such a market would have had the following six

characteristics.

Prediction 1: Specific brands of medicine devoid of curative or therapeutic value could have long product lives. Their survival would have been predicated on a set of ingredients that induced physiological changes that fooled consumers, for at least a limited amount of time, into believing that the medicine was working. Consumers trying a medicine for multiple periods signaled to other potential consumers that maybe this medicine is working.

Prediction 2: Because markets with a low η do not punish firms for misleading advertising, and on the contrary, positively encourage it, one expects the market for quack medicines to have been rife with fraudulent and exaggerated advertising claims. Why promise to cure just one disease, and unnecessarily limit your market? Promise to cure everything, and more people try the product—the more vile, painful, and incurable the disease, the better. Similarly, do not just claim to make the patient feel better, promise a full blown cure.

Prediction 3: There are at least two reasons to expect older firms to have advertised as much, or more than, newer firms. First, because older firms had longer histories, they had more failures to overcome. New products had an advantage in this sense. Second, because no one was ever truly cured with these medicines, manufacturers could not rely on their reputations and word-of-mouth to sell their products. They had to continually tell patients that their product was effective. This prediction contrasts sharply with the information model of advertising which predicts advertising expenditures peak when the product is first introduced—to inform consumers of its presence and promote its diffusion—and decay as the product ages. (See Horsky and Simon, 1983, for a model and evidence.)

Prediction 4: The number of brands of medicine would have proliferated and grown increasingly bizarre with time. In the context of equation (7), by creating new products and new brands of medicines, the promoters of quack medicines raised π_m by increasing ε . A well-devised new brand signaled to consumers that the product was novel and different from its

predecessors, and that consumers should ignore all those other failed medicines that they observed others using or tried first hand. With new brands of medicines continually emerging, one also expects that the market for patent medicines would have grown increasingly competitive with time.

The prediction that the market would become more and more competitive over time becomes even more plausible when one considers that developing, producing, and distributing patent medicines demanded no more special skills than those required to build a still and distribute bootleg whiskey. For example, Lydia Pinkham, the inventor of the immensely successful Pinkham's Vegetable Compound, was a housewife with no training in medicine or any other field. All she had was a ne're-do-well husband who drove her to search out a successful vocation in an act of financial desperation (Holbrook 1959, pp. 58-69). Similarly, the inventor of Warner's Safe Cures manufactured safes and bank vaults before he turned to medicine. A study of quackery in Germany around 1900 found that 60 percent of all quack providers were ordinary day laborers before entering the business; 40 percent had only an elementary school education; and 30 percent had criminal records (Osborne 1904, p. 3).

Prediction 5: Prices would have fallen with time for two reasons. First, because failures (f) accumulated with time, consumers would have steadily reduced expected efficacy (π_m). The extent to which prices fell, however, would have differed across products. In particular, the price of medicines for which failures were especially difficult to observe would have been smaller than for other products. For example, given the social stigma and shame associated with venereal disease, patients probably did not communicate effectively with one another regarding their experiences with various medicines, as say, patients with arthritis or kidney disease. Second, as the number of brands and products proliferated (see prediction 2), the market would have grown increasingly competitive and drove down prices independent of the effects of consumer updating. In addition, to the extent that consumers attached a very low

probability to any given medicine working, prices would have been low relative to potential value (imagine a cure for cancer selling for \$20 in 2009 dollars).

Prediction 6: The market for quack medicines would have been robust to both (a) finite increases in consumer knowledge; and (b) competition from an honest, high-quality physicians. Proposition (a) stems from the functional form specified in equation (2), which as explained above seems an appropriate structure in any environment where it is very difficult to be 100 percent certain that marketing claims are false.

Assuming that high-quality (i.e., non-quack) physicians incurred higher costs of production perhaps because they required greater training, proposition (b) flows from two observations. First, the high-cost provider would have trouble signaling high quality through advertising because all providers, even the low-quality ones, are using their advertising to signal high quality. Consumers would therefore discount the claims of the high-quality provider just as much as they discount the claims of the low-quality, dishonest provider. Second, if the high-quality provider is also honest his or her advertising might actually signal lower quality. In the case of patent medicines, consider the services of a legitimate, high-cost physician who was honest, well-trained, and understood human physiology and the etiology of disease. Such a physician would have told the patient sick with cancer or kidney disease that the condition was incurable, though medications to ameliorate the pain would have been available and prescribed. (See section 4 for a history of the competition between legitimate physicians and patent medicines.) The same physician might have also told the patient: “don’t waste your money on patent medicines; they will not be able to cure you either.” But absent some independent authority telling patients that the physician knew more than the advertiser of patent medicines, it is not clear why patients would have attached any more meaning to such a statement than they attached to advertisements.

Given the threat that science—even nineteenth-century science—posed to quack

practitioners, it is no surprise that defenders of patent medicines argued that there was no such thing as medical authority. According to the quacks, general scientific principles did not dictate what medicines worked or failed; only individual experience mattered. Consider the following editorial from *Scribner's Monthly* (June 1881, p. 304) defending the magazine's practice of publishing advertisements for patent medicines, despite objections from physicians:

There is no such thing as medical authority. Medicine is all empirical. Diseases change in their type, from generation to generation, local influences and climatic perturbations, and variety of temperaments and constitutions in the sick themselves, make every new case a special case, removed from all fixed rules of practice, and place every exhibition of medicine in the category of experiments.

According to *Scribner's*, the absence of generally accepted principles meant that all patients could do was try various medicines until they found one that worked. Consumers, not physicians, dictated medical efficacy: "The people are, and are obliged to be, the only judges of medicine and of physicians. They are always obliged to select those agencies for their own healing which seem the best, and to what comes of it."

3. Were Patent Medicines Really Quack Medicines?

Prediction 1 suggests that long-term brands emerged because well-designed quack medicines contained ingredients, that while not curative in any fundamental sense, induced easily observed physiological changes that fooled consumers into believing that maybe they were getting better. By inducing "maybes" and repeated tries, such medicines also attracted other customers. While consumers might have eventually realized that increased urination and bowel movements did little to actually improve their underlying conditions, by that point they had already "infected" other possible consumers with their belief that medicine in question could be working. A competing explanation for long-term brands is that such medicines had genuine curative power, and that the industry's broader success was based on that power. If so, one expects that the longest-lasting and most popular medicines would have contained ingredients

recognized by modern science as powerful curative and therapeutic agents. Another possibility is that long-term brands emerged because they contained addictive substances such as opium, morphine, cocaine, and alcohol. A close look at the most popular and enduring medicines generates little support for these two competing arguments, however. On the contrary and consistent with prediction 1, the evidence below indicates that brands survived because they contained ingredients that generated physiological changes that fooled people into thinking they might be getting better.

3.a Brand Histories: Composition and Advertising Claims

Table 1 lists some of the best-known patent medicines, their product life, and their main ingredients. A brief survey of table 1 indicates that most of these products were on the market for at least 50 years, and that several had life spans of 100 years or more. One product, Peruna, was on the market for nearly 300 years. Most of these medicines were innocuous mixtures of vegetable compounds and alcohol—Peruna, for example, was nothing more than a combination of whiskey, champagne, wine, and beer. Common ingredients included herbal laxatives such as glycerin, yellow dock, and jalap; or herbal cathartics such as colocynth; or herbal pain relievers such as capsicum (chili peppers) which is sometimes used today in topical ointments, though not ingested as with Holloway's Pills. Still other medicines contained herbal sedatives and/or stimulants such as valerian; herbal astringents which caused muscles and membranes to tighten when applied directly; or herbal diuretics such as May apple to induce urination.⁶ Three medicines, however, contained gasoline and/or turpentine and two of these were intended for ingestion or inhalation.

Nearly all brands of sarsaparilla, whether or not they are listed in table 1, contained potassium iodide. Today, potassium iodide is used mostly in the context of nuclear events: in

⁶On the medicinal effects of various herbs, see Henkel (1911) and Bentley and Trimen (1875).

case of nuclear accident or attack, public health officials recommend those exposed ingest the compound to forestall thyroid cancer. Historically however, potassium iodide was used to treat hypothyroidism because it stimulated thyroid function (Waller 1911, pp. 121-127; Marine 1925). For the set of individuals in the United States whose hypothyroidism was treatable with potassium iodide, sarsaparilla would have been a useful medicine.⁷ Promoters, however, used efficacy on this one narrow margin to encourage the use of sarsaparilla as a panacea, claiming that this root-based medicine could cure everything from kidney disease to epilepsy. This proved a successful strategy because patients who lacked energy and were generally fatigued as a result of hypothyroidism genuinely benefitted from the potassium iodide in the sarsaparilla (not the sarsaparilla itself), and their endorsements encouraged others, who did not understand how and why the medicine worked, to try the product for their particular ailment. In addition, potassium iodide induced physiological changes, such as increased appetite and energy, and changes in one's pulse and blood pressure, that patients might have misconstrued as improvement or even as a cure (State of Massachusetts 1897, pp. 615-619).

Only three of the twenty-one medicines listed in table 1 contained anything more powerful than alcohol. These are Wistar's Balsam of Cherry (on the market at least 77 years), Perry Davis's Painkiller (on the market at least 118 years), and Dr. Pierce's Golden Medical Discovery (on the market at least 83 years), all of which contained opium. Although drugs like morphine and opium were typically found only in trace amounts and were used in less than a

⁷There is an important caveat to this. At low levels, potassium iodide stimulates thyroid function; at high levels, it depresses thyroid function. This is known as the Wolff-Chaikoff effect, which was first documented during the 1940s. For those patients who took too much sarsaparilla, they might have undermined their energy and health. For evidence on the effects of the potassium iodide on thyroid function in general, and the Wolff-Chaikoff effect in particular, see the following: Johnson and Rapini (1988); Wood and Maloof (1975); and Frey (1964). It is possible that repeated doses of potassium iodide generated something akin to addiction. Because the thyroid adapts to higher levels of exposure, increased levels of potassium iodide are required to generate the same physiological responses. On this effect, see Braverman and Ingbar (1963) and Eng et al. (1999).

quarter of all patent medicines on the market in 1879, there were isolated cases where individuals developed addictions.⁸ Surprisingly, the medicines that were probably the most likely to contain morphine and opium were children's medications for teething. The most popular of these was Mrs. Winslow's Soothing Syrup (not listed in table 1), which contained about one grain of opium alkaloids to every one ounce of syrup. Although there were well-documented cases of pediatric narcosis following treatment with Winslow's syrup, the medicine was on the market for more than 50 years.⁹ According to the American Medical Association (1908, pp. 227-28), a less popular opium-based teething medicine, Kopp's Baby's Friend, led to the deaths of ten children over a three year interval. The same source presented experimental evidence that 20 to 30 drops of Kopp's Baby Friend could cause death in small dogs and cats.

Consider the following examples from table 1 in greater detail. These examples document both the pervasive misleading advertising found in the industry (see prediction 2) and the ingredients found in successful medicines (prediction 1). In its advertising, Ayer's Sarsaparilla claimed to cure tuberculosis, liver disease, nervous disorders, melancholia, and kidney disease (Ayer 1888), yet aside from potassium iodine the product contained mainly sarsaparilla (a root now used to make soda), yellow dock, and May apple (a plant which in large amounts is toxic). This medicine was on the market for more than 82 years. Brandreth's Pills claimed similarly diverse powers. Ads touted its ability to cure multiple ailments stemming from

⁸Prescott (1882, p. 157) wrote: "Three years ago Professor Richter published a summary of 938 secret remedies analyzed by himself and other chemists. Of these he found 22 percent having some violent or poisonous constituents, 25 percent having medicinally powerful constituents, [and] 52 percent having only harmless or inert constituents." See also, Oliver (1872).

⁹See *The Practitioner*, Jan. 1870, p. 58; *Journal of the American Medical Association*, April 23, 1910, p. 352; *Boston Medical and Surgical Journal*, Sept. 4, 1873, p. 247; *Journal of the South Carolina Medical Association*, April 1907, p.571. For an advertisement documenting age of product, see *Brooklyn Daily Eagle Almanac*, 1897, p. 504. On the general composition of soothing syrups for infants, see *British Medical Journal*, March 23, 1912, p. 683.

impure blood, including tuberculosis, general lethargy, and liver disease (*Tribune Almanac and Political Register* 1874, pp. 107-12). A mixture of aloe, various cathartic herbs, peppermint, cinnamon, and alcohol, this cure was on the market for nearly a century. Holloway's Pills also claimed to purify the blood and purge the body of constitutional diseases like tuberculosis. Holloway's Pills contained no alcohol, relying instead on aloe, rhubarb, chili peppers, ginger, and soap.

Day's Kidney Pad promised to "cure by absorption all diseases of the kidneys, bladder, and urinary organs(*Western Christian Advocate*, Jan. 14, 1880, p. 15)." It was, according one advertisement, "the only true method of curing and controlling the most prevalent diseases that afflict mankind (*Southern Planter*, Sept. 1880, p. 324)." Coated with a compound of benzine, dried flowers, and juniper berries, the pad was applied on the patient's back over the kidneys (Oleson 1899, p. 54). This product was on the market for at least 32 years. A mixture of ammonia, turpentine, and other less objectionable ingredients, Hamlin's Wizard Oil was also applied topically. On the market for nearly 50 years, it was marketed as a cure for host of ailments, ranging from burns and abrasions to rheumatism and diphtheria. A combination of turpentine, sodium, and jalap, Jaynes Vermifuge claimed to cure indigestion, heartburn, and diarrheal diseases (*Medical and Surgical Reporter*, March 15, 1884, p. 350; *New York Observer and Chronicle*, Feb. 27, 1902, p. 284). It survived at least 73 years.

Illustrative of cancer cures generally, Kline's Painless Cancer Cure was a mixture of white wax, fir-tree extract, and chromic acid (used today for chrome plating and glass work) applied directly to the skin over a tumor. In one ad, Kline claimed that his medicine was "preeminently unrivalled [sic] in the treatment" of cancer. The same ad also indicated that Kline's treatment could eradicate the "largest of cancers or tumors" without a "knife, caustics,

loss of blood, or other fearful treatments.”¹⁰ This medicine was on the market over 20 years. In its advertising, the makers of Moxie Nerve Food proclaimed it “the successful enemy of the rum fiend” and the “finest nerve food” ever found (*The Independent*, May 20, 1886, p. 15). Aside from curing alcoholism, one ad described the miraculous and unprecedented case of a Mrs. Bulme, who recovered from “a complete paralysis of both the motory [*sic*] and sensitive nerves of the left side” as a result of her use of Moxie (*Zion’s Herald*, Nov. 24, 1886, p. 373). On the market for nearly half a century, Moxie Nerve Food was a mixture of oats, syrup, sassafras, and wintergreen. Saul’s Catarrh Remedy was an inhalant that purportedly cured tuberculosis. A concoction of benzine, chloroform, sulphur, ammonia, and distilled spirits (Oleson 1899, p. 214), Saul’s Remedy was on the market for at least 20 years. Lastly, Swaim’s Panacea was marketed as a cure-all, relieving patients of the burdens of heart disease, leprosy, liver disease, rheumatism, scurvy, various skin eruptions, and melancholia (*Saturday Evening Post*, May 15, 1824, p. 3). On the market for 79 years, it contained herbs, dried flowers, and rhubarb.

It is difficult to see how anyone could legitimately market these medicines as cures for alcoholism, cancer, diarrheal diseases, diphtheria, epilepsy, heart disease, kidney disease, liver disease, rheumatism, tuberculosis, or anything else. Such an argument would imply that oats, sassafras, and wintergreen cure alcoholism; that putting the equivalent of chrome plating over a tumor cures cancer; that external applications of turpentine and ammonia cure rheumatism and diphtheria; that gasoline and juniper berries cure kidney disease; that aloe, herbal laxatives, and soap cure liver disease; and that inhaling ammonia, distilled spirits, and chloroform cures tuberculosis. Even for the three of medications that contained opium, the products did nothing to actually cure the diseases they claimed. For example, Wistar’s Balsam of Cherry was said to

¹⁰The formulas for the medicines described in this paragraph are from Oleson (1899), pp. 41, 151, and 225. The quotations for Kline’s Cancer Cure are from *Arthur’s Home Magazine*, July 1884, p. A4.

cure tuberculosis, yet aside from opium, contained only cherries, syrup, sugar, and alcohol. Similarly, there were numerous cures for epilepsy, melancholia, and other psychological and neurological disorders which contained opium, morphine, or cocaine. At best, patients who discovered and used these products replaced one form of addiction and psychological suffering with another. Some patent medicines were calculated to work just this way. Promoters would advertise the medicine as a cure for alcoholism or opium addiction, but then put large amounts of the same addictive agent in the medicine itself. Only after a period of direct experimentation did the patient discover that medicine was not a cure but a more expensive way of feeding his or her habit (Prescott 1882; State of Massachusetts 1886, p. 190).

