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A feedback perspective of healthcare demand/supply relationship and behavior

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A Feedback Perspective of Healthcare Demand/Supply Relationship and Behavior

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June 2003

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However, recent studies have found that more care may not necessarily mean better health. These demonstrate that more hospitals in an area lead to more days spent in hospitals with no discernible improvements in health. Interestingly, supply tends to drive demand; more doctors and hospitals lead to more demand for services. This appears to be an unintended consequence or policy resistance to public policy.

One contributor to this “vicious” cycle is hospitals’ competing for specialist affiliations, which in turn, compete for patients by offering specialized services. Apart from care retailing hospitals tend to duplicate services and aggressively expand capacity when their competitors do.

The objective of this MBA Project is to further explore the relationship between demand and supply of healthcare in the United States using the System Dynamics feedback loop perspective. Furthermore it discusses how System Dynamics and Systems Thinking fields of study facilitate understanding the behavior of complex of problem structures.

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A FEEDBACK PERSPECTIVE OF HEALTHCARE DEMAND/SUPPLY RELATIONSHIP AND BEHAVIOR

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LIST OF ABBREVIATIONS AND ACRONYMS

AHA	American Hospital Association
CBGS	Coronary Artery Bypass Graft Surgery
CEO	Chief of Executive
CLD	Causal Loop Diagram
COE	Centers of Excellence
ED	Emergency Department
FFS	Fee-For-Service
GDP	Gross Domestic Product
GNP	Gross National Product
HMO	Health Maintenance Organization
HRR	Healthcare Referral Regions
ICU	Intensive Care Units
MAR	Medical Arms Race
MIT	Massachusetts Institute of Technology
ODS	Organized Delivery of Services
PPO	Preferred Provider Organization
ROI	Return on Investment
SA	Systems Archetype
SD	System Dynamics
ST	Systems Thinking

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I. A SYSTEM DYNAMICS PERSPECTIVE OF THE U.S. HEALTHCARE SECTOR

A. INTRODUCTION

The United States has experienced a dramatic growth both in technical capabilities and in its allocation of resources to medical care. In 2000, the U.S. spent $1.4 trillion or 14 % of its Gross Domestic Product (GDP) on medical care (Business Week, August 2002). This is twice as much as the amount of resources pumped into information technology during that same year. There is a concern that the problem will get even worse before it gets better. Because of the aging population, the U.S fears that demand for healthcare will outstrip available resources causing a drop in care. This would suggest the need for adding more healthcare capacity. However, recent studies find that more may not necessary mean better healthcare. [1] These studies demonstrate that more hospitals in an area lead to more days spent in hospitals with no discernible improvements in health. Interestingly, supply tends to drive demand; therefore, more doctors and hospitals lead to more demand for service, explaining the ever-increasing cost of the American healthcare system.

How precisely does this dynamic work? How would supply drive demand in the health market of the United States? And why? This report will attempt to shed some light on these questions. Addressing these questions is interesting because it appears that efforts to improve American healthcare are just another example of unintended consequences or policy resistance to public policy. This happens when a solution or a fix to solve a problem often makes the problem worse. Moreover, further attempts to stabilize the system may destabilize it. As an expert says "the tendency for interventions tend to be delayed, diluted, or

[1] See for example the conclusions of the important study, The Dartmouth Atlas of Healthcare 1998 (The Center for the Evaluative Clinical Sciences, Dartmouth Medical School); Lindsay Thompson, David Goodman, and George Little, "Is More Neonatal Intensive Care Always Better? Insights from a Cross-National Comparison of Reproductive Care", Pediatrics 109, n. 6 (June), 2002.

defeated by the response of the system to the intervention itself".[2] This phenomenon is not uncommon when implementing public policy. Whether and how this counterintuitive behavioral dynamics is working in the American healthcare market is an interesting issue to explore.

The objective of the project is to explore structures within the system that might cause such a policy resistant behavior in the US healthcare system. It seeks to understand the relationship between the system supply and demand. The dynamics of the system will, specifically, be discussed through the feedback perspective of the System Dynamics approach. Furthermore, the mechanism of how capacity and utilization affect one another will be discussed.

This report is organized into three main sections. First, it summarizes the context of the U.S. healthcare system; second, it presents an overview of the system dynamics perspective; third, it applies the demand-supply dynamic hypothesis to the healthcare sector and provides a discussion and a conclusion that summarizes the findings.

Part I provides an overview of the American healthcare system and discusses why it is comparatively too costly. Section I.C presents an overview of the project's main research question and methodology. Section I.D provides a brief discussion of the "System Dynamics Approach" as a framework to study the questions of interest and to discuss some of the main arguments of the thesis.
Part II, section II.A defines the System Dynamics (SD) field of study. Section II.D discusses the SD approach to the problem concept based on an adopted mental model. Then the project's primary hypothesis is presented (section II.B.3) arguing that there is a positive feedback loop structure that couples capacity and utilization in the US healthcare sector. Next a causal loop diagram (CLD) is constructed to demonstrate that high system utilization does not mean a vast improvement in health. Then the project examines how capacity affects utilization and how utilization affects capacity to show the dynamic behavior of the designed feedback loop. Section II.D.2 will discuss the Medical Arms Race

[2] Sterman, John, Business Dynamics: Systems Thinking and Modeling for a Complex World, McGraw Hill, 2000

(MAR) phenomenon while section II.E explores the key variables of behavior over time.

Finally, part three concludes by discussing the impact shock input on the system, such as the "baby boomers" entering the healthcare system. In addition, the report addresses suggestions for further research. Based on the findings and analysis, further research on building a software model to simulate and generate behavior over time is recommended.

B. BACKGROUND: THE U.S. HEALTHCARE SYSTEM

The World Health Organization defines a healthcare system as "comprising all the organizations, institutions, and resources that are devoted to producing health actions in a country" (Teruel and Yen, 2001, p. 1). In the United States, healthcare plays an important role in the economy. In 1997, $1,092 billion was spent on healthcare, consuming 13.5% of GDP (Iglehart, January 7, 1999, p. 72). Total expenditures on health currently total 1.4 trillion dollars reaching 14% of GDP (Business Week, August 2002). In short, the role of health in the U.S. economy has been increasing over time.

What impact have these growing health expenditures had on the U.S. economy? First, these increases in expenditures have not automatically increased the quality of healthcare and health standards thus they have been criticized as wasteful.[3] Second, this growth in health expenditures consumes resources from the economy that potentially have negative consequences for the economy as a whole, reducing the resources for investment (Business Week, August 2002). Third, since this growth in expenditures has not necessarily increased the quality of care, it also represents a drain on government resources in a time of fiscal shortfalls. In 1997, the federal government spent $3,925 per person on healthcare, which is very high compared to other countries (Iglehart,

[3] For example, one cross-national study of the nineteen richest democracies in the world shows that the U.S. spends more per capita than any nation but ranks only as "medium" in terms of "health performance." Harold Wilensky, "Health Performance: Affluence, Political Economy, and Public Policy as Source of Health" in Rich Democracies (Berkeley: University of California Press, 2002, p. 587).

January 7, 1999, p. 71). The opportunity costs of these expenditures are great given the budget deficits the federal government currently faces.

To understand why costs are so high, understanding the U.S. healthcare system is essential. A market model of healthcare determines the number and variety of providers, prices, and payers. The U.S has a market-based healthcare system. Answering this question requires addressing three other questions 1. How are prices set? 2. Who provides healthcare? 3. Who pays? First, in the U.S., the free-market rather than the government determines prices and quantity of the healthcare consumed; second, both the public and private sectors provide care in facilities, such as non-profit hospitals, for-profit hospitals, and community and university hospitals (Packer, October 22, 2002); third, there are three main sources of system revenue contributors—employers, government, and individuals (Iglehart, January 7, 1999, p. 71). Figure 1 depicts the distribution of payments for healthcare in the United States in 2001 (Levit, 2003).