One might nevertheless argue that these medicines had some benefit because they induced inebriation, placebo effects, or had some value as laxatives. This line of thought suggests that people chose to purchase patent medicines to get drunk or high, despite the fact the medicines cost orders of magnitude more per unit of alcohol than beer or ordinary distilled spirits. As for using them as a means of acquiring harder drugs, as already mentioned, more than 75 percent of medicines did not contain such drugs, and in most states, opium and morphine could be purchased from a druggist without a prescription, and without the advertising expenses that came with patent medicines. If Americans used patent medicines as placebos, they spent *more* money in 1909 on a massive act of self delusion than they spent on agricultural tools and machinery—at the time, about 1/3 of the American labor force was engaged in agriculture.

3.B. Conventional Elasticity Arguments

The brand histories above highlight the difficulty of explaining the rise of the patent medicine industry by focusing solely on price, cross-price, and income elasticities. Given the evidence above, the objective value of the typical patent medicine was zero, and the puzzle that should interest economists is why consumers did not reject patent medicines outright.

Increases in consumer demand, whether or not they were driven by income growth and price reductions, were predicated on the belief that patent medicines *might* work, and that tentative belief is the interesting part of the story. Furthermore, standard elasticity arguments can not account for many of the anomalous features of the patent medicine industry documented below, including the proliferation of different brands of medicine, the behavior of prices over time and across brands, a heavy reliance on advertising and investments in product differentiation, and its robust growth in the face of improved medical knowledge and treatment, and an increasingly hostile regulatory environment.

Finally, even if one sets aside these concerns and adopts the elasticity framework, the elasticities implied by the available data far exceed those estimated in the current literature on health-care spending. For example, per capita spending on patent medicines grew at an annual rate of .041 between 1800 and 1900, while real wages grew at annual rate of .01 over the same period. Ignoring all other possible factors, these data suggest an income elasticity of demand of 4. To appreciate the implausibility of this estimate, consider a close parallel to the market for patent medicines in nineteenth-century America: the market for self medication in the developing world today. Self-medication is commonplace in poor countries and involves patients seeking out and purchasing medicines from drug vendors without any professional supervision. In wealthier countries such medicines would be acquired through prescriptions. The available evidence indicates that self-medication is a normal good for the very poorest segments of the developing world, and an inferior good for everyone else (Chang and Trivedi 2003; Hjortsberg 2003). For the United States, which by 1870 was already much wealthier than places like Zambia today, this suggests an income elasticity of less than one.

4. On the Centrality and Persistence of Advertising

More than a century ago, the prominent physician George F. Shrady wrote: “Man is

sick; he wants to live; he sees a statement that such a medicine will surely cure him. He half believes it, entirely hopes it, and buys the bottle (*Medical Record*, July 8, 1882, p. 42)."

Shrady's pithy insight, which encapsulates much of the analysis here, is based on a simple assumption: that advertising, even if people did not completely believe it, or even if they mostly disbelieved it, might have induced patients to purchase medicines of little or no value. All patent medicines promoters had to do was raise the probability that their medicine would work above zero. According to Shrady, more than any other industry, patent medicines depended on advertising: "It is admitted that no industry depends so much upon advertising as does that of patent medicines. Here, indeed, is where the business is shown in its most lurid aspect."

Similarly, in a survey of 35 pharmacists in New England and the Midwest, Lowden (1906, p. 35) asked, "what sells patent medicines?" There was "but one answer." "Patent medicines are sold wholly through the susceptibility of people to advertising." Other observers were equally convinced of the centrality of advertising to the patent medicine business. Clarke (1891, p. 45), for example, wrote: "Their chief first cost and ultimate measure of their sale depends upon the liberality or profuseness with which they are advertised in newspapers."

Shrady went on to argue that success required more than just a large, one-time investment in advertising. Producers had to keep on advertising, regularly cajoling people into purchasing their medicines, otherwise demand quickly subsided (*Medical Record*, July 8, 1882, p. 42):

We are told that the moment a new drug ceases to be advertised the demand for it fails. If, after judicious advertising for ten years, the advertisement is stopped, the demand falls about seventy-five percent. There will then continue for several years a steady call for the drug equaling about twenty-five percent of that which originally existed.

Other observers concurred, arguing that advertising "must be continuous, first to start the trade and then to hold it (*Printers Ink*, May 18, 1910, p. 84)." A clear example of the importance of continual advertising is afforded by Wistar's Balsam of Cherry. As indicated in table 1, this

patent medicine contained opium and might therefore have possessed addictive qualities, yet when the manufacturers of Wistar's stopped advertising during the mid-nineteenth century the company's business was nearly destroyed, and did not pick up again until a strong advertising campaign was resumed.¹¹ There is also anecdotal evidence that as firms grew and aged over time, advertising expanded, suggesting that older firms advertised more than new entrants.

MacDonald (1902, p. 286), for example, wrote that:

Perry Davis began his great Pain Killer business by peddling bottles of Pain Killer from door to door. When he got a little ahead he began advertising—his sales then began to increase with the better knowledge of his Pain Killer and in proportion to the increase of business Mr. Davis enlarged his advertising appropriation. I believe Dr. J.C. Ayer started in about the same way.

Note that both Perry Davis's Pain Killer and Ayer's Sarsaparilla are listed in table 1. Other sources also indicate that spending on advertising expanded as firms and products aged.

Although it is hard to know how much of this was hyperbole, the idea that the patent medicine industry was unusual in terms of advertising expenditures receives support from data in the *Census of Manufactures* for 1899/1900. With information on 333 industries, figure 3 plots the log of the industry's advertising expenditures (for most industries the largest expense included under the rubric "miscellaneous expenses") against the log of the total value of the industry's output. Two patterns stand out. First, the patent medicine industry, denoted by the black triangle, was relatively large in terms of the value of its output. Second, given its size, its advertising expenditures were unusually high. These data suggest that the only other industries with larger expenditures, given their size, were malt liquors, distilled liquors, and

¹¹Rowell (1870, p. 144) described the fortunes of the owner of Wistar's Balsam of Cherry, a man named Seth W. Fowle, this way: "Having established a large sale for the Balsam, and knowing it to be an article of great real worth, he thought it would continue to sell upon its own merits, and consequently withdrew all his advertising. When Mr. Fowle withdrew his advertising the sale of the Balsam fell off, as new medicines were introduced, and they being extensively advertised the sale of these articles soon in a great measure supplanted that of Wistar's Balsam."

oleomargarine. Two regressions, reported in table 2, indicate that after controlling for industry output or expenses in other areas (wages, salaries, raw materials, and capital) spending on advertising in the patent medicine industry was 62 to 73 percent greater than predicted. The quotations from Shrady and these regression results are consistent with predictions 2 and 3: that fraudulent advertising would be pervasive and frequent relative to other industries; and that advertising would remain constant, or perhaps even increase, over the product life cycle.

Advertising served two functions. First, it positioned the medicine in a product space. Some medicines were marketed as safe and benign so that even if they did not affect a cure, they would not harm the patient.¹² Other brands were marketed as traditional cures based on Eastern or Native American medicines.¹³ Still others created whole new systems and theories of medicine, sometimes publishing books that ran into the thousands of pages, and based their advertising on those new theories.¹⁴ Some medicines were marketed as cathartics on the idea that regular internal cleansing purged the system of disease-causing pathogens (Clarke 1891, pp. 42-43). Homeopathy and Thompsonian medicine were popular during the nineteenth century, and some patent medicines were marketed as herbal and natural remedies. Examples include Kilmer's Swamp Root and Lydia Pinkham's Vegetable Compound.

¹²See, for example, advertisements for Warner's Safe Remedies, which characterized the medicines of this company as "pure, harmless, and effective." See *Western Christian Advocate*, Jan. 14, 1880, p. 15; and *Once a Month: An Illustrated Australian Magazine*, July 15, 1885, p. xvii.

¹³Examples include Himalya, a cure for asthma (see *The Cosmopolitan*, April 1895, p. 866) or Kickapoo Indian Remedies, a range of medical products that claimed to cure everything from eczema to tuberculosis (see *Beckwith's Almanac*, 1889, p. 93, or any of the almanacs published directly by the Kickapoo Indian Medicine Company available at books.google.com). While there was an Indian Nation known as the Kickapoo, the medicines were produced by a man of European ancestry with no connection to the Kickapoo.

¹⁴One example of this the Pulmonary Chemical Company of Columbus, Ohio, which created something called the Pneumo-Chemic System to cure tuberculosis, bronchitis, asthma, and hay fever. See *The Cosmopolitan*, April 1895, p. 863.

The most popular method of product positioning tapped into the widespread belief that all diseases were caused by impure blood. At least seven of the medicines described in table 1 were marketed as blood purifiers, including, Ayer's Sarsaparilla, Brandreth's Pills, Holloway's Pills, Hood's Sarsaparilla, Hop Bitters, and Hostetter's Stomach Bitters, and Swaim's Panacea. The following ad for Ayer's Sarsaparilla illustrates:

This compound . . . purifies the blood, and purges out the lurking humors in the system that undermine health and settle into troublesome disorders. . . . When [the humors] are gone the disorders they produce disappear: such as, ulcerations of the liver, stomach, kidneys, lungs, St. Anthony's Fire (epilepsy), boils, tumors, neuralgia, and general debility (*Western Christian Advocate*, Jan. 14, 1880, p. 47).

Similarly, an advertisement for Hood's Sarsaparilla claimed that the medicine "builds up the shattered system, by giving vigorous action to the digestive organs, creating an appetite, and purifying the blood." One customer testified: "Hood's Sarsaparilla is the best medicine I have ever taken for a blood purifier (*The Outlook*, October 27, 1894, p. 676). In the context of equation (7), the popularity and persistence of medicines that claimed to purify the blood might have stemmed from either a static base of knowledge (κ) or the ease with which producers were able to generate "maybes" (ϵ) for products that claimed to purify the system and purge the body of toxins: simply include laxatives, cathartics, and diuretics in the medicine.

Second, advertising functioned as a misinformation campaign; it sent misleading signals (ϵ 's) to consumers, making it appear that more people were recovering from patent medicines than truly were. For example, patent medicine companies regularly published long and largely fictitious testimonials in newspapers, often cleverly disguised as editorials or articles.¹⁵ It was also not uncommon for manufacturers to appropriate the names of deceased physicians in creating fictitious endorsements. On other occasions, they paid preachers, businessmen, and

¹⁵Examples of ads disguised as newspaper articles, include *Christian Union*, June 1881, p. 526; *Puck*, Feb. 14, 1883, p. 373; and *Scribner's Monthly Magazine*, April 1881, p. 22.

politicians to endorse the medicines. The connection between patent medicines and the clergy was particularly strong, as the following editorial suggests (*Cincinnati Lancet and Observer*, November 1875, p. 683):

No other class of persons have ever done so much to promote the interests of quackery as the clergy. Time and again have we heard them advocate the remarkable power of infinitesimal doses, and of the evil effects of mercurials, in any form, on the human system. Pick up almost any patent medicine almanac, and you will find the virtues of patent pills and potions eulogized, ad nauseam, by reverends and [Doctors of Divinity]. Take up almost any religious newspaper (there are two or three honorable exceptions) and you will generally find about two-thirds of their advertising patronage made up of quack nostrums.

The *American Journal of Medical Sciences* (Jan. 1842, p. 262) argued that endorsements and testimonials by the clergy had an especially powerful effect because nineteenth-century America was such a religious society:¹⁶

We can scarcely open a newspaper, without meeting with the advertisement of one more quack medicines, recommended, and avouched [sic] by clergymen. Now such is the confidence of the mass of the people in their spiritual pastors, that these certificates have in them a power even greater than the forged testimonials of eminent, deceased physicians, so often attached to the same advertisements.

According to an article in the *Boston Medical and Surgical Journal* (*BMSJ*), there was even a vibrant second and third hand market for letters and testimonials. One letter broker claimed to have seven million letters on hand, broken down by categories for consumption cures (55,000), female complaints (95,000), paralysis (7,000), deafness (65,000), cancer (3,000), and other diseases and chronic conditions. Echoing and expanding on Shradys's criticisms, the *BMSJ* (March 1, 1906, p. 244) wrote: "Of course, a letter would not have second, third, and fourth hand value unless the dupes, like lambs in the stock market, return to the temptation over and over again. After trying one medicine they go to another and so on."

¹⁶For other statements on the connection between the clergy and the patent medicine industry, see for example, *Medical and Surgical Reporter*, Sept. 1858, p. 614; and *Puck*, April 28, 1897, p. 1.

Quoting a particularly forthcoming letter broker, the journal continued:

‘To be sure, they have all tried one remedy or more; but that is all right; they will keep on trying new remedies until they die. Buy or rent a few thousand of those letters from me, at a few dollars a thousand, and tackle them with a new proposition—something new, something with a new name—jolly ‘em along a little, and they’ll come up with the money for a new treatment.’

This quotation testifies to the argument that in markets with a low η , consumers do not punish marketers for misleading advertising. On the contrary, they return to the market over and over again, no matter how many times they have been duped in the past.

5. Prices, Market Structure, and the Proliferation of New Brands

Despite heavy investments in advertising and product differentiation, there was remarkable uniformity in prices across brands, classes of medicines, and over time. Consider first prices as reported in nominal dollars. Between 1840 and 1900, five cures for gonorrhea sold for \$1 per unit (box, tube, or bottle). These were Dr. Sorm’s Specific Compound, Cross’s Specific Mixture, Charleston Whitewash, Macqueen’s Matico Injection, and the Two-Day Injection Cure. Over the same period, Sarsaparilla cost \$1 per bottle, whatever the brand: Ayer’s, Hood’s, Sand’s or Scoville’s.¹⁷ If one plots prices over time in real terms all variation is driven by changes in the general price level, and with the exception of the Civil War and the years immediately following, the long-term trend in real prices was flat, or exhibited a mild downward trend. For example, in constant 1870 dollars, a bottle of sarsaparilla cost around \$1.10 during the 1840s, and around \$0.99 during the 1890s. See figure 4. The picture changes somewhat if the price of three popular medicines—Brandreth’s Pills, Holloway’s Pills, and Swaim’s Panacea—are plotted in constant dollars. As figure 5 shows, all three series exhibit a steep downward trend, moving in tandem and falling by around 70 percent between 1810 and 1900. It is notable that products that contained opium (such as Wistar’s Balsam of

¹⁷These price observations are based on data gathered from survey of advertisements found in journals and periodicals contained in the *American Periodical Series Online*.

Cherry) exhibit the same basic pattern in prices. As figure 4 shows, the price of a bottle of Wistar's also fell by around 70 percent between 1840 and 1900.

It useful to ask why sarsaparillas and gonorrhoea cures were able to maintain prices better than the other medicines. Gonorrhoea carried a heavy social stigma and it is difficult to imagine patients openly discussing the disease and the treatments they used. In the case of sarsaparillas, nearly all brands of sarsaparilla contained potassium iodine. As explained above, potassium iodine is useful in treating at least some cases hypothyroidism, and helps stimulate thyroid function. For those patients who unknowingly suffered from hypothyroidism, and experienced the subsequent bouts of irritability, drowsiness, and fatigue, and were susceptible to treatment with potassium iodine, sarsaparillas represented an effective treatment, though not a cure. Nevertheless, because sarsaparillas promised to cure just about every human ailment imaginable, promoters were able to parlay the medicines usefulness in the treatment of a fairly narrow class of diseases into a bull blown panacea.

While one cannot rule out the possibility of price-fixing and market power, the available evidence suggests the market for patent medicines was fairly competitive and grew more competitive with time. In contrast to other industries, where reports of cartels and trusts were commonplace, no such reports can be found for patent medicines. On the contrary, anecdotal reports emphasized frequent entry, failures, and exits, and claimed that "not one in a thousand patent medicine men has succeeded" (e.g., *Southern Practitioner* 1886, p. 423; Cantley 1898). Census data indicate that the number of establishments producing patent medicines grew tenfold between 1860 and 1900, while the number of establishments in all industries grew fourfold over the same period. See figure 6. Increased demand undoubtedly drove the growth in the number of firms, but those increases were not met with expansions in average firm size, as was the case in other industries. In absolute terms, firm size in the patent medicine industry remained constant between 1810 and 1910, and relative to other industries, fell steadily after

1860. See figure 7. (Note that after 1905, firm size rises sharply. Evidence presented in a subsequent paper suggests that this was the result of passage of the Pure Food and Drug Act.) Overall, the patterns in prices and market structure are consistent with predictions 4 and 5 regarding non-increasing prices and growing competition.

The rapid entry into the patent medicine industry over the course of the nineteenth century brought with it a proliferation of new and increasingly bizarre products, often based on new technologies and scientific discoveries. Examples include electro-belts and vibrating chairs. Introduced during the late 1800s and early 1900s, products like these claimed to cure cancer, heart disease, tuberculosis, and a host of other afflictions (e.g., *Puck*, Oct. 8, 1884, p. 93). Other new patent medicines exploited and distorted genuine discoveries in the germ theory of disease. Prominent examples include the Carbolic Smoke Ball, the Pillow Inhaler, and Radam's Microbe Killer. The subject of a court case known to most first year law students, the Carbolic Smoke Ball worked just as its name implied (Simpson 1985). The patient ignited the ball and inhaled the smoke which contained phenol (carbolic acid). Although phenol has antiseptic qualities, there is no evidence that it cures influenza, tuberculosis, or other diseases of the respiratory system, as promoters of the smoke ball claimed. Similarly, the Pillow Inhaler was a "pillow containing receptacles filled with an inhalant mixture, the fumes of which [were] breathed at night (*Christian Union*, June 1, 1881, p. 526)." Promoter's claimed that the antiseptic fumes emitted by the inhaler destroyed the pathogens that caused asthma, tuberculosis, whooping cough, bronchitis, and a host of other respiratory ailments (*Scribner's Monthly Magazine*, April 1881, p. 22). Finally, to manufacture the industrial-sized Radam's Microbe Killer (a product sold in large gallon jugs), a gallon of water was combined with a few drops of muriatic acid, a little red wine, and four ounces of sulphuric acid. While such a concoction might serve as a useful household cleanser or disinfectant, Mr. Radam intended that patients drink the mixture to kill the germs that were making them sick (Oleson 1899, p. 141).