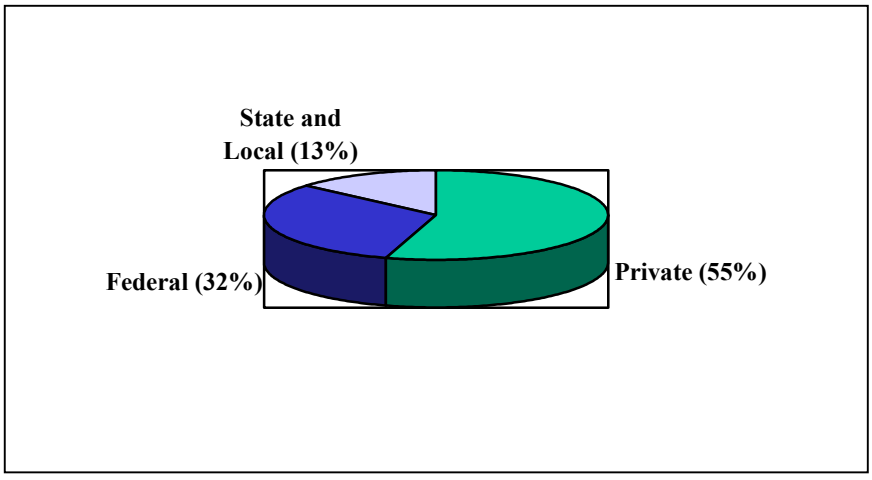

Figure 1. Distribution of Payments for the Healthcare in the United States in 2001.

Next the system of payments for care provision offers an insight into how the market forces impact each other. First, the employer expenditures are typically paid in the form of premiums through deductions from gross wages of an

employee's paycheck. Additionally, a typical employer pays about 80 percent of the premium. This constitutes 60 percent of total healthcare expenditures in the United States. Second the government resources are made up of state and federal taxes, which are redistributed directly as income (typically Medicaid and Medicare programs) to healthcare providers. The Medicaid program contribution, itself, constitutes 39 percent of all federal outlays (Iglehart, 1999, p. 71). Then a less commonly recognized program is an indirect government subsidization of healthcare provided by the government to employers in the form of tax breaks for paying for employee healthcare. For example eight of ten Americans receive federally subsidized healthcare (Wilensky, 2002, p. 597). Excluding this indirect subsidization of healthcare, the government still pays 16 percent of total healthcare expenditures in the United States.

Individuals' payments constitute the third form of expenditures comprising 17 percent of healthcare. Known as "out of pocket" expenditures, this type of payment includes coinsurance and deductible payments as well as direct payment for service (Iglehart, 1999, p. 72).

In sum, the U.S. healthcare system is typically complex involving a diverse group of important actors—non-profit hospitals, for profit hospitals, the health providers themselves (e.g. doctors, nurses, etc.), insurance companies, the government, employers, and finally the consumers of healthcare--patients. To understand why the system has experienced such a growth in total expenditures, it is important to recognize this complexity and multiplicity of actors.

C. RESEARCH QUESTION AND METHODOLOGY

The project research question is as follows: Does increased capacity of healthcare increase rather than decrease demand for healthcare service, and if so how? How can this relationship be better understood? Analysts usually think that demographic changes cause change in demand for healthcare. For example, as the population ages, demand for healthcare tends to increase (Kirchhiemer, 2001, p. 1). Published cross-national studies argue that increased

societal wealth (high GNP per capita) explains increased spending on healthcare (Wilensky, 2002, p. 582). Next economists argue that the expenditures on hospital bed provision and physician employment increase with greater GDP per capita (Perkins, Radelet, et al, 2001, p. 367). In general, these analyses conclude that although demand and supply of healthcare are independent of each other, they both are caused by similar social factors.

This MBA Project seeks to explain the relationship between demand and supply of healthcare and their dynamics over time. Unlike traditional ways of discussing this relationship, we propose the System Dynamics view that depicts this relationship from the feedback perspective. We argue that the healthcare as a specific good on the market may not always be consumed at the best market conditions for both suppliers and consumers. This shift in equilibrium is presumably caused by supply that endogenously stimulates demand although there is little need to increase the demand. We will support our proposed hypothesis through findings from empirical studies and will argue for why expand on healthcare expenditures may skyrocket in the future.

Using the System Dynamics (SD) approach and understanding the system's problematic behavior outlines some negative repercussions of the behavior dynamics. This approach draws on organizational studies, behavioral decision theory, and engineering to provide a theoretical and empirical base for structuring the relationships in complex systems. Furthermore the bottom line of SD is centered on the idea of "feedback" as an important social dynamic inherent to systems' behavior. Further explanation of SD will be covered in II.A.

A problem labeled as the "traffic congestion problem" is a well-known example of the application of the feedback system dynamic model. Succinctly it explains the relationship of the supply of highways and highway lanes to their demand. To decrease traffic congestion, political pressure demands expanding the highway network and increasing the region accessibility from outside. More utilized highways lead to even more traffic and, ultimately, regional population growth (Sterman, 2000, p. 183). The same notion of traffic congestion can be

applied in the study of a supply and demand relationship in the healthcare market.

D. A FRAMEWORK FOR STUDY: SUPPLY/DEMAND—A FEEDBACK LOOP PERSPECTIVE

Normally, an increase in supply causes a decrease in market prices. The Demand and supply relationship in U.S. healthcare, though, is distorted. These market principal elements show a great inelasticity indicating that demand rises more in areas with greater supply although the population in these regions is not far sicker. Research used for this project largely supports this argument (Roemer and Shain, 1959, pp. 12-16; Fuchs, 1986, pp. 144-147; Wilensky, 2002, p. 598). Using the SD framework, we argue that similar to the "traffic congestion problem", crowding in hospitals initiates growth of the healthcare system's capacity over time, which is followed by an increase in demand. For example, if more hospital beds are available, the "threshold" for admitting patients tends to be lower (Dartmouth Study, 1998, p. 5), increasing utilization.

What makes supply drive demand in the healthcare market in the United States? The main reasons are found in the distinctive system of *organizing* and *financing* the American healthcare system. According to sociologists of healthcare, the *organizing* of a healthcare system typically refers to the manner in which personnel and facilities are coordinated and controlled (Anderson, 1972). The *financing* of a healthcare system refers to two features of a healthcare system: a) the source of funds for healthcare and b) the way of paying for services (Lin, 1994). The way the healthcare system in the U.S. is organized and financed contributes to the system's supply-demand dynamic that this study identifies.

1. The Organizing of Healthcare

First, as a result of organization, the healthcare system in the United States is more costly than in most countries. An important part of the organization of healthcare is the ownership structure because this affects how a

healthcare system is managed. Two types of ownership structure exist: the public and private sectors. In the private sector, there exist two subtypes: not-for profit and for profit institutions (Lin, 1994; Packer, 2002). Interestingly, sociologists of healthcare have found that decentralized market systems of ownership tend to "generate unequal distribution of resources, duplication, inefficiency, and increasing costs" (Lin, p. 3). Also, according to another study, the U.S. outpaces other more centralized state-controlled systems in terms of administrative cost (Wilensky, 2002, p. 611-612). Wilensky states that in the decentralized American system,

> Hundreds of competing insurance companies each generates its own insurance packages and claim forms with varying and voluminous regulations on coverage, eligibility, documentation, referrals, and utilization. United States hospitals, doctors, and other medical care personnel waste prodigious amounts of time just keeping track of bills (Wilensky, 2002, p. 612).

As a result, then, in a decentralized system of healthcare, a tendency for higher costs exists, caused by higher administrative costs as well as other inefficiencies.

2. The Financing of Healthcare

The second dimension of a healthcare system is the financing of healthcare, which refers to a) the source of funds for healthcare and b) the way services are paid for (Lin, 1994). An entity that controls the budget determines the source from where the money comes (Lin, 1994). There are four different ways of financing a healthcare system: personal payments, voluntary and private insurance, social insurance, and general taxes (Lin, 1994). Although the U.S. uses all of these types simultaneously, it heavily relies on the first two types of financing.