New and increasingly bizarre products such as the Pillow Inhaler, the Carbolic Smoke Ball, and Randam's Microbe Killer are consistent with prediction 5 above.

In his aforementioned critique of the patent medicine industry, Shradly argued that competitive pressures encouraged firms to substitute more expensive, and potentially effective ingredients, with cheap, ineffective ones (*Medical Record*, July 8, 1882, p. 42). "The greed of money," Shradly wrote, "is at the root of the patent medicine failure. The proprietor wants to make his medicine at less cost, and after a while puts in cheaper ingredients. The mixture which costs fifteen cents, and sells for a dollar, is finally made for five cents."¹⁸ There were a few products that took this thinking to its logical extreme, such as Poor Richard's Eye Water. This medicine was purported to "refresh and strengthen the eye, and cure inflammation, blindness, etc.," but apparently contained nothing more than ordinary tap water (*School*, June 6, 1895, p. 343).¹⁹ However, the long-term viability of the Carbolic Smoke Ball, the Pillow Inhaler, and many of the medicines listed in table 1, suggests that the incentives to substitute increasingly cheaper ingredients for more expensive ones were limited. Producers did not only differentiate their medicines by advertising; they also differentiated them by the raw materials they used. This might help explain why medicines grew increasingly bizarre over time. As the number of medicines proliferated, it might have grown harder to differentiate products through advertising alone so that the medicines themselves had to appear wholly new and original.

6. The Pathology of Progress, Part 1: Legitimate Medicine

Another way to explain the rise of patent medicines is to argue that nineteenth-century consumers had a limited choice set: physicians were expensive, and the cures they offered

¹⁸Rogerson (1988) shows that when price advertising is allowed, firms use price to signal quality. This logic suggests a clear limit to Shradly's argument.

¹⁹Other examples in this regard include a "Swiss Elixir of Life and Cure for Lung Diseases" which contained only spring water, and a "Soothing Powder" which contained only rice starch. These medicines are described in Prescott (1882), p. 155.

patients were no better than those promised by the makers of quack medicines. This argument is problematic in ways similar to the income elasticity argument raised at the end of section 3. First, whatever the effectiveness of ordinary physicians, why did patients choose to purchase medicines of no objective value? Second, while ordinary physicians before 1950 were not as effective as physicians today, the evidence below indicates that a well trained doctor was capable of distinguishing quack medical services and products from legitimate ones. Third, the argument assumes that the price of physician services rose over time, and that the efficacy of those services fell, or at least did not rise enough to offset increased prices. It is difficult to square these assumptions with the available data and evidence. On the contrary, the question one should be asking is how the market for quack medicines withstood increasingly effective competition from ordinary physicians. Accordingly, the rest of this section proceeds as follows. It first documents improvements in the quality and productivity physicians using both anecdotal and quantitative evidence. It then considers how and why quack medicines survived these improvements. Overall, the history reviewed in this section seems broadly consistent with prediction 6 (see section 2).

In his acclaimed history of American medicine, Starr (1982, pp. 71-77) shows that increased urbanization and reduced transportation costs allowed physicians to see and treat more patients, driving up physician productivity between 1870 and 1950. In emphasizing an expanding market driven by declining transport costs, Starr's explanation for rising physician-productivity parallels Chandler's (1977) explanation for increasing firm size and the emergence of the great industrial trusts of the nineteenth century. Starr also shows that improved medical training and knowledge helped to raise physician productivity and effectiveness. During the nineteenth century, medical training grew increasingly general and scientific. More and more, medical schools instructed physicians, not about how to use mercury or some specific herbal remedy in this circumstance or that, but rather about general principles in human anatomy,

physiology, and the pathogenesis of disease. This allowed all physicians— whether specialists, surgeons, or family physicians—to more effectively treat a broader range of ailments.

With improved scientific understanding, physicians abandoned counterproductive interventions such as bleeding, purging (induced vomiting), and the use of heavy metals such as mercury, lead, and antimony, though as explained below, some metals, such as arsenic-related compounds, copper, and gold had legitimate uses in medicine. By the 1890s, leading physicians such as William Osler were using more benign therapeutic strategies, such as milk-based diets, fresh air, and bed rest (Osler and McCrae 1913, pp. 167-79; *Medical Record*, Dec. 7, 1901, pp. 911-12; *Medical World*, Nov. 1903, pp. 498-504). For a disease like diabetes a diet-based therapy was not only benign, it affirmatively promoted better health (Donkin 1875). Similarly, there is evidence that, though expensive, open-air and climatological treatments of tuberculosis ameliorated the patient's condition, even if they did not result in full-blown cures (Williams 1901). In the case of pneumonia, a common sequella to many of the infectious diseases that flourished during the 1800s and early 1900s, physicians slowly came to recognize that nothing could be done to actively abort the disease. Instead, the best that could be offered was a constructive, supportive therapy based on diet and bed rest, increased oxygen if necessary, and perhaps a sedative if the disease was associated with sleeplessness or an elevated pulse (West 1908).

Improvements in the stock of knowledge also enabled physicians to make more accurate diagnoses. This not only promoted more accurate mortality statistics, it also enabled physicians to better treat the disease at hand and helped them contain outbreaks of infectious diseases. For example, over the course of the nineteenth century, physicians abandoned the use of such inaccurate diagnostic categories as typho-malarial fever and scrofula, and began rejecting the notion that diseases could transform themselves into other diseases (Troesken 2004, pp. 170-78; Smith 1982). Specific diagnostic tools introduced during this period include

the Widal test for typhoid fever, Koch's tuberculin for tuberculosis, the Wassermann test for syphilis, and the use of throat cultures to identify cases of diphtheria (Starr 1982, pp. 87-124; Kiple 1993). In the case of diphtheria, a quick and accurate diagnosis allowed physicians to inoculate the patient with a highly effective antitoxin (Bosanquet and Eyre 1917, pp. 94-137; Hammonds 1999). Devices like stethoscopes, spirometers (to measure lung capacity) and microscopes were developed during the nineteenth century and helped physicians better diagnose and classify disease (Singer 1950; Starr 1982, pp. 155-57). The same discoveries that facilitated more accurate diagnoses, enabled nineteenth-century scientists to formulate effective vaccines for cholera, plague, typhoid fever, tetanus, and rabies, and laid the foundation for a host of vaccines for other infectious diseases such as polio and whooping cough during the mid-twentieth century.²⁰

It would be mistake, however, to argue that medicine made progress only on the margins of diagnosis and disease prevention. There were therapeutic advances as well. For example, by the 1870s, physicians were documenting and propounding the efficacy of salicylic acid (aspirin) in ameliorating the pain associated with rheumatism and arthritis (e.g., Stricker et al. 1876; Lees 1909). For most of the nineteenth century, physicians used potassium bromide with reasonable effectiveness to treat the seizures and convulsions associated with epilepsy, eclampsia, and other neurological disorders (Dujardin-Beaumetz 1883; Troesken 2006, pp. 83-85; Macleod 1900). Phenobarbital, which was discovered and popularized by German scientists during the early 1900s, is still used in the treatment of such maladies and in the U.S.

²⁰For a general history of vaccination in the United States during the nineteenth and twentieth centuries, see Colgrove (2007) and Starr (1982), pp. 136-39. See also McVail (1922) for discussion that focuses on the fifty year period between 1870 and 1920. On the Haffkine inoculation for cholera, see Hankin (1892). On the Haffkine inoculation for plague, see the unsigned article "Report of the Indian Plague Commission on Haffkine's Antiplague Inoculation," *British Medical Journal*, Feb. 24, 1900, pp. 455-57. For a brief discussion of the typhoid vaccine, see Troesken (2004), p. 24.

bromides are still used to treat epilepsy in dogs. A recent econometric study of Union Army veterans finds that trusses, though an admittedly crude device, were effective in treating hernias and returning the injured to work (Song and Nguyen 2003; see also, *British Medical Journal*, March 11, 1899, p. 606). Anticipating modern radiological treatments of cancer, physicians during the early 1900s began experimenting with x-rays and radium to slow the growth of tumors (Tousey 1915; Finzi 1910).

One of the most widespread diseases circa 1900 was syphilis.²¹ Surveys at the time indicated that 10 to 15 percent of all hospital admissions had active cases of syphilis, and censuses taken in Europe and the United States indicate that the proportion of the population with active infections was as high as 1 or 2 percent in urban areas (White 1925; Newcomer et al. 1919; Clark and Usilton 1934; Morris 1912). Even more striking is a study by Harrison (1931), who showed that in some European cities nearly 30 percent of all men and around 10 percent of all women were infected with syphilis at some point in their lives. In its 1916 report, the Royal Commission on Venereal Disease reported similar findings for the United Kingdom (White 1924). Syphilis ranked among the fifteen most common causes of death in the United States, and for disadvantaged social groups, the disease killed more people than diseases like typhoid, diphtheria, and measles (Hindman 1915). In 1908, researchers in the laboratory of the German researcher Paul Ehrlich discovered that salvarsan, an arsenic-based compound, reduced the severity of the symptoms of the disease and in many cases generated a complete recovery in the sense that patients received a negative Wassermann test.²² In one study, 12 of

²¹With some hyperbole, Sir William Osler guessed that there were more latent cases of syphilis than there were of tuberculosis.

²²One the efficacy of salvarsan, see Shaw (1912), Carter (1915), Gibbs and Calthrop (1911), Harrison (1927). Before the discovery of salvarsan, physicians used potassium iodine and mercury to treat syphilis. Sarsaparilla was also thought to be an especially effective drug, supposedly heightening the efficacy of any drug it supplemented (e.g., Allbutt 1870; *Medical Times and Gazette*, Sept. 25, 1869, p. 392). More than a century later, it is impossible to

12 patients treated with salvarsan were able to return to work, while those untreated remained incapacitated (Newcomer et al. 1919). Harrison (1937) reported that 83 percent of patients treated with mercury alone ($N = 378$) experienced clinical relapses of syphilis, while only 4 percent of those treated with salvarsan relapsed ($N = 152$). Some modern writers argue that salvarsan was about as effective as early generation antibiotics in the treatment of syphilis, though the evidentiary basis for such a claim is unclear (Marlow 1974; Joliffe 1993).

In terms of surgical interventions, Lister's discoveries about the need to sterilize medical instruments and the broader environment, made surgery safer and reduced the risk of infections and sepsis. Although Lister first announced the importance of antiseptics in 1867, it was another ten to fifteen years before his recommendations were in wide use (Starr 1982, pp. 94-96). Initially, Listerian antiseptics employed carbolic acid but this agent was soon abandoned because of its volatility and slow action. In later years, surgeons used cyanide, mercury, or corrosive sublimate. The beneficial effects of antiseptic surgery were striking. Consider the experience of Guy's Hospital in London in treating compound fractures. Between 1841 and 1861, there were 208 compound fracture cases treated in the hospital; of these, 50 perished from infection, a case fatality rate of 26 percent. In the years immediately following the introduction of antiseptics, the fatality rate fell to 4 percent, and in later time periods no deaths were recorded. Lister himself reported that before the use antiseptic methods his death rate from surgery was 46 percent, while in the three years immediately following the introduction of antiseptics, his death rate from surgery fell to 15 percent (White 1891).

General anaesthetics were introduced by Dr. William Morton in Boston in 1846. Surgery before this innovation was an almost unimaginable horror. Here is how one patient, himself a

assess the accuracy of such claims. But if sarsaparilla had a beneficial effect, it is surprising to note that most patent medicines marketed as sarsaparillas actually contained little, if any, of the root (Oleson 1892; State of Massachusetts 1897, pp. 615-18).

surgeon, recalled an operation without anaesthesia he had to endure (Ashhurst 1896, p. 377):

The operation . . . necessitated cruel cutting through inflamed and morbidly sensitive parts, and could not be despatched by a few strokes of the knife. . . . Of the agony it occasioned I will say nothing. Suffering so great as I underwent cannot be expressed in words, and thus fortunately cannot be recalled. The particular pangs are now forgotten; but the blank whirlwind of emotion, the horror of great darkness, and the sense of desertion by God and man, bordering close upon despair, which swept through my mind and overwhelmed my heart, I can never forget, however gladly I would do so.

The same patient went on to say:

During the operation, in spite of the pain it occasioned, my senses were preternaturally acute, as I have been told they generally are in patients under such circumstances. I watched all that the surgeon did with a fascinated intensity. I still recall with unwelcome vividness the spreading out of the instruments, the twisting of the tourniquet, the first incision, the fingering of the sawed bone, the sponge pressed on the flap, the tying of the blood-vessels, the stitching of the skin, and the bloody dismembered limb lying on the floor. Those are not pleasant remembrances.

Cheever (1896) argued that proper antiseptic care was predicated on effective anaesthesia, because without the immobility and unconsciousness associated with the latter it was impossible to keep the wound clean and free from disease causing pathogens. The most common anaesthetics were ether and chloroform.²³ These innovations in antisepsis and anaesthesia enabled surgeons to cure ailments like appendicitis and gallstones with a high degree of success.²⁴

Three years before he was to receive a Nobel prize in medicine for his work on thyroid disorders, Emil Theodor Kocher addressed the Medical Society of London. His remarks, later

²³Ether was the far safer anaesthetic: 1 in 15,000 patients died as a result of ether; 1 in 3,000 from chloroform. See Cheever (1896) and Davis (1896).

²⁴In the cases of appendicitis and gall stones, operative mortality was between 5 and 25 percent during the late nineteenth and early twentieth centuries. On mortality in appendectomies, see Treves (1905). On mortality in cholecystotomies, see Robson (1894). Note, however, that the science of transfusions and blood types was still in its infancy in the early 1900s. It was not until the mid-twentieth century that physicians possessed a well-developed body of research on which to base blood transfusion practices. For the state of the art during the early 1900s, see White (1917).

published in the *British Medical Journal*, highlight the progress nineteenth-century medicine made in treating diseases of the thyroid. Kocher reported that he had treated 401 patients for Grave's Disease (hyperthyroidism). Of these, he operated on 176; 130 (74 percent) were fully cured; 11 (6 percent) experienced great amelioration; 17 (10 percent) experienced some amelioration; the results for 9 (5 percent) patients went unrecorded; and 9 (5 percent) patients perished in surgery or soon afterwards. In removing goiters, out of 1,000 patients so treated, Kocher lost only 3 (Kocher 1906). Ten years before Kocher reported his promising surgical results—results that were not atypical (see for example, Rogers 1910)—the British physician George R. Murray (1896) published a short paper documenting the first case of myxoedema (hypothyroidism) successfully treated by thyroid extract. Murray first began treating his patient with a drachma of thyroid extract per week in 1891, and four years later her disease was still under control and she was “living an active life as the wife of a working man.” Prior to treatment, she had swollen face, hands, and feet, hair loss, below normal body temperatures, languor, and slow speech and activity. Murray's discovery gave rise to the development of thyroxine during the early 1900s. Besides surgery and thyroid extract, from the early nineteenth century onward, physicians employed arsenic-based compounds and potassium iodide to effectively regulate thyroid function (Frazier 1932; Waller 1911, pp. 117-34).

Perhaps the most effective and enduring therapeutic discovery of nineteenth-century medicine was nitroglycerin for the treatment of ischaemic heart disease. William Murrell revealed this treatment to the world in a lengthy article published in the *Lancet* in 1879. Murrell showed that nitroglycerin stimulated the heart muscle and aborted aginal symptoms within a few minutes of ingestion, reaching its maximal impact after six minutes and persisting up to 30 minutes. Initially, Murrell had his patients take the drug at mealtime, but in response to suggestions by two test subjects, he altered his strategy and had patients take the drug at the onset of the first symptoms of heart trouble. More than a century later, this approach still

stands. Although his study was based on a small sample of patients, Murrell employed a longitudinal experimental design. Carefully monitoring patients over time, he first gave the subjects placebos and then introduced nitroglycerin (Smith and Hart 1971). Also during the nineteenth century, the introduction of cardiac sedatives such as digitalis and aconite were used with apparent success to treat heart problems such as murmurs and arrhythmia (Hare 1895). The introduction and commercialization of the electrocardiograph during the early 1900s gave physicians an unprecedented ability to diagnose and treat heart problems, and to better understand the origins of cardiovascular pathologies (Robinson 1912; Bishop 1917).