Even more important for the supply-demand dynamic is the payment system of healthcare which has an important impact on access, cost, quantity, quality of care, and administrative processes (Lin, 1994). Three types of payment systems exist: 1) fee for service, 2) capitation, and 3) salary-based systems. A Fee-for service (FFS) system is the principal payment method in the United States, which succinctly means that the number of procedures administered and the number of patients seen pays the doctors as the care provision facilitators. This system increases system costs because doctors are motivated to do more work and provide more technologically advanced and expensive services (Lin, 1994). In the other words, the "fee for service" payment system creates incentives for doctors to do expensive surgeries, increasing the need for capacity, and increasing demand. Wilensky sums up the logic of supply driving demand: "The more surgeons, the more expensive surgery" (Wilensky, p. 598).

In sum, we found that because of the organizing and financing of the U.S. healthcare system, there is a strong tendency for growing capacity and growing demand to co-exist and reinforce each other. From the SD perspective, the structure of the system produces the behavior of its constituent parts. One structure of a subsystem affects another subpart. The dynamics of these relationships make it hard to identify the fundamental problem of the system. As a result, if players try to manage their own problems, the individual fix may then cause another problem for the others. Responding to ones' problems might not be enough to address the skyrocketing cost in the healthcare. Understanding the system as a whole, and identifying causes and effects from the feedback loop perspective may be more effective when exploring the dynamics of the relationship among key variables.

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II. HEALTHCARE PHENOMENA: A SYSTEM DYNAMICS STUDY

A. SYSTEM DYNAMICS AND THE U.S. HEALTHCARE

Applying the System Dynamics approach further explores the relationship between capacity and utilization in the US healthcare system. The bottom line of this approach is to understand the dynamics of their mutual interaction. Part 2 introduces the basic terminology definitions as follows: System Dynamics, Systems Thinking and Systems Archetype. Later in this part the Report discusses application of the System Dynamics concept applying a feedback loop tool as a framework for exploring the dynamics of processes in healthcare in the United States.

1. Systems Dynamics (SD)

The Massachusetts Institute of Technology (MIT) researcher Jay Forrester first introduced the System Dynamics field of study in the 1950s. System Dynamics is an overarching field of thinking and it is compatible to fields as diverse as mechanical engineering, biology, and the social sciences. It includes a methodology for constructing computer simulation models to achieve better understanding of social and corporate systems. It draws on organizational studies, behavioral decision theory, and engineering to provide a theoretical and empirical base for structuring the relationships in complex systems. System Dynamics focuses on stocks and flows as well as delays in the feedback loop structure of the system. Behaviors are the results of these flows. For example, in a reinforcing process, feedback flows generate exponential growth or collapse; whereas, balancing processes are feedback flows that help a system maintain stability.

These reinforcing and balancing processes really aren't mysterious—they're all around us and within us. The world population explosion, the U.S. stock market crash of the 1930s, and the sudden onset of disease when foreign microbes proliferate in our bodies are all examples of reinforcing cycles. Our

bodies' ability to maintain a basic temperature of 98.6 degrees Fahrenheit, the stability that occurs in predator/prey systems, and the difficulty we often face when we try to change the way our organization does things are all examples of balancing cycles.[4]

2. Systems Thinking (ST)

ST is a school of thought that focuses on recognizing the interconnections between the parts of a system and synthesizing them into a unified view of the whole. A Systems Thinking approach takes the principles of systemic behavior that System Dynamics discovered. Then it applies those principles in practical ways to common problems in organizational life. In fact, simulation modeling, management flight simulators, and micro-worlds are some of the tools used by systems thinkers to understand the world around them and address relevant problems.

3. Systems Archetype (SA)

SA is a class of Systems Thinking tools that capture common challenges occurring in all kinds of industries and organizations.[5] These patterns are generic and provide similar behavior. For example, the behavior of "word of mouth" product marketing technique and "escalation of arms race" produce a similar exponential growth process even though they are different in terms of organizational context; however, they operate in the same generic structure that encourages escalation archetype.

All together, these techniques are powerful tools to diagnose, learn, and manage the system of interest. Interestingly, they help craft a better understanding of the dynamic complexity of U.S. healthcare. For example, the next section illustrates that when more services and capacity are available, they lead to high utilization such as more specialist visits. Consequently, the perceived need of increasing services and capacity is derived from utilization rates and anticipated demand. Therefore, the structure enables a positive

[4] http://www.thesystemsthinker.com/tstaboutsd.html
[5] The definitions of System Dynamics, Systems Thinking and Systems Archetype are drawn from http://www.thesystemsthinker.com/tstglossary.html

reinforcing loop to operate in the healthcare sector. However various findings contradict results from the mental model based on the assumption of more is better. If the system's processes tend to be balanced, more capacity would create more care. With more care, many diseases would be detected and treated creating therefore healthier population. As a result, in terms of preventive care, a healthier population would significantly reduce demand for healthcare services.
Using feedback loops in SD, one can develop a dynamics hypothesis that capacity induces demand while utilization drives services and capacity expansion. We claim that the relationship between supply and demand operates in a positive reinforcing loop influenced by a number of factors. Section II.B will use SD strengths to diagnose and identify significant variables and factors and point out related behaviors of the system.

B. DEMAND/SUPPLY RELATIONSHIP IN THE U.S. HEALTHCARE (PROPOSED HYPOTHESIS: A POSITIVE FEEDBACK LOOP)

1. Initial Model Development

The tendency of rapid growth in the U.S. healthcare sector has been significantly prevalent since the end of World War II--with a short period of leveling off during the mid 90s and with a dramatic increase ever since. This pattern of growth has been the key cause of draining the resources of both private contributors as well as the federal government. Indeed, the relatively fast growing population has more frequently used the healthcare capacity although not all are eligible to be beneficiaries of the healthcare system. The demand for healthcare capacity has increased because of the national growth in wealth as well as technological advances. The healthcare system capacity has also increased even though the population, on average, has not become sicker. This issue will be discussed further in section II.B.3.

According to Wennberg (2002), there is a certain level of care that helps people live healthy as long as possible. It has been suggested that excess care does not offer clear benefits, even for those who consider that more is better or who believe that it cannot hurt. Research done by the Center for Evaluative

Clinical Sciences at Dartmouth Medical School, Hanover, New Hampshire has revealed that 20 to 30 percent of health-care spending goes for procedures, office visits, drugs, hospitalization, and treatments that do absolutely nothing to improve the quality or increase the length of patients' lives.[6] In the contemporary United States where an actual excess of care exists, it hardly facilitates the recipients to live healthier or guarantee extending their lifespan; there is some predictable risk that excessive care may even have negative repercussions on the recipients' lives.[7]

Nevertheless the United States' healthcare capacity as defined has encountered an ever-increasing utilization rate thus proving to be even more effective. Along with the aggregate healthcare costs and relevant payments that have risen dramatically, the per capita costs have skyrocketed. Increases in costs lead to concerns about their future behavior. Even though it is difficult to establish unbiased metrics to assess the effectiveness of healthcare system capacity and its utilization for the population health status, some recent empirical work (Fisher and Welch, 1999) suggests metrics relevant to a specific segment of population that assess life expectancy and quality of life.

Other works, such as Gleckman (2002), argue that rather than explicit metrics there are handfuls of implicit parameters to discuss and empirically assess the health status of the US population while linking these to the healthcare system capacity and utilization rates.

2. Dynamic Hypothesis

Sterman (2000) argues that problematic behavior inherent in systems can be captured by a dynamic hypothesis that describes dynamics as endogenous consequences of a feedback structure progression. A feedback structure refers to logical linkages among principal elements of the problematic system that interact with each other to impact their behavior over time. Dynamic hypothesis is further mapped by causal structures, broken down by key variables, and

[6] Centers' research results are reached at http//www.theatlantic.com/
[7] Referring to studies published by Krakauer (1996), Kessler (2000), and Fisher (2003) to be reached at www.dartmouthatlas.org

reference modes, which are quantitatively assessed. Assessments are further applied to policy formulation and evaluation (Figure 2).