Furthermore, while it is true that a capable physician in 1870 might not have been able to cure as many ailments as the same physician in 2000, he or she was nearly equal in terms of the ability to identify cases in which it was appropriate to say: “nothing further can be done; additional treatment is fruitless.” Indeed, one of the most frequent indictments physicians and other health professionals made of patent medicine industry was that it deluded the incurable into believing that they might be cured. As the editors of the *Medical Sentinel* (Feb. 1894, p. 82) wrote of the business: “It is an outrage upon the sick because it makes false promises and inspires false hopes.” A letter to the *Medical Times* (July 12, 1851, p. 55), published forty years earlier, expressed the identical sentiments:

It is a dishonest business because by reason of false representations, and bought or forged certificates, it holds out to the invalid promises which cannot be fulfilled. The consumptive’s last dollar is drawn from his pocket to purchase some worthless compound, which, in the simplicity of their hearts, he and his friends are led to believe will restore him to health—a hope founded on these false statements of the patent medicine dealer, but soon to be quenched in death.

In contrast to the quack, legitimate physicians recognized a duty to provide palliative care to the dying, but they also believed that it was improper to mislead patients and provide false hope. This norm was well-stated by George Shradly (*American Medical Times*, Dec. 14, 1861, p. 392) when he wrote:

It is not contended that the services of physician should cease when a disease is proved to be incurable. All incurable diseases may be palliated, and the progress of many may be materially arrested by proper treatment. This is, indeed, all that can be done, and this it is our duty to do; but all such efforts should be made with a distinct understanding that they are not curative.

Accepting that a disease was incurable was a signal of physician quality and experience. This is illustrated by a debate in the *British Medical Journal* during 1880s, when the England's leading authority on venereal disease proclaimed that such diseases were often incurable, only to have lesser lights respond by arguing that the judicious use of mercury and potassium iodide could affect a cure (*BMJ*, March 2, 1889, pp. 500-01; March 23, 1889, pp. 680-81).²⁵

Along these same lines, a well trained physician could distinguish quack medicines and treatments from legitimate ones in part because the physician knew what was possible and what was not. Blindness and glaucoma, for example, could not be cured by dissolving cataracts and other optical obstructions. Any medicine that claimed to do so was an imposture (Rogers 1904). Medicines that claimed to cure tuberculosis were even more common, and physicians rejected such cures out of hand, arguing that the only known way to treat and care for patients with tuberculosis was with rest, fresh air, and a wholesome diet (*Medical World*, Aug. 1910, p. 361). Similarly, practitioners in the late nineteenth century rejected Hahnemannian cures, a popular form of homeopathy, because they were based on absurd and antiquated medical ideas, such as the notion that disease was spread by miasmas and syphilitic poisons, or that to make a drug more powerful, the physician should dilute it as much as possible in water (Gould 1892). Similarly, as early as 1851 practitioners knew that ovarian tumors were not susceptible to mercury, zinc oxide, and various other chemotherapies. The only effective tool was surgery, and barring this, the best that could be hoped for was to

²⁵See also Semon (1901) who discussed the intractability of a variety of upper-respiratory diseases. Semon critiqued, for example, efforts to treat asthma through operations on the nasal cavities. He argued that the search for local causes of diseases was often retrograde and counterproductive.

maintain good general health (Bird 1851; Bashford 1911). Not unlike today, physicians of this era pleaded with patients and those who suspected a malignancy to seek treatment early and avoid quack medicines. The months spent experimenting with bogus products only allowed tumors to grow and metastasize, and in some cases, left the malignancy so large and pervasive that effective surgery was impossible (Gregor 1910).

Figures 8 and 9 plot the impact of these changes on the market for physicians. As figure 8 shows, the series on physicians per capita is noisy but exhibits no strong overall trends, bouncing around between 150 to 180 physicians per 100,000 persons. Furthermore, while the population-adjusted supply of physicians remained relatively constant, the number of patients treated per physician rose steadily after 1870: between 1810 and 1865, most physicians saw between 4 and 5 patients per day, but between 1870 and 1910, that number rose to 16, indicating that physician productivity rose nearly fourfold. Taken together, these two series suggest that, with the onset of rising productivity, the proportion of the population using physician services rose sharply after 1870. Figure 9 plots the average annual income of physicians (in constant 1870 dollars) and physician income per patient visit over time. These data reveal that physician incomes were stagnant before 1870 (hovering around \$650), but rose threefold between 1870 and 1910. While physician incomes rose sharply after 1870, that growth was driven by the fact that physicians were seeing and treating an increasing number of patients, not an increase in prices. On the contrary, the behavior of the income-per-patient-visit variable suggests the price of medical services was declining over time.

Taken together, the evidence above contradicts the argument that rising prices for physician services and/or declining physician quality drove up demand for patent medicines over time. If anything, the evidence suggests that changes in the market for physicians would have undermined demand for patent medicines. There are at least three possible explanations for why quack medicines withstood competition from legitimate physicians. First, despite all of

genuine medical innovations of the nineteenth century, there remained a broad swath of common and chronic diseases for which physicians could do very little to treat, let alone cure. For those ailments for which nineteenth-century medicine had no answer, and patients refused to relinquish their quest for a cure, quack products were a natural response. This explanation for the persistence of quackery requires that consumer knowledge remained limited so that patients did not know with certainty that the medicines they were purchasing were bogus. In the context of the model developed in section 1, knowledge (κ) has to be finite. As George Shrady explained in an editorial on the treatment of incurable diseases, there were two solutions to the problem of quackery: science could shrink the set of diseases deemed intractable; or patients could become more intelligent and better informed. In Shrady's parlance (*American Medical Times*, Dec. 14, 1861, p. 392):

Incurable diseases furnish quackery, in every form and grade, its chief source of support and profit. Could these affections be stricken from the list of human ills, or could specific remedies be found . . . there would never be another pretender. Equally fatal to the pretensions of charlatanism would be a profound and unalterable conviction in the popular mind of the absolute incurability of certain diseases. The attempt to create such a belief will be deemed utopian. But may we not rationally conclude, that the same course of instruction, which has established the present universal belief in the efficacy of medicines, could, rightly directed, not only remove this ill-grounded faith, but in its stead implant in the mind of at least every rational person, a firm conviction of the incurability of many diseases.

The second explanation for the persistence of quack medicines in the face of improving physician care focuses on the costs and the limited claims of regular physicians. (See prediction 6, section 2.) In contrast to quack medicine providers, legitimate physicians promised little. As discussed earlier, high quality physicians were high quality in part because they were honest: they did not guarantee a cure. The spoke in probabilities, and when they believed a disease was incurable they were obliged to express that belief and offer only palliative care. And when physicians could do something, that something usually came at a very high price, not only in monetary terms, but also in terms of fear, bodily risk, and physical

suffering. Consider the case of cancer where the “quack seize[d] every opportunity to exploit uncertainty, ignorance, fear, and credulity, when honest men offer[ed] no alternative to the knife (Bashford 1911, p. 1223).” For example, Charles Weber of Cincinnati advertised that he could cure cancer “using no knife or other severe measures (*Puritan*, May 1899, p. 803).” Dr. Ben Bye of Indianapolis advertised a cancer cure that involved only “soothing balmy oils (*Cosmopolitan*, October 1901, p. 504);” no knives, surgery, or plaster casts here. Not to be outdone, the Flower Medical Company announced in one advertisement: “Cancer and Tumor cured at home. No knife, pain, or plaster (*Lippincott’s Monthly Magazine*, June 1900, p. 689).” In the same vein, the Cancer Institute of New York City sold a product called Vitalia that it claimed cured cancer without any pain or surgery (*Everybody’s Magazine*, July 1901, p. 878).

The third reason regular practitioners failed to drive out quacks is that the line that separated the former from the latter was neither bright nor well-defined. Sometimes the experiments conducted by legitimate and otherwise accomplished medical researchers looked an awful lot like quackery. In such an environment, it was easy for consumers and patients to mistake the ridiculous and impossible claims of the quack with genuine scientific progress. Consider the development of electricity and its application to medicine. After 1880, many physicians became enamored with the idea that electricity could be used to treat, and perhaps cure, a wide range of ailments, including high blood pressure (Arnold 1908), skin lesions and moles (Jones 1908), and obstructions of the prostate (Bolton 1910). Only a small proportion of these ideas proved successful, however, and the most able practitioners recognized the limits of electrical medicine, arguing that electricity would have its greatest use not in curing diseases but as diagnostic and therapeutic tool (Butcher 1908). This was certainly the case with heart disease.

The producers of quack medicines recognized, exploited, and hyped these early forays in medicinal electricity. In one advertisement, for example, the makers of Dr. Scott’s Genuine

Electric Belt claimed that “electro-magnetism acts quickly, generally in the first week, more frequently in the first day, and often even during the first hour they are worn their wonderful curative powers are felt (*Puck*, Oct. 8, 1884, p. 93).” After noting that Dr. Scott’s device was lined with “medicated felt,” the same ad explained that the belt would cure the following improbable list of ailments: male and female weakness; nervous and general debility; rheumatism; paralysis; neuralgia; sciatica; asthma; dyspepsia; constipation; erysipelas; catarrh; piles; epilepsy; pain in the head, hips, back or limbs; diseases of the spine, kidneys, liver, and heart; and inflammation and ulceration.

In the context of the model developed in section 1, progress by legitimate physicians and scientists might have functioned as a positive signal. More precisely, genuine scientific and medical advances could have driven up ϵ , and in turn raised the expected probability (π) that any given quack medicine (m) might function as promised. That quack medicine producers were, in a sense, free-riding on genuine scientific breakthroughs is well illustrated by a promotional booklet that accompanied a medicine called Tuberculozyne. In a passage quoted in the *British Medical Journal* (Aug. 22, 1908, p. 507) the promoters of this product used the successes medicine had realized in preventing smallpox, diphtheria, and yellow fever to establish the plausibility of a cure for tuberculosis. The same might also be said of the so-called gold cures, such as Dr. Pierce’s Golden Medical Discovery. This product claimed to cure tuberculosis and variety of other respiratory ailments. It is not unreasonable to believe that the marketing of this “golden” cure might have drawn its inspiration from the (misguided) popularity of gold-based compounds among ordinary physicians in treating tuberculosis. The natural but unhealthy affinity between quackery and developments in regular medicine is further illustrated by the history of the germ theory of disease.

7. The Pathology of Progress, Part II: The Germ Theory of Disease

Among the most important medical discoveries of the nineteenth and early twentieth century were those having to do with the pathogenesis of disease, particularly the findings that specific bacteria caused diseases such as tuberculosis, typhoid fever, anthrax, and diphtheria.²⁶ Once physicians came to understand the role that germs played in propagating diseases they were better able to manage, control, and prevent those diseases. In an ideal world, these innovations would have increased patient knowledge, and undercut demand for quack medicines. More formally, driving up κ , such knowledge would have driven down π as patients began to realize the implausibility of the claims made by quack medicine promoters. There is, however, no evidence to support such an argument. The advent of the germ theory during the latter half of the nineteenth century was associated with no slowdown in per capita spending on patent medicines.²⁷ Nor is there much evidence to suggest that the germ theory undercut the viability and profitability of the existing brands of medicine listed in table 1, with many of these medicines persisting well into the twentieth century. Furthermore, despite the advent of the germ theory, promoters continued to market patent medicines using the scientifically bankrupt notion that the medicines purified the blood and purged the system of disease causing toxins

²⁶Worboys (2000) argues that the significance of the germ theory of disease has been vastly overstated. There was no single “germ theory” but rather a collection of theories, some correct and some not. More generally, the idea that germs were the ultimate cause of a variety of infectious diseases was not universally accepted. As late as 1900, one can find prominent physicians arguing against the idea that specific types of bacteria caused diseases like diphtheria and tuberculosis. Bantock (1899, p. 848), for example, concluded an extended indictment of “modern” bacteriology with the following observation: “All these things—which are facts, not opinions, capable of demonstration and proof—go to show that the modern doctrine of bacteriology is a gigantic mistake; that we are already at the parting of the ways, and that it is safe to predict that, ere long, it will come to be recognised tha these various bacilli play a beneficent role in the economy of Nature.”

²⁷Spending slowed only after the creation of the FDA during the early 1900s. If anything the data suggest spending on patent medicines rose most quickly during the formative era of the so-called bacteriological revolution (1870-1900). See figure 1.

(e.g., *Western Christian Advocate*, Jan. 14, 1880, p. 47; and *The Outlook*, October 27, 1894, p. 676).

To the extent that the germ theory changed consumer thinking, those changes made it easier for new producers to enter and differentiate their products from those sold by older, more established firms. Consider advertisements for Radam's Microbe Killer, the aforementioned mixture of muriatic acid, wine, and water. First introduced during the 1880s, Radam's advertising showed a man successfully battling a skeleton with a club. Proclaiming it the "Greatest Medicine in the World" ads described how Radam's Microbe Killer cured all diseases (including cancer) by destroying the germs that caused those diseases (e.g., *Overland Monthly*, June 1890, p. 881; *Centennial Celebration of George Washington's Inauguration*, 1889, p. 166). Another product, called Liquozone, claimed to attack germs without harming the body—"And it is the only way known to kill germs in the body without killing the tissues too." The diseases Liquozone purportedly cured included, but were not limited to, the following: kidney disease; tumors and ulcers; liver troubles; malaria; gonorrhea and syphilis; tuberculosis; and heart troubles (*Recreation*, Feb. 1905, p. lxx). An advertisement for a similar product called Hydrozone read as follows (*National Magazine*, Sept. 1903, p. 837): "This scientific germicide is used and endorsed by leading physicians everywhere. It is absolutely harmless, yet a most powerful healing agent. By killing the germs that cause these diseases, without injury to the tissue, Hydrozone cures the patient."

In some cases, quack medicine promoters distorted and misrepresented promising (or even failed) experimental findings involving disinfectants, touting the medicine "derived" from the underlying experiments as a certain and guaranteed cure. This is well illustrated by the case of copper. During the late 1800s and early 1900s, scientists showed that copper had antimicrobial properties. In France, the Lutons (a father and son team) uncovered evidence that copper inhibited the propagation of the mycobacterium that causes tuberculosis (*Medical*

Times, March 1, 1888, p. 334). Although physicians quickly realized that these findings were of little immediate import in terms of treating the disease (Riviere 1926; White 1926; Burrell 1928), modern research confirms the Lutons' claim that copper possesses antimicrobial properties particularly with regards to the tubercle bacillus (e.g., Michels et al. 2009; Mehtar 2008). In the United States, a series of experiments conducted by scientists affiliated with the Public Health Service and other governmental agencies during the early 1900s showed that copper slowed the growth of algae and waterborne pathogens. Following these experiments, some American cities began experimenting with copper in their water treatment systems as a means of preventing typhoid fever and other diarrheal diseases (Clark and Gage 1905; *Medical Bulletin*, Oct. 1904, pp. 404-06).

Paralleling these genuine advances in bacteriology were a series of quack medicines. Specifically marketed as cures for tuberculosis, influenza, and other respiratory diseases, these medicines advertised that they contained copper and that copper cured respiratory diseases because of its antimicrobial properties. Examples of such medicines include the aforementioned Tuberculozene and the Copper Cure sold by the Kalamazoo Tuberculosis Remedy Company (*National Magazine*, Sept. 1903, p. 835). The same process was at work with Carbolic Smoke Balls discussed in section 3. As noted above, the idea behind this product was that the carbolic acid contained in the smoke would act as a disinfectant, that once inhaled by the patient, would destroy the pathogens attacking the lungs. Physicians experimented with similar ideas during the 1880s and 1890s, using a wide variety of chemicals including chlorine gas and carbolic acid as a means of trying to cure tuberculosis. These experiments, however, were limited to a small subset of patients and generally researchers did not claim that such disinfectant treatments resulted in full-blown cures (*British Medical Journal*, Supp., May 16, 1891, p. 157). Soon recognizing the danger such chemical treatments posed to humans, physicians began experimenting on animals and started to place a much greater emphasis on

how to marshal the human body's own antibodies to fight bacteria (Behring 1891).

Whatever its effect on consumer thinking and behavior,²⁸ the diffusion of the germ theory had a major impact on mortality rates and the disease profiles of Western countries. These demographic effects, in turn, altered consumer demand for patent medicines, but not in the way one might initially think. Consider first the demographic shifts brought about by the germ theory. Around 1890, largely in response to discoveries by John Snow and William Budd regarding the pathogenesis of cholera and typhoid fever, and the proselytizing of men like Edwin Chadwick, cities throughout the United States and Europe began investing in public health infrastructure, particularly urban water systems, to prevent the spread of infectious diseases such as typhoid, diarrhea, tuberculosis, and diphtheria.²⁹ These investments had an enormous effect on overall mortality rates.³⁰ Using data from the State of Massachusetts and five major American cities (Boston, Chicago, New Orleans, New York, and Philadelphia), figures 10 and 11 show how these investments reduced the crude death rate by 30 to 60 percent in the years following 1890, depending on the region considered. More than half of the

²⁸Besides affecting consumer demand for patent medicines, Mokyr (2000) and Mokyr Stein (1997) show that the germ theory altered household behavior, leading household heads to invest more heavily in cleanliness and disease prevention. Tomes (1998) develops similar arguments.

²⁹For a short overview of the germ theory and public health advances in the United States, see McVail (1922). For a more thorough treatment, see Melosi's wonderful (2000) book, especially, pp. 17-103. For Budd's original paper on the propagation of typhoid fever, see Budd (1873).

³⁰The demographic literature on the causes and consequences of the urban mortality transition is vast. Some notable contributions by health economists and economic historians, include Brown (1989); Cain and Rotella (2001); Haines (2001); Cutler and Miller (2005); Higgs (1979); and Meeker (1974). Important contributions by historical demographers and sociologists include Condran and Crimmins-Gardner (1978); Condran et al. (1984); and Szreter (1988 and 1997). Urban mortality rates were halved between 1870 and 1940, largely as a result of investments in public health, especially public water systems (Ferrie and Troesken 2008). Disadvantaged socioeconomic groups benefitted more from these investments than did wealthier groups (Troesken 2004, pp. 65-92; 117-36).

reduction in mortality observed during this period can be attributed to water purification efforts, which not only reduced deaths from waterborne diseases like typhoid but also deaths from typhoid's sequella including kidney disease, heart failure, and tuberculosis.³¹

Given such large reductions in mortality, one is tempted to argue that the germ theory also reduced demand for quack medicines. There is some weak, qualitative evidence consistent with this argument. For example, patent medicines were sometimes marketed as cures for infectious diseases and their sequella. Consider the following testimonial for Hood's Sarsaparilla (*Public Opinion*, April 8, 1897, p. 442):

'After I had typhoid fever, for a long time I could not get over the weak and languid feeling. I had no appetite and was taken with horrible itching, burning heat on my limbs and hands. I was treated for a long time, but I did not get any better. I could not eat or sleep. A friend advised me to try Hood's Sarsaparilla, and I procured a bottle and began taking it. In a few days I felt better, and could eat and sleep. I continued taking Hood's Sarsaparilla until I was entirely cured.'
Mrs. R. Avery, Bergen, N.Y.

With the eradication of typhoid fever through water filtration, advertisements like this would have surely declined. A difficulty with this line of thought, however, is that patent medicines were, almost universally, marketed as cures for chronic diseases, not acute and infectious ones (Horton 1891; Smith 1985).

Another problem with arguing that reductions in infectious diseases undermined demand for quack medicines is that it ignores how the eradication of those diseases altered the age-distribution of American society and the overall disease profile. In short, as diseases and

³¹The idea that purifying water not only reduced deaths from waterborne diseases narrowly construed, but also the secondary diseases that stemmed from exposure to typhoid and diarrheal diseases, was known as the Mills-Reincke Effect (MRE). Although first documented (independently) in the 1890s by scientists in Massachusetts and Hamburg, Germany, the MRE was formalized by Sedgwick and MacNutt (1910) in lengthy article in *The Journal of Infectious Diseases*. According to Sedgwick and MacNutt, for every death from typhoid prevented by water purification there were four or more additional deaths from other causes also prevented. Ferrie and Troesken (2007) present econometric evidence that the MRE was probably closer to seven than to four, but the basic idea remains. See also, Hill and Whitcomb (1913) and McGee (1920).

deaths among the young were reduced, the country's age distribution shifted upward, with a greater proportion of the population than ever before living past the age of 65. Also, long-term, chronic diseases replaced acute, infectious ones as the leading causes of death. Because patent medicines were designed and marketed mainly toward older individuals with more chronic health problems than young people, increases in the proportion of the population that lived into old age probably stimulated demand for patent medicines. The irony of this should not be missed: rather than undermining the market quack medicines, the germ theory and the subsequent investments in disease prevention probably helped expand the market.

As evidence for such a demographic mechanism, consider the experience of Chicago. As table 3 shows, between 1870 and 1879, nearly 60 percent of all deaths in Chicago occurred among children four years old or younger, with most causes of death ascribed to infectious diseases such tuberculosis, diphtheria, typhoid fever, and diarrheal diseases. Nearly fifty years later (the 1915-1925 decade), the overall death rate had fallen by 40 percent, and deaths among infants and young children represented only 27 percent of all deaths. In addition, chronic, long-term diseases replaced acute, infectious diseases as leading causes of death, with diphtheria, typhoid, and measles largely vanishing, and deaths from heart disease, kidney disease, and cancer now representing 30 percent of all deaths—previously these pathologies had accounted for less than 10 percent of all deaths. Figure 12 illustrates how these changes in the urban disease profile affected the country's age structure. Notice that before 1880, the proportion of the American population over the age of 65 hovered around 3 percent, but after this point, it rose to 8 percent by the mid twentieth century, with the most rapid growth in this age group taking place after 1900.

8. Concluding Remarks

In recounting the economic history of quack medicines, this paper contributes to debates in health economics, industrial organization, and regulation. For example, some economists maintain that medical licensing laws are unnecessary and inefficient. The argument is that competition weeds out quack providers, and that licensing creates entry barriers that give rise to market power and reduce consumer welfare. There are reasons to question this logic, however. Suppose that the quality of medical care is difficult for patients to monitor and that high-quality care is costly to provide. In this case quack providers might enjoy a competitive advantage. In a complementary line of thought, Spiegler (2006) demonstrates that quack physicians can survive in equilibrium because patients randomly recover for reasons independent of the quack's treatment and because patients are boundedly-rational, making decisions based on anecdotes rather than general principles or a full assessment of relative probabilities. If patients adopted a non-anecdotal form of reasoning, they would not be fooled by random, non-treatment based recoveries. But as long as patients are boundedly rational, quacks can withstand competition from legitimate physicians.

A superficial reading of Speigler's "Market for Quacks" (*MFQ*) and the economic history of patent medicines might suggest that the two are unrelated. Except for a brief discussion at the end of the paper, the Spiegler's model is a static, equilibrium construct driven by boundedly-rational decision making and random recovery. In contrast, the analysis here considers a 150-year history of growth and change, and focuses mainly on medicines that claimed to cure diseases from which no one ever recovered, random or otherwise. There are, however, several key aspects of the analysis here that could be seen as paralleling Spiegler's model. This is especially true if one interprets the random recoveries in the *MFQ* not as recoveries *per se*, but as noise given meaning by actors with limited knowledge—because patients do not know

enough about the underlying structure of the world, they are fooled by misleading signals, whatever their form. There are more concrete parallels as well. For example, the *MFQ* predicts that quacks invest heavily in product differentiation, and that up to a point consumer spending rises as the number of quacks increases. The framework here carries similar implications: quack medicines would not have survived had their promoters not been able effectively differentiate their medicines; and market expansion was facilitated by new and increasingly novel products. At a more fundamental level, the history of patent medicines suggests that positive signals (like random recoveries) can be endogenous: if producers recognize that consumers use anecdotal reasoning, they might find ways to induce events that mimic recoveries and cures.

The economic history of quack medicines also sheds light on the origins of the Food and Drug Administration (FDA) and why the agency has grown increasingly aggressive and interventionist over the course of the twentieth century. In so doing, the paper addresses an enduring debate among regulatory economists and historians. An older literature maintains that Pure Food and Drug Act (which created the FDA) was the product of rent-seeking and special interest politics, pushed either by big businesses who wanted to credibly signal that their products were of high quality to potential consumers, or by small businesses who wanted to use increased federal regulation and oversight as a means of hampering their larger, interstate competitors (Wood 1986). More recent economic research, however, suggests that the creation of the FDA and other efforts to regulate commercial speech, enhanced consumer welfare (Law 2006; Hansen and Law 2008; Glaeser and Shliefer 2003). In the context of the model developed in section 1, whenever products exhibit a very low elasticity of demand with respect to product failures, stringent regulations on commercial speech are appropriate. In the absence of such regulations, consumers are vulnerable to misleading and fraudulent advertising claims, in part because consumers do not adequately punish those manufacturers

who make baseless pronouncements about the efficacy of their products. On the contrary, consumers desperate to find a cure for what ails them might return to those manufacturers repeatedly in the withering though ever-present hope of finding an efficacious product.

References

- Allbutt, T. Clifford. 1870. "On the Use of Sarsaparilla in Syphilis," *The Practitioner*, 2:257-61.
- American Medical Association. 1908. *The Propaganda for Reform in Propriety Medicines*. Chicago: AMA.
- American Medical Association. 1911. *Nostrums and Quackery: Articles on the Nostrum Evil and Quackery*. Chicago: AMA.
- Anderson, Ann. 2000. *Snake Oil, Hustlers and Hambones: the American Medicine Show*. Jefferson, N.C.: McFarland & Company.
- Arnold, Horace D. 1908. "High Frequency Electricity in the Treatment of Cardiac Diseases," *Transactions of the American Clinical and Climatological Association*, 24:207-25.
- Ashhurst, John. 1896. "Surgery Before the Days of Anesthesia," *Boston Medical and Surgical Journal*, 85:378-80.
- Bantock, Geo. Granville. 1899. "The Modern Doctrine of Bacteriology, or the Germ Theory of Disease," *British Medical Journal*, April 8, 1899, pp. 846-48.
- Bashford, E.F. 1911. "Cancer, Credulity, and Quackery," *British Medical Journal*, May 27, 1911, pp. 1221-30.
- Behring, Stabsarzt. 1891. "Disinfection in the Living Body," *British Medical Journal*, Aug. 22, 1891, pp. 406-08.
- Bentley, Robert, and Henry Trimen. 1875. *Medicinal Plants Being Descriptions with Original Figures of the Principal Plants Employed in Medicine and an Account of Their Properties and Uses*. London: J. & A. Churchill.
- Bird, Frederic. 1851. "Diagnosis, Treatment, and Pathology of Ovarian Tumors," *Medical Times*, 24:60-67.
- Bishop, Louis Faugeres. 1917. "The Pathological Physiology of the Heart as Revealed by the Polygraph and the Electrocardiograph," *Medical Record*, Sept. 15, 1917, pp. 450-51.
- Bolton, J.S. 1910. "The Relief of Symptoms of Prostatic Obstruction by Electrical Treatment," *Proceedings of the Royal Society of Medicine*, 3(Electro-Therapeutical Section):141-48.
- Bosanquet, William Cecil, and John W.H. Eyre. 1916. *Serums, Vaccines, and Toxins in Treatment and Diagnosis*. Third edition. London: Cassell and Company, Ltd.
- Braverman, Lewis E., and Sidney H. Ingbar. 1963. "Changes in Thyroidal Function During Adaptation to Large Doses of Iodide," *Journal of Clinical Investigation*, 42:1216-31.

- Brown, John C. 1989. "Reforming the Urban Environment: Sanitation, Housing, and Government Intervention in Germany, 1870-1910," *Journal of Economic History*, 49:450-72.
- Budd, William. 1873. "Typhoid Fever: Its Nature, Mode of Spreading, and Prevention." Reprinted in *American Journal of Public Health*, 8:610-12.
- Burrell, L.S.T. 1928. "The Therapeutic Value of the Heavy Metals in Pulmonary Tuberculosis," *British Medical Journal*, October 27, 1928, pp. 737-38.
- Butcher, M.W. Deane. 1908. "The Future of Electricity in Medicine," *Proceedings of the Royal Society of Medicine*, 1(Electro-Therapeutical Section):1-14.
- Cain, Louis P., and Elyce J. Rotella. "Death and Spending: Urban Mortality and Municipal Expenditures on Sanitation," *Annales de Démographie Historique*, 45:139-54.
- Chang, Fwu-Ranq, and Pravin K. Trivedi, "Economics of Self-Medication: Theory and Evidence," *Health Economics*, 12:721-39.
- Cheever, David W. 1896. "What Anesthesia Has Done for Surgery," *Boston Medical and Surgical Journal*, 85:381-84.
- Clark, H.W., and Stephen D. Gage. 1905. "On the Bactericidal Action of Copper," *Public Health Papers and Reports*, 31:175-204.
- Condran, Gretchen A., and Ellen Crimmins-Gardner. 1978. "Public Health Measures and Mortality in U.S. Cities in the Late Nineteenth Century," *Human Ecology*, 6:27-54.
- Condran, Gretchen A., H. Williams, and R.A. Cheney. 1984. "The Decline in Mortality in Philadelphia from 1870 to 1930: The Role of Municipal Services," *Pennsylvania Magazine of History and Biography*, 108-153-77.
- Cutler, David, and Grant Miller. 2005. "The Role of Public Health Improvements in Health Advances: The Twentieth-Century United States," *Demography*, 42:1-22.
- Davis, Robert F. 1896. "Reminiscences of 1846," *Boston Medical and Surgical Journal*, 85:377-78.
- Doherty, Francis. 1990. "The Anodyne Necklace: A Quack Remedy and Its Promotion," *Medical History*, 34:268-93.
- Donkin, Arthur Scott. 1875. *On the Relation Between Diabetes and Food and Its Application to the Treatment of the Disease*. New York: G.F. Putnam's Sons.
- Dujardin-Beaumetz, P. 1883. "On the Treatment of Epilepsy," *Medical Record*, 24:207-11.
- Eng, Peter H., Guemalli R. Cardona, Shih-Lieh Fang, et al. 1999. "Escape from the Acute Wolff-Chaikoff Effect Is Associated With a Decrease in Thyroid Sodium/Iodide Symporter Messenger Ribonucleic Acid and Protein," *Endocrinology*, 140:3404-09.

- Ferrie, Joseph P., and Werner Troesken. 2008. "Water and Chicago's Mortality Transition, 1850-1925," *Explorations in Economic History*, 45:1-16.
- Finzi, N.S. 1910. "Radium in the Treatment of Malignant Growths," *Proceedings of the Royal Society of Medicine* 3(Electro-Therapeutical Section):53-72.
- Fosbroke, John. 1842. "On Quack Compositions and Patent Medicines," *Providence Medical and Surgical Journal*, 3:269-71.
- Frazier, Charles H. 1932. "The Use of Potassium Iodide in Hyperthyroidism," *Annals of Surgery*, 95:517-24.
- Frey, H. 1964. "Hypofunction of the Thyroid Gland, Due to Prolonged and Excessive Intake of Potassium Iodide," *Acta Endocrinologica*, 47:105-20.
- Glaeser, Edward L., and Andrei Shleifer. 2003. "The Rise of the Regulatory State," *Journal of Economic Literature*, 41:401-25.
- Gould, George M. 1892. "The Etiology, Diagnosis, and Treatment of the Prevalent Epidemic of Quackery," *Medical News*, May 7, 1892, pp. 510-18.
- Gregor, Gilbert D. 1910. "The Duty of the Medical Profession Toward the Cancer Problem," *New York State Journal of Medicine*, 10:343-46.
- Haines, Michael R. 2001. "The Urban Mortality Transition in the United States, 1800-1940." Historical paper no. 134. Cambridge: National Bureau of Economic Research.
- Hammonds, Evelyn Maxine. 1999. *Childhood's Deadly Scourge: The Campaign to Control Diphtheria in New York City, 1880-1930*. Baltimore: Johns Hopkins University Press.
- Hansen, Zeynep K., and Marc T. Law. 2008. "The Political Economy of Truth in Advertising Regulation During the Progressive Era," *The Journal of Law and Economics*, 51:251-69.
- Hare, Hobart Amery. 1895. "The Employment of Cardiac Sedatives in Heart Disease," *Medicine*, 1:19-22.
- Harrison, L.W. 1927. "The Prognosis of Syphilis in the Light of Modern Methods of Treatment," *British Journal of Venereal Disease*, 3:299-319.
- Harrison, L.W. 1937. "Experiences with Anti-Syphilitic Treatment from the Pre-Salvarsan Era to the Present and Their Possible Bearing on Present Treatment Practice," *British Journal of Venereal Disease*, 13:1-22.
- Henkel, Alice. 1911. *American Medicinal Leaves and Herbs*. U.S. Department of Agriculture. Bureau of Plant Industry—Bulletin No. 219. Washington: Government Printing Office.
- Higgs, Robert. 1979. "Cycles and Trends of Mortality in 18 Large American Cities, 1871-1900," *Explorations in Economic History*, 16:381-408.