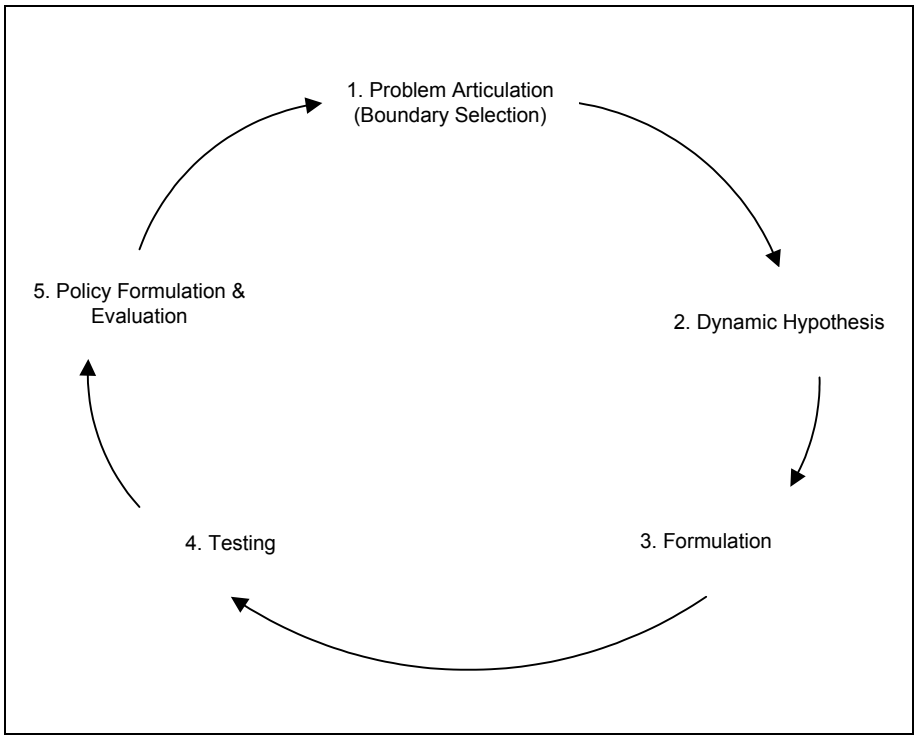


Figure 2. Modeling Process[8]

In a market driven economy, market forces tend to balance supply and demand to find equilibrium. Figure 3 applies this macroeconomic logic to the healthcare system. If demand for services exceeds capacity (leading to a capacity gap) market forces stimulate capacity augmentation to close the gap and shift the system back to equilibrium. It illustrates that an increase in capacity lowers the demand for it.

[8] Adopted from Sterman's Business Dynamics: Systems Thinking and Modeling for a Complex World, McGraw Hill, 2000, P87.