- Hill, Nicholas S., and Leon R. Whitcomb. 1913. "The Relation of Water to Chronic Intestinal Tract Infection," *American Journal of Public Health*, 3:915-28.
- Hjortsberg, Catharina. 2003. "Why Do the Sick Not Utilise Health Care? The Case of Zambia," *Health Economics*, 12:755-70.
- Holbrook, Stuart H. 1959. *The Golden Age of Quackery*. New York: MacMillan Company.
- Horsky Dan, and Leonard S. Simon. 1983. "Advertising and the Diffusion of New Products," *Marketing Science*, 2:1-14.
- Horton, Albert H. 1891. "The Necessity for More Stringent Legislation to Repress Empiricism," *Public Health Papers and Reports*, 17:24-33.
- Jameson, Eric. 1961. *The Natural History of Quackery*. London: Michael Joseph.
- Jolliffe, D.M. 1993. "A History of the Use of Arsenicals in Man," *Journal of the Royal Society of Medicine*, 86:287-89.
- Jones, H. Lewis. 1909. "The Treatment of Naevus by Electrical Methods, With Notes of 1,600 Cases," *Proceedings of the Royal Society of Medicine*, 2(Electro-Therapeutical Section):107-22.
- Johnson, T.M., and R.P. Rapini. 1988. "The Wolff-Chaikoff Effect: Hypothyroidism Due to Potassium Iodide," *Archives of Dermatology*, 124:1184-85.
- Kihlstrom, Richard E., and Michael H. Riordan. 1984. "Advertising as a Signal," *Journal of Political Economy*, 92:427-50.
- Kiple, Kenneth F (editor). 1993. *The Cambridge World History of Human Disease*. Cambridge: Cambridge University of Press.
- Kocher, Emil Theodor. 1906. "A Contribution to the Pathology of the Thyroid Gland," *British Medical Journal*, June 2, 1906, pp. 1261-66.
- Law, Marc T. 2006. "How Do Regulators Regulate? Enforcement of the Pure and Food and Drugs Act, 1907-38," *Journal of Law, Economics, and Organization*, 22:459-89.
- Lees, D.B. 1909. "The Effective Treatment of Acute and Subacute Rheumatism," *Proceedings of the Royal Society of Medicine*, 2:34-48.
- Marine, David. 1925. "Iodine in the Treatment of Disease of the Thyroid Gland," *Transactions of the American Clinical and Climatological Association*, 41:38-52.
- Massachusetts. State Board of Health, Lunacy, and Charity. 1886. *Seventh Annual Report of the State Board of Health, Lunacy, and Charity of Massachusetts. Supplement Containing the Report and Papers on Public Health, with a General Index*. Boston: Wright & Potter Printing.

- Massachusetts. State Board of Health. 1897. *Twenty-Eighth Annual Report of the State Board of Health of Massachusetts*. Public Document No. 34. Boston: Wright & Potter Printing Co.
- Marlow, F.W. 1974. "Syphilis Then and Now," *Journal of the American Medical Association*, 230:1320-21.
- Mason, Lewis D. 1903. "Patent and Proprietary Medicines as the Cause of the Alcohol and Opium Habit or Other Forms of Narcomania—With Some Suggestions as to How the Evil May be Remedied," *Quarterly Journal of Inebriety*, 25:1-13.
- McGee, Harold G. 1920. "The Mills-Reincke Phenomenon and Typhoid Control By Vaccine," *American Journal of Public Health*, 10:585-87.
- McGlaughlin, Allan J. 1912. "Sewage-Polluted Water Supplies in Relation to Infant Mortality," *Public Health Reports*, 27:579-627.
- Mehtar, S., I. Wild, and S.D. Todorov. 2008. "The Antimicrobial Activity of Copper and Copper Alloys Against Nosocomial Pathogens and Mycobacterium Tuberculosis Isolated from Hospital Facilities in the Western Cape: An In-Vitro Study," *Journal of Hospital Infection*, 68:45-51.
- Melosi, Martin V. 2000. *The Sanitary City: Urban Infrastructure in America from Colonial Times to the Present*. Baltimore: The Johns Hopkins University Press.
- Michels, H.T., J.O. Noyce, and C.W. Keevil. 2009. "Effects of Temperature and Humidity on the Efficacy of Methicillin-Resistant Staphylococcus Aureus Challenged Antimicrobial Materials Containing Silver and Copper," *Letters in Applied Microbiology*, 49:191-95.
- Milgrom, Paul, and John Roberts. 1986. "Price and Advertising Signals of Product Quality," *Journal of Political Economy*, 94:796-821.
- Mokyr, Joel. 2000. "Why 'More Work for Mother?' Knowledge and Household Behavior, 1870-1945," *Journal of Economic History*, 60:1-41.
- Mokyr, Joel and Rebecca Stein. 1997. "Science, Health, and Household Technology: The Effect of the Pasteur Revolution on Consumer Demand," in *The Economics of New Goods*, pp. 143-208. Timothy F. Bresnahan and Robert J. Gordon, editors. Chicago: University of Chicago Press.
- Morris, Henry. 1912. "A Discussion on Syphilis, with Special Reference to (a) Its Prevalence and Intensity in the Past and at the Present Day; (b) Its Relation to Public Health, Including Congenital Syphilis; (c) the Treatment of Disease," *Proceedings of the Royal Society of Medicine*, 5:115-32.
- Murray, George R. 1896. "After-History of the First Case of Myxoedema Cured by Thyroid Extract," *British Medical Journal*, Feb. 8, 1896, pp. 334-35.

- Newcomer, H.S., Russell Richardson, Charlotte Ashbrooke, and Paul A. Lewis. 1919. "One Aspect of Syphilis as a Community Problem," *American Journal of Medical Sciences*, 158:141-65.
- Oleson, Charles W. 1899. *Secret Nostrums and Systems of Medicine: A Book of Formulas*. Chicago: Oleson and Company Publishers.
- Oliver, F.E. 1872. "The Use and Abuse of Opium." In *Third Annual Report of the State Board of Health of Massachusetts*, January 1872, pp. 162-77. Public Document 31. Boston: Wright & Potter.
- Osborne, Oliver T. 1904. "The Scourge of Nostrums and Irregular Practitioners," *Journal of the American Medical Association*, 43:1-7.
- Osler, Sir William, and Thomas McCrae (editors). 1913. *Modern Medicine: Its Theory and Practice*. Volume 1. Bacterial Diseases—Diseases of Doubtful or Unknown Etiology—Non-Bacterial Fungus Infections—The Mycoses. Second Edition. Philadelphia: Lea & Febiger.
- Prescott, Albert B. 1882. "Nostrums in Their Relation to the Public Health." In *Ninth Annual Report of the Secretary of the State Board of Health of the State of Michigan for the Fiscal Year Ending Sept. 30, 1881*, pp. 151-60. Lansing: W.S. George & Co., State Printers.
- Riviere, Clive. 1926. "The Principles of Treatment of Pulmonary Tuberculosis," *British Medical Journal*, May 1, 1926, pp. 771-75.
- Robinson, G. Canby. 1912. "A Study With the Electrocardiograph of the Mode of Death of the Human Heart," *Journal of Experimental Medicine*, 16:291-302.
- Robson, A.W. Mayo. 1894. "The Surgery of the Gall Bladder and Bile Ducts, With Brief Notes of 78 Cases," *British Medical Journal*, April 28, 1894, pp. 901-904.
- Rogers, F.T. 1904. "The Correspondence Method of Treating Disease," *Bulletin of the American Academy of Medicine*, 6:835-47.
- Rogers, John. 1910. "The Results of 'Specific' Remedies in Diseased States Accompanied by Hypertrophy of the Thyroid," *Annals of Surgery*, 40:140-72.
- Rogerson, William P. 1988. "Price Advertising and the Deterioration of Product Quality," *Review of Economic Studies*, 55:215-29.
- Semon, Felix. 1901. "Some Thoughts on the Principles of Local Treatment in Diseases of the Upper Air Passages," *British Medical Journal*, Nov. 9, 1901, pp. 1396-1406.
- Singer, Charles. 1950. "Medical Progress from 1850 to 1900," *British Medical Journal*, Jan. 7, 1950, pp. 57-61.

- Smith, Barry. 1985. "Gullible's Travails: Tuberculosis and Quackery, 1890-1930," *Journal of Contemporary History*, 20:733-56.
- Smith, Edith, and F. Dudley Hart. 1971. "William Murrell, Physician and Practical Therapist," *British Medical Journal*, September 11, 1971, pp. 632-33.
- Spiegler, Ran. 2006. "The Market for Quacks," *Review of Economic Studies*, 73:1113-1131.
- Starr, Paul. 1982. *The Social Transformation of American Medicine: The Rise of a Sovereign Profession and the Making of a Vast Industry*. New York: Basic Books.
- (Dr.'s) Stricker, Reiss, Broadbent, Maclagan, et al. 1876. "On the Use of Salicylic Acid and Salicin in Acute Rheumatism," *Retrospect of Medicine*, 74:38-47.
- Tousey, Sinclair. 1915. *Medical Electricity, Röntgen Rays, and Radium*. Second edition. Philadelphia: W.B. Saunders Company.
- Treves, Frederick. 1905. "Discussion on the Subsequent Course and Later History of Cases of Appendicitis After Operation," *Medico-Chirurgical Transactions*, 88:429-610.
- Troesken, Werner. 2004. *Water, Race, and Disease*. Cambridge: MIT Press.
- Troesken, Werner. 2006. *The Great Lead Water Pipe Disaster*. Cambridge: MIT Press.
- Waller, Herbert Ewan. 1911. *Theory and Practice of Thyroid Therapy*. New York: William Wood and Company.
- White, Douglas. 1925. "Thoughts on the Prevalence of Syphilis," *British Journal of Venereal Disease*, 1:136-145.
- White, J. William. 1891. "The Present Position of Antiseptic Surgery," *Annals of Surgery*, 13:1-30.
- White, William Charles. 1926. "Chemical Treatment of Tuberculosis and Vaccines in Immunization Against Tuberculosis," *American Journal of Public Health*, 16:532-35.
- White, W. Hale. 1917. "The Principles of the Transfusion of Blood," *Proceedings of the Royal Society of Medicine*, 10:1-18.
- Williams, C. Theodore. 1901. "A Discussion on the Treatment of Consumption by Climate," *British Medical Journal*, July 27, 1901, pp. 198-218.
- Wood, Donna. 1986. *Strategic Uses of Public Policy*. New York: Pitman Publishing.
- Wood, L.C., and F. Maloof. 1975. "Thyroid Failure After Potassium Iodide Treatment of Diffuse Toxic Goiter," *Transactions of the Association of American Physicians*, 88:235-47.
- Worboys, Michael. 2000. *Spreading Germs: Disease Theories and Medical Practice in Britain, 1865-1900*. Cambridge: Cambridge University Press.

Young, James Harvey. 1961. *The Toadstool Millionaires: A Social History of Patent Medicines in America Before Federal Regulation*. Princeton: Princeton University Press.

Product	First obs'd	Last obs'd	Min life	Main ingredients
Ayer's Sarsaparilla	1824	1906	82 yr's	sarsaparilla, yellow dock, May apple, sugar
Brandreth's Pills	1827	1920	93	aloe, colocynth, peppermint, cinnamon, alcohol
Hamlin's Wizard Oil	1864	1920	46	ammonia, chloroform, sassafras, turpentine, cloves
Holloway's Pills	1823	1920	97	aloe, rhubarb, capsicum (chili peppers), ginger, soap
Hood's Sarsaparilla	1884	1915	31	sarsaparilla, sassafras, sugar, maple syrup, alcohol
Hop Bitters	1873	1920	47	alcohol (16-20 percent)
Hostetter's Stomach Bitters	1853	1958	105	roots, Peruvian bark (quinine), orange peels, alcohol
Jayne's Vermifuge	1863	1920	57	sodium, turpentine, pink root, jalap (a cathartic plant)
Kilmer's Swamp Root	1880	1959	79	water, alcohol, willow bark, sugar
Moxie Nerve Food	1870s	1910s	≈45	oats, syrup, sassafras, wintergreen
Pinkham's Vegetable Comp.	1873	1958	85	alcohol, aloe, glycerin (a laxative), tansy, lovage (plants)
Peruna (later called Ka-tar-no)	1638	1927	289	whiskey, champagne, claret, beer
Old Hinkley's Bone Liniment	1856	1959	103	wormwood, hemlock, thyme, turpentine, capsicum
Perry Davis's Painkiller	1840	1958	118	opium, camphor, capsicum
Dr. Pierce's Golden Med. Disc.	1875	1958	83	opium, May apple, guaiacum (tree extract)
Dr. Sanford's Liver Invigorator	1858	1911	65	unknown
Swaim's Panacea	1820	1899	79	worm-seed, valerian, cloves, agaric, rhubarb, tansy
Wistar's Balsam of Wild Cherry	1843	1920	77	opium, cherries, syrup, sugar, alcohol

Table 1. Long-Lasting Patent Medicines

Source: see text.

Variable	Mean (std. dev.)	Log(misc. exp.)	
		(1)	(2)
Log(total value)	6.888 (.826)	.972* (.017)	—
Log(capital)	6.737 (.840)	—	.336* (.058)
Log(salaries)	5.466 (.772)	—	.426* (.052)
Log(wages)	6.125 (.827)	—	.204* (.046)
Log(raw materials)	6.550 (.893)	—	.062 (.247)
= 1 if patent medicine industry	—	.725* (.267)	.621* (.247)
Adjusted R^2	—	.902	.918
Number of observations	—	333	333

Table 2. Determinants of Advertising Expenditures at the Industry Level

Notes: * - indicates significance at the .01 level or higher. Constant included but not reported.

Source: see text.

	1870-1879		1915-1925 (excluding 1918)	
	Death rate	Share of deaths	Death rate	Share of deaths
<i>Deaths by cause:</i>				
All causes	211.8	1.000	125.3	1.000
Typhoid fever	6.2	.029	.2	.002
Measles	1.8	.009	.6	.005
Scarlet Fever	7.8	.037	.5	.004
Whooping Cough	2.8	.013	.5	.004
Diphtheria	11.2	.053	2.2	.018
Respiratory diseases	36.7	.173	27.2	.217
Heart disease	5.1	.024	18.3	.146
Kidney disease	1.6	.008	9.1	.071
Cancer	1.4	.014	9.6	.078
<i>Deaths by age-group:</i>				
Infant mortality (< 1)	74.0	.349	18.3	.162
Child mortality (1-4)	48.1	.227	8.9	.073

Table 3. Leading Causes of Death in Chicago, 1870-1925

Source: Annual Reports Department of Public Health, City of Chicago. Various years.

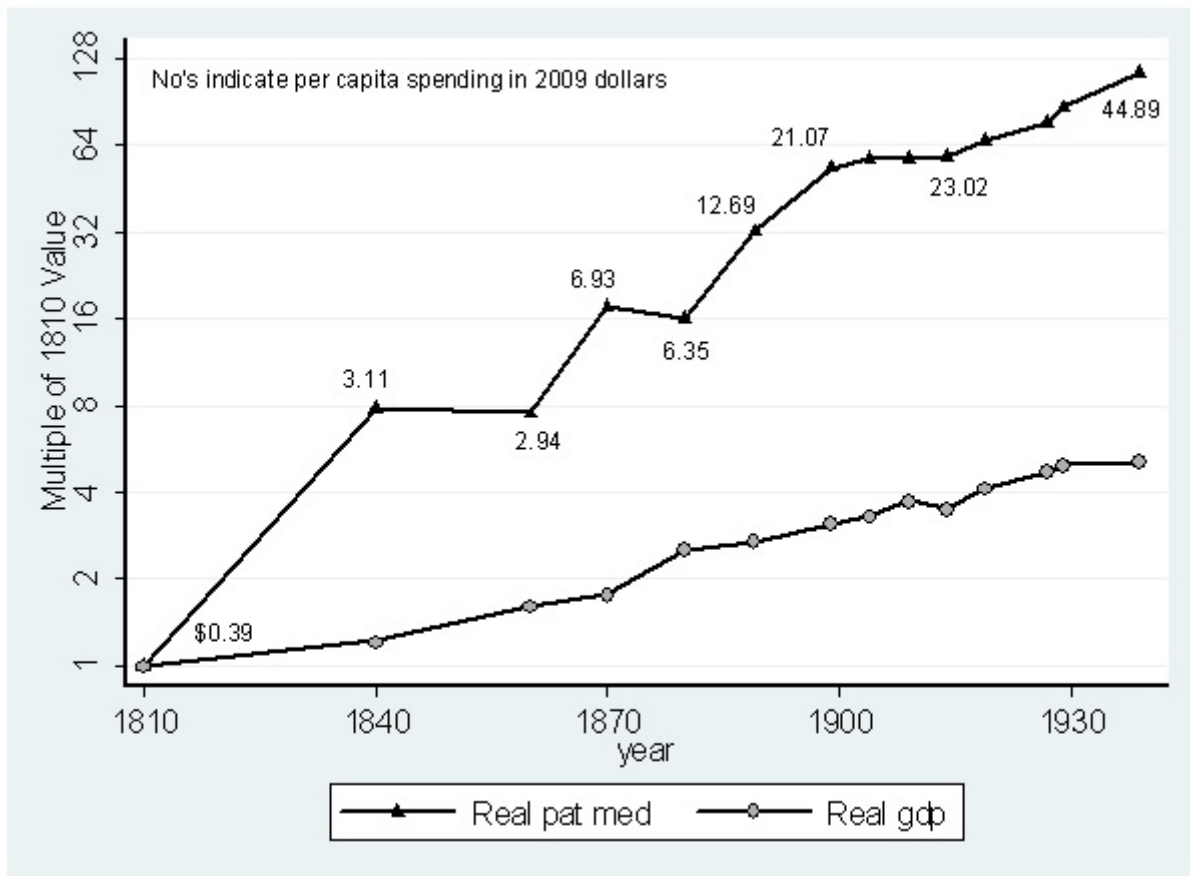


Figure 1. Growth in Spending on Patent Medicines and GDP per Capita

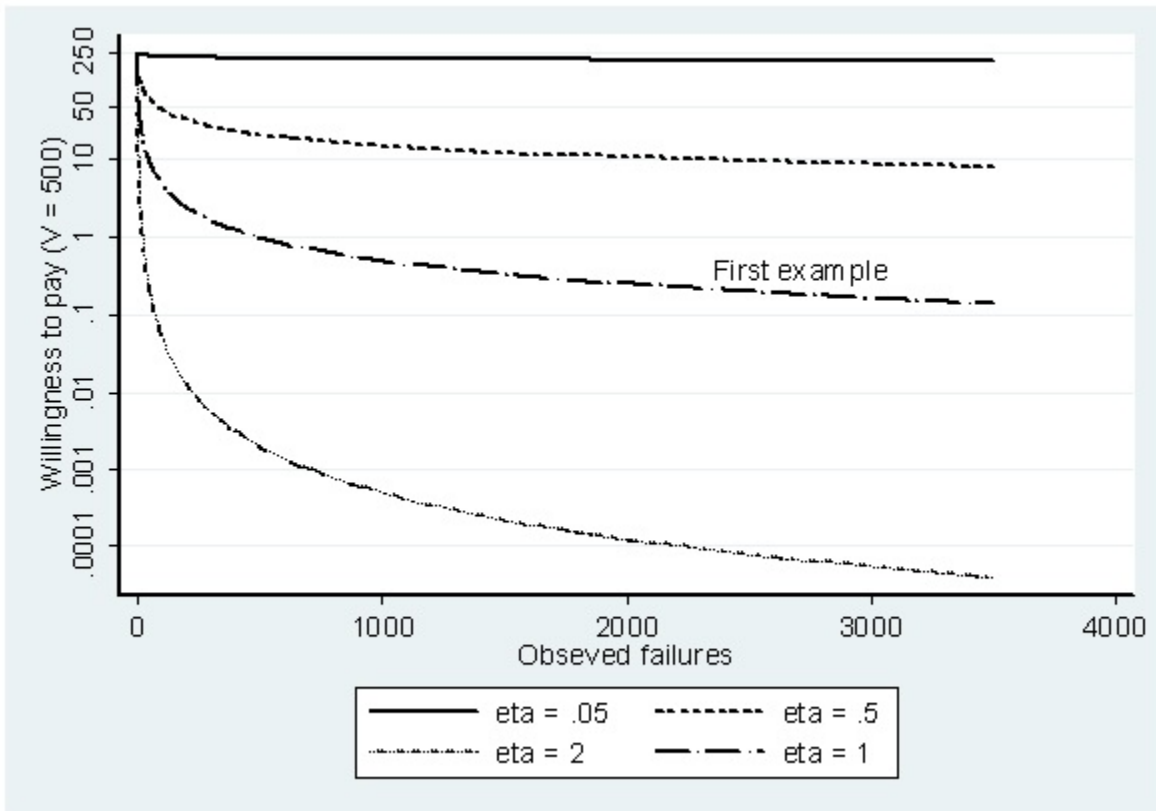


Figure 2. Willingness to Pay and the Elasticity of Demand with Respect to Product Failures

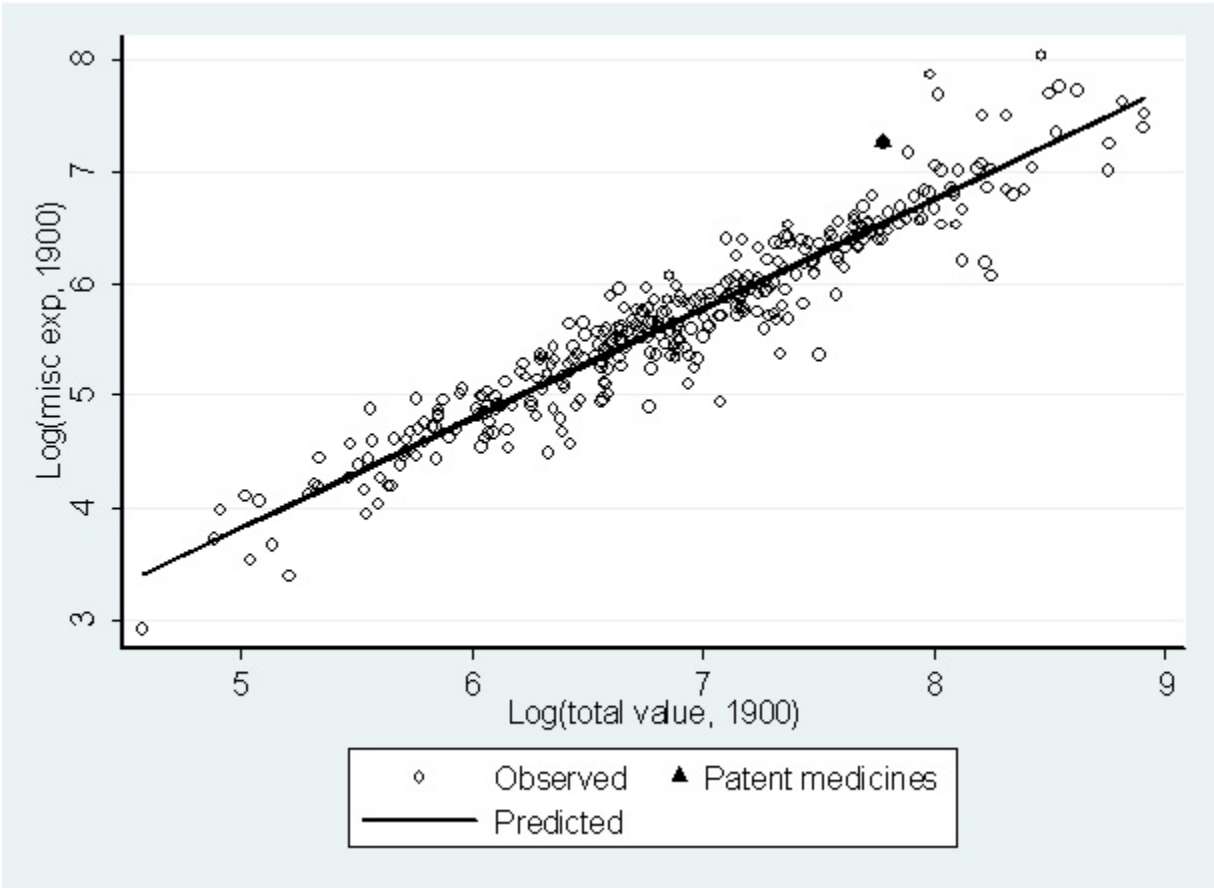


Figure 3. Advertising Expenditures and Market Value of Industry Output

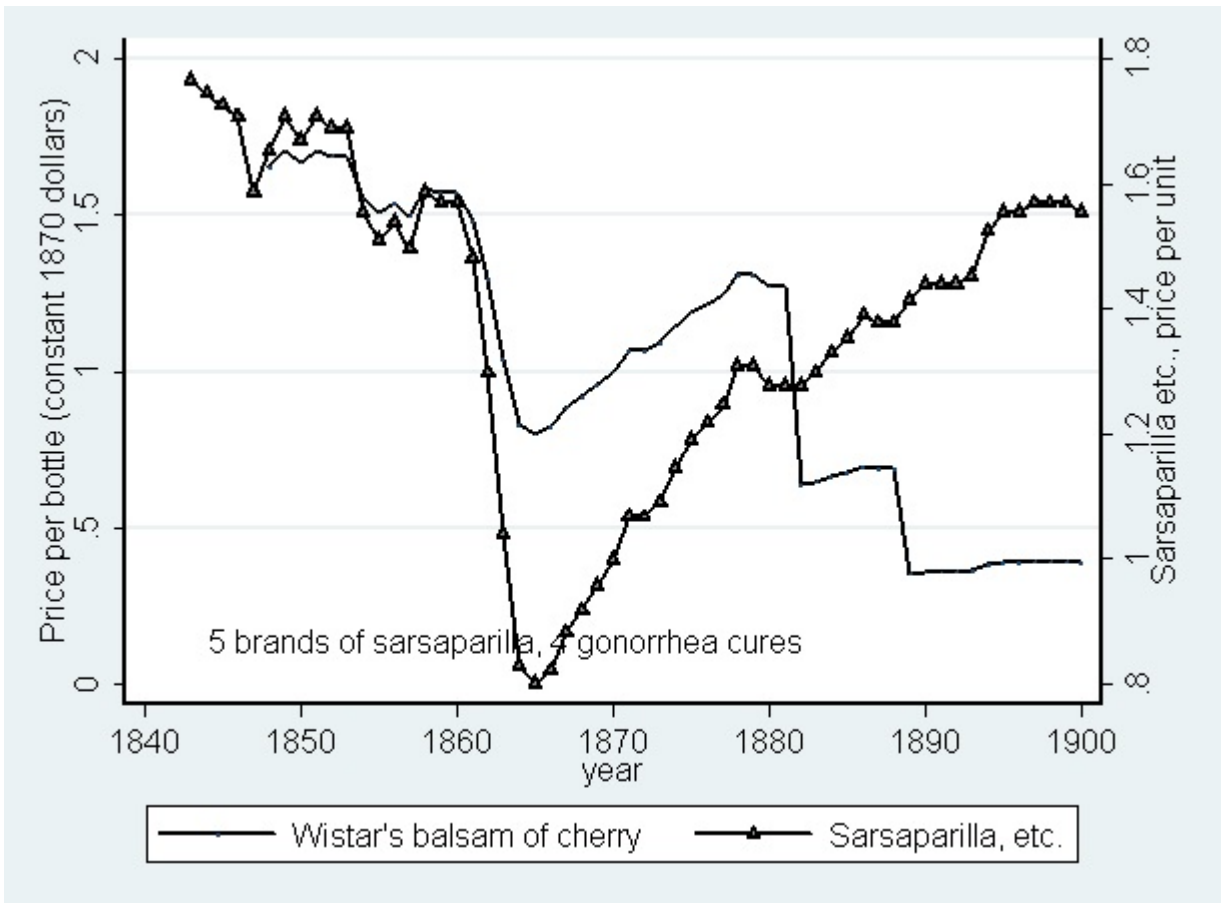


Figure 4. Prices of Patent Medicines

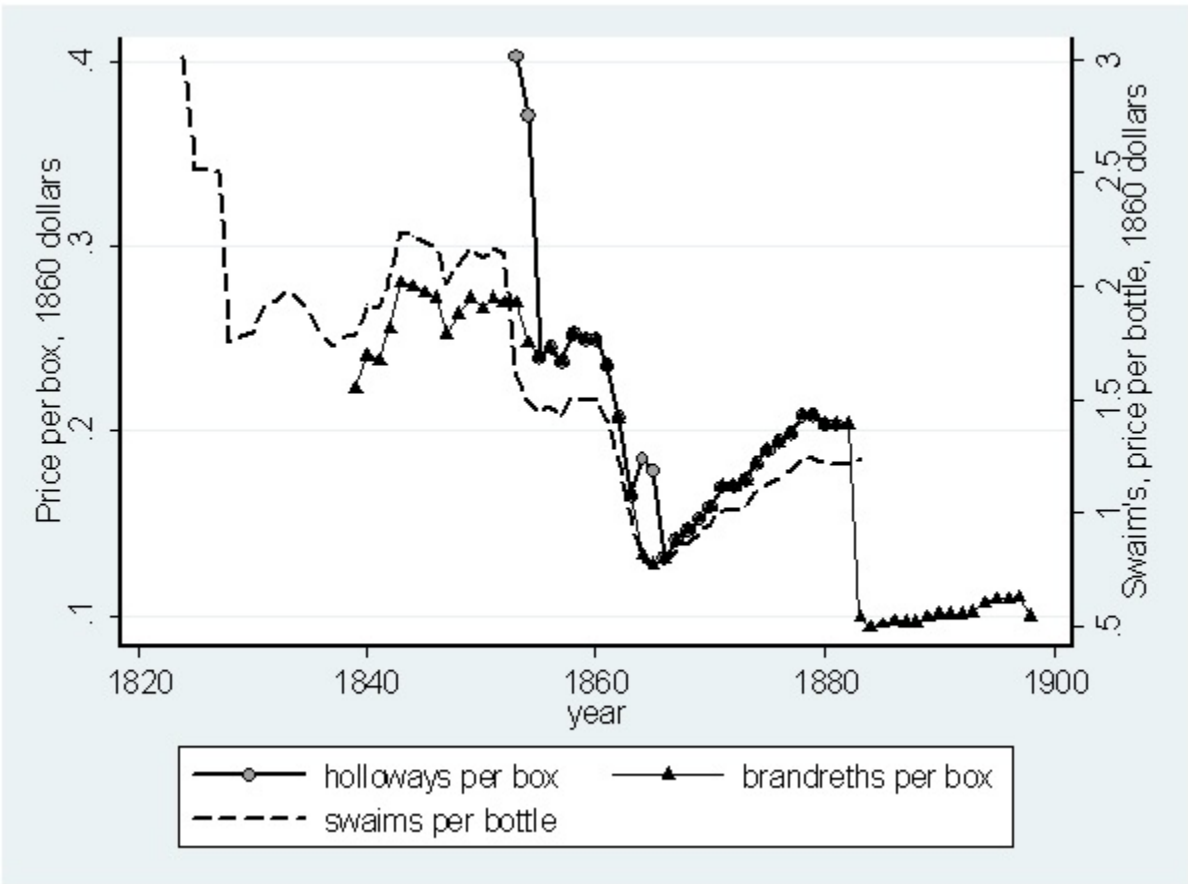


Figure 5. Prices of More Patent Medicines

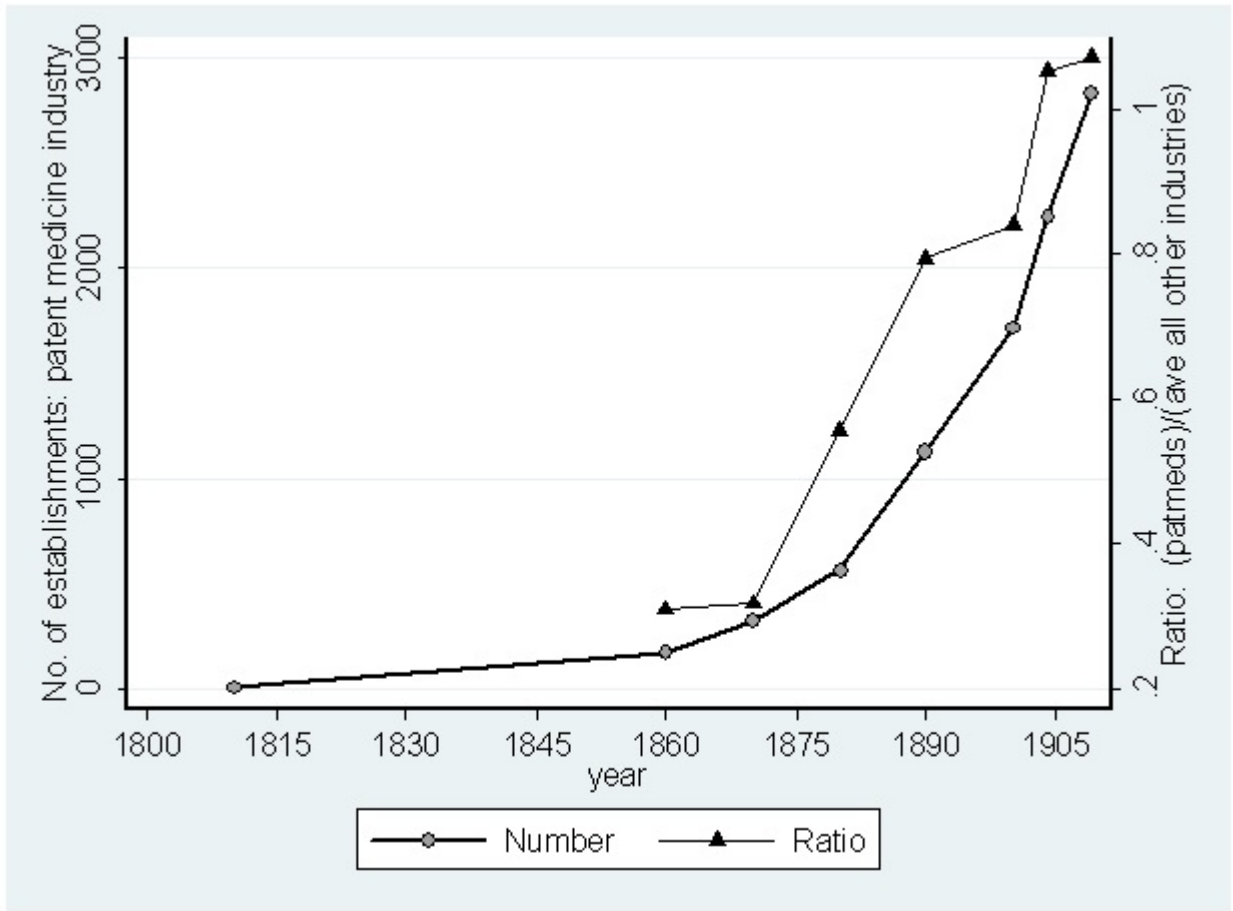


Figure 6. Number of Firms in Patent Medicine Industry: Absolute and Relative Measures

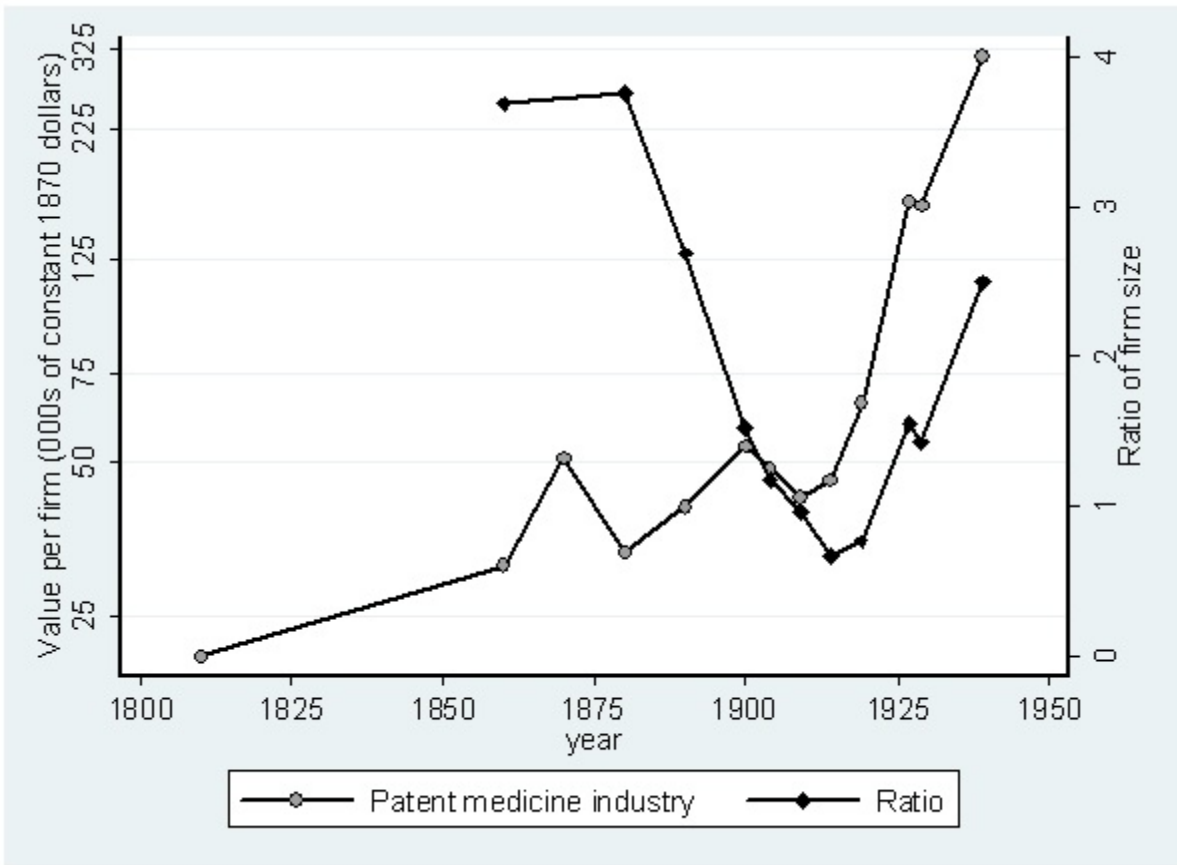


Figure 7. Firm Size in the Patent Medicine Industry: Absolute and Relative Measures

Note: the sharp rise in firm size, both in absolute and relative terms, follows passage of the Pure Food Drug Act in 1906. The effects of this measure will be considered in detail in later work.

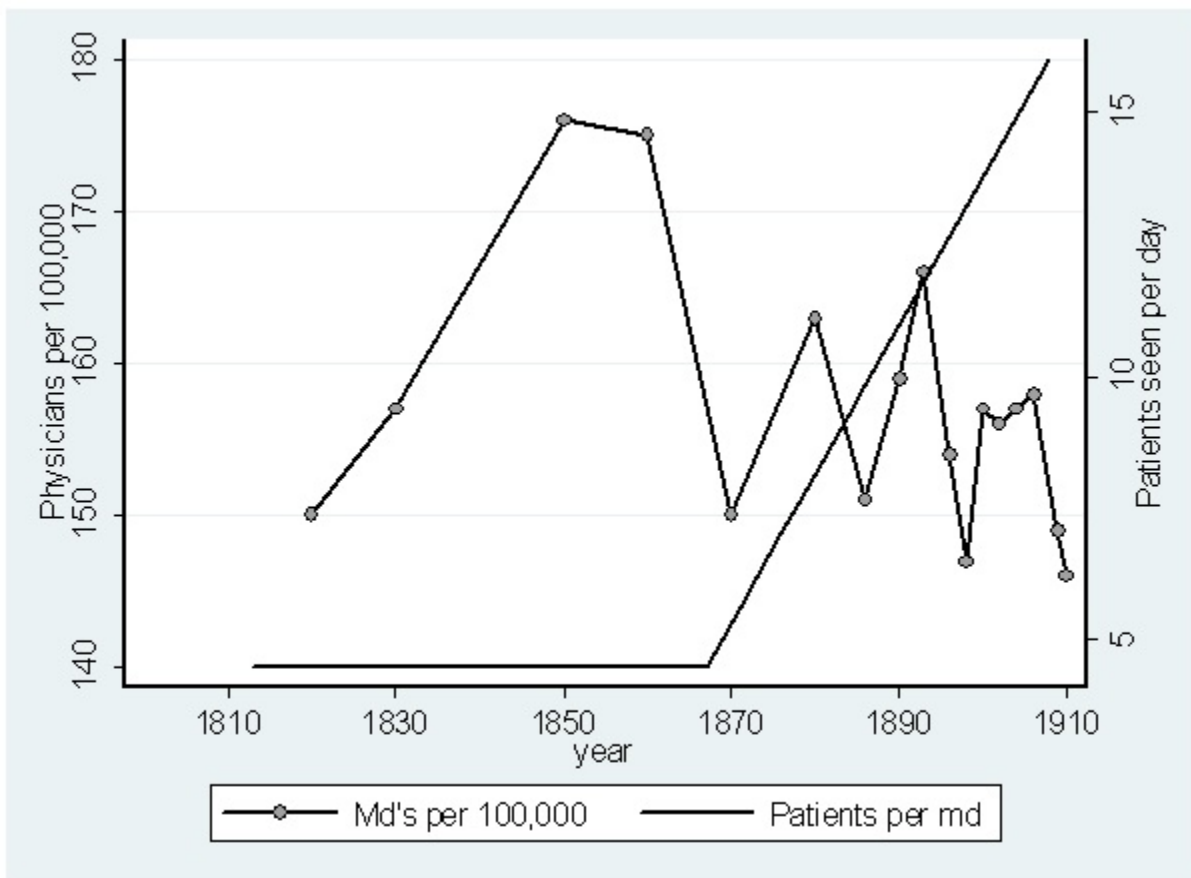


Figure 8. Physicians per Capita and Physician Productivity: 1810-1910



Figure 9. Physician Income and Income per Patient: 1810-1910

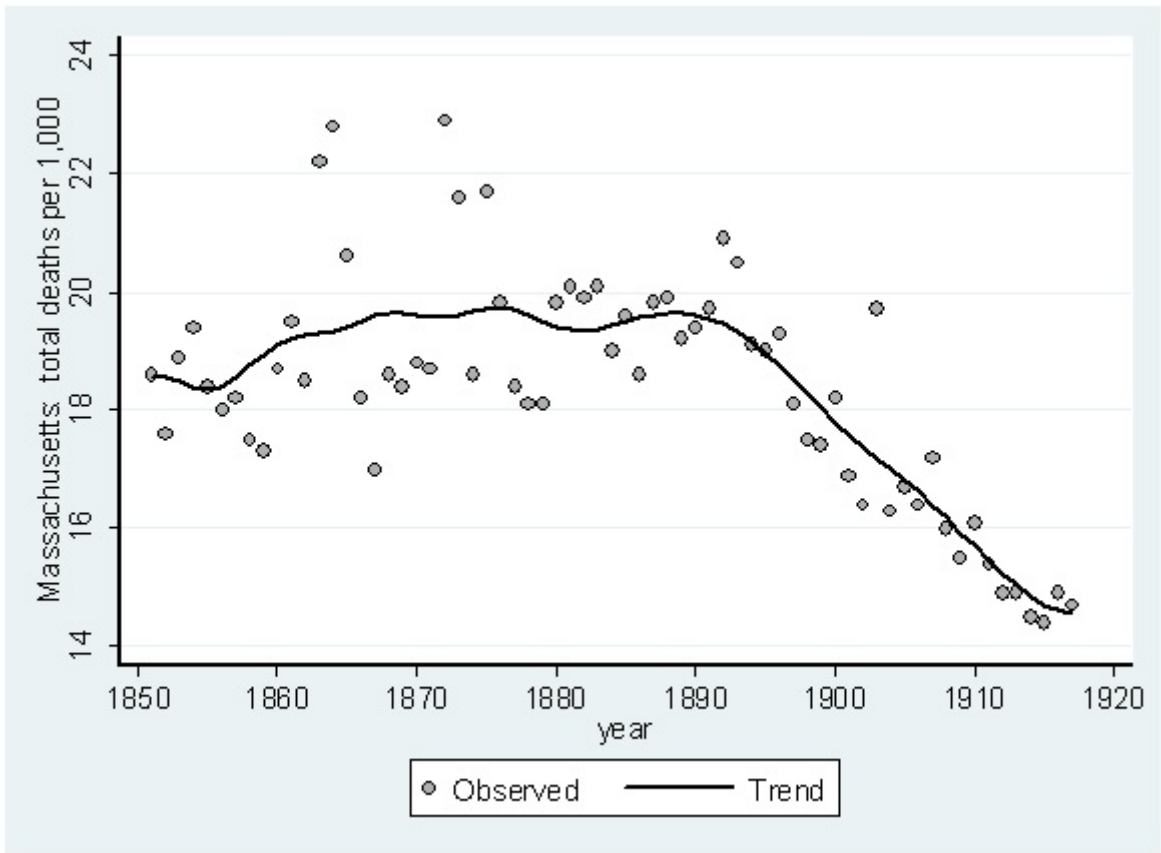


Figure 10. The Death Rate in Massachusetts: 1850-1920

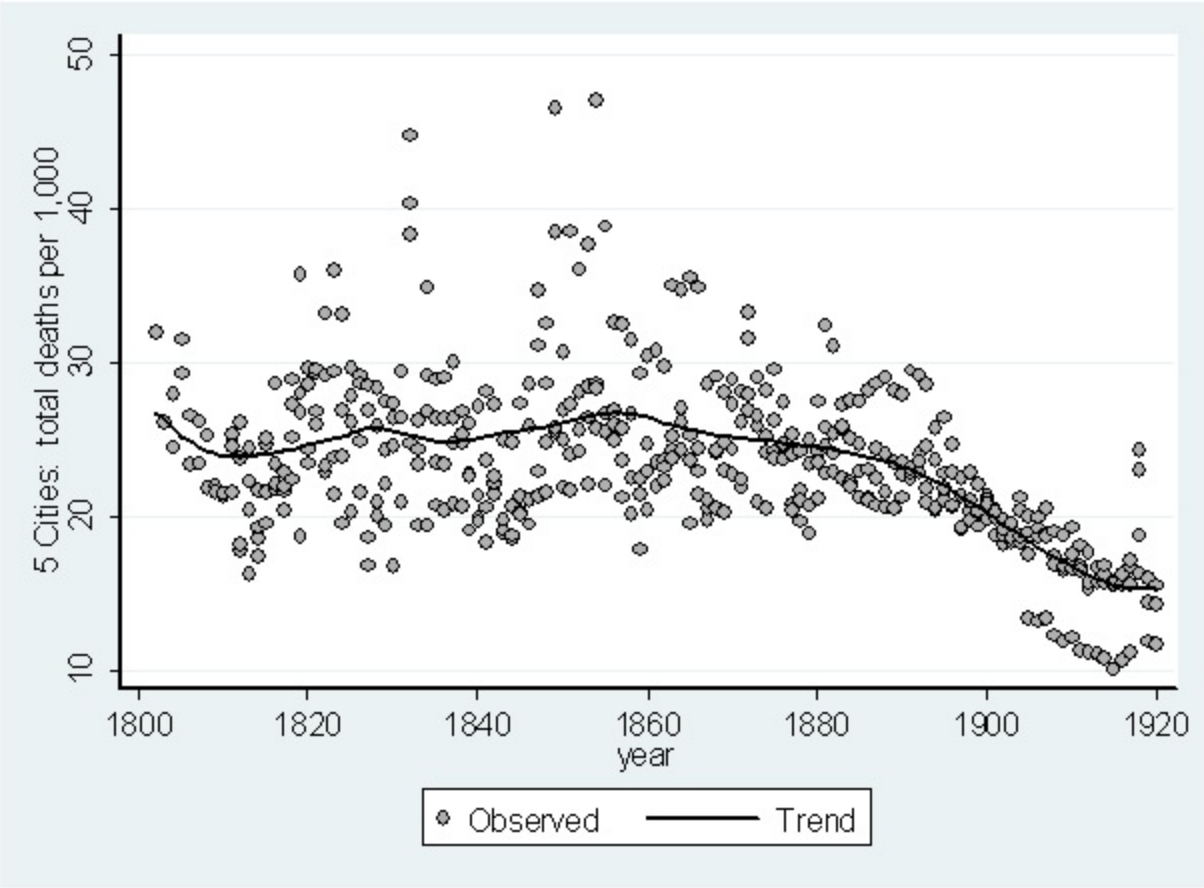


Figure 11. The Death Rate in Five American Cities: 1800-1920

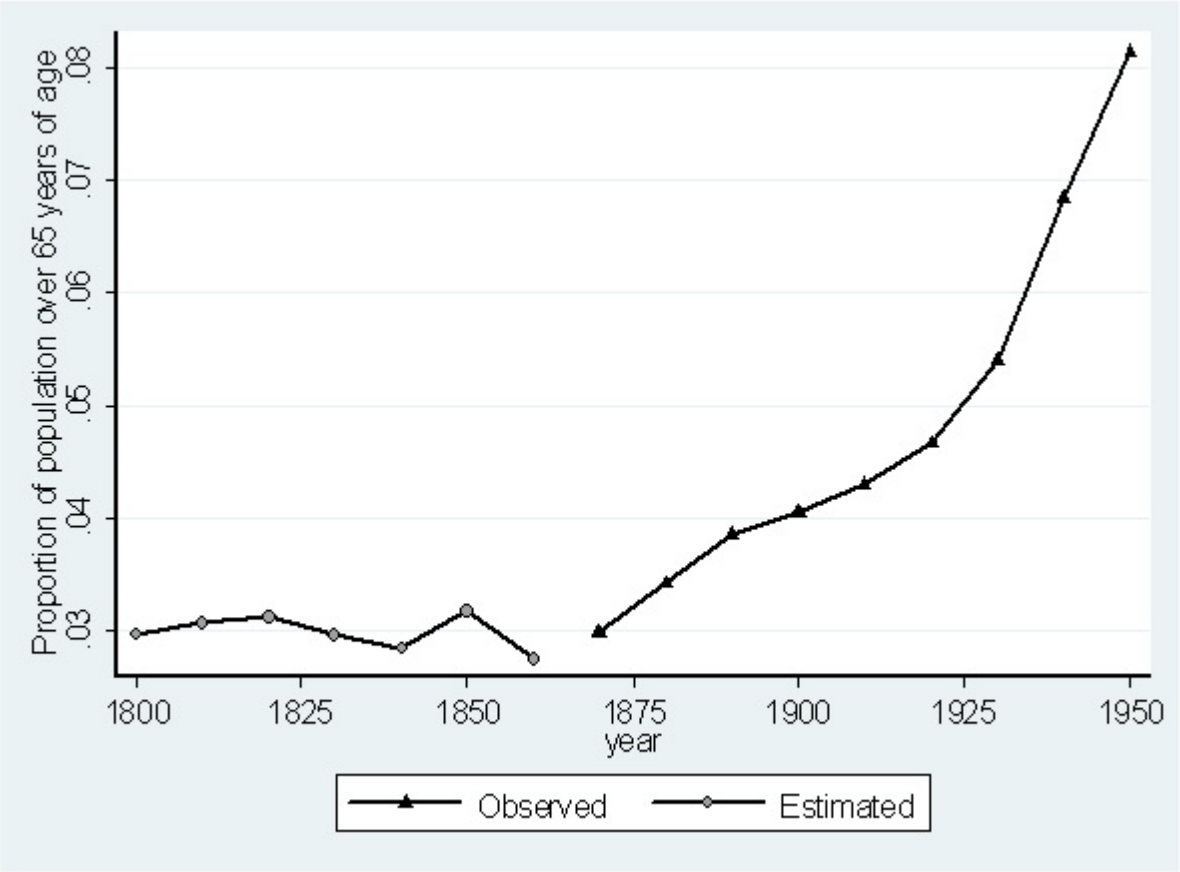


Figure 12. Proportion of the Population 65 Years of Age and Older: 1800-1950.