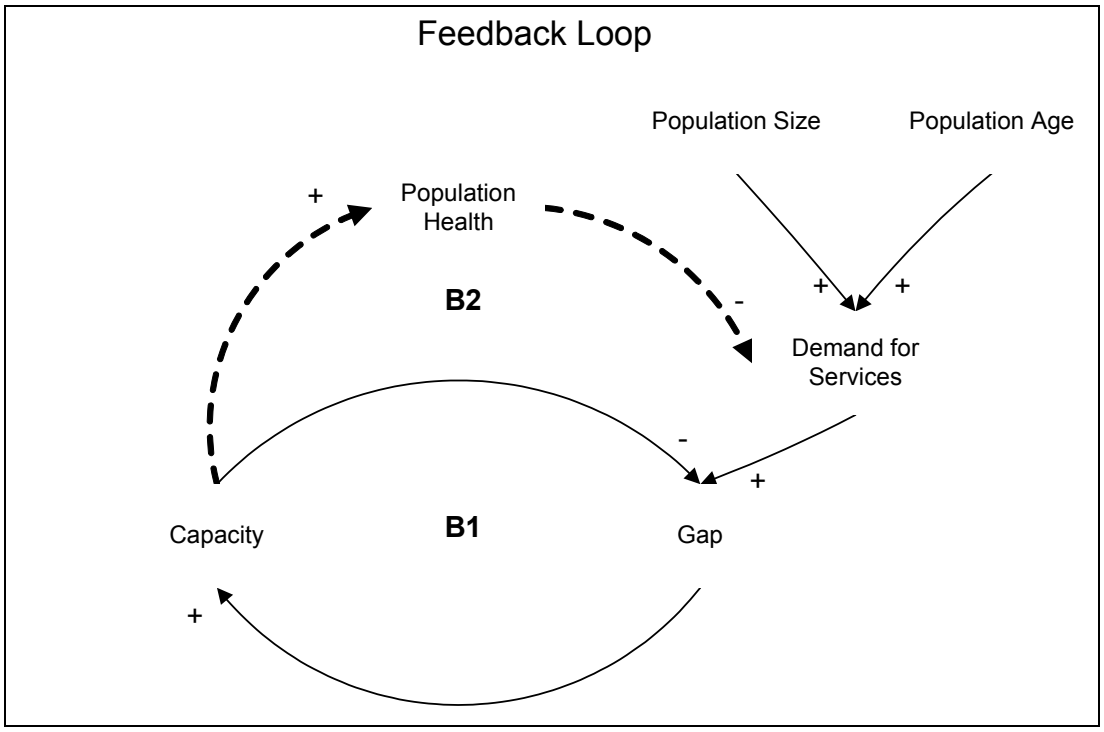


Figure 3. Macroeconomic View of Key Elements of the United States Healthcare System in Assumed Conditions[9],[10]

This system diagram expresses a finding based on the assumption that an increase of system capacity satisfies demand for services because additional capacity is perceived to cause the population to be healthier thus seek less healthcare system capacity (measured by metrics such as life expectancy). Obviously, effective preventive care improves the population health and reduces demand for the system's services, whereas consistent treatment of diseases' causes has just the opposite effect. Imbalance between the preventive care effectiveness and the volume and quality services delivered is caused by a number of variables, having poor living habits is the most prevalent one. As a result an unhealthy population tends to re-enter the system.

[9] Applied from the advice of Professor Abdel-Hamed Tarek during literature review
[10] The diagram is expressed in "Casual Loop Diagram" structure. Arrow line represents that one variable affects the other with a positive (adding) or negative (subtracting) effect based on the sign.

Nowadays, the healthcare system possesses capacity to diagnose and treat what was lacking in the past, such as cardiac angioplasties, bypass surgery, high-tech cancer treatment and oncology treatment to name a few. However, the demand for services is constrained by size and age of the population. A large population is more likely to increase the demand for care. Similarly, the older the population, the more need for care due to a naturally failing variety of body functions. If an increase in demand is aligned with a proportional addition of capacity, the system operations should constitute a feedback structure called a balancing loop (B1 and B2) producing an equilibrium condition between Capacity and Demand for services.

Reality, though, looks different. Fisher and Welch (1999) argue that people tend to overuse the available healthcare system capacity because the system's capacity stimulates them to do so. When the population does not feel healthier after a certain level of consumption, and/or they assume that extra care means better heath, the people re-enter the system seeking additional service thus utilizing the capacity even more. In conjunction with some extra care availability, marketed healthcare attractiveness further stimulates potential customers' need for available services. This occurrence also constitutes a mutual reinforcing effect because most patients pay only a small fraction of a bill (if any) thus they identify a small positive benefit to themselves. In a patient's rationale, the marginal benefit is greater than the marginal cost even though the total cost of care is greater than the total of all benefits. In other words, the patient will seek more services as long as there is a positive benefit.

From the SD point of view, demand for the healthcare stimulates supply delivered while over time increased supply does not cut demand but, conversely, it boosts it, which consequently stimulates an ever increasing in supply.

We argue that although demand for the care should drive its supply, the opposite is also true. The suggested hypothesis is that the more healthcare capacity that is available, the more utilization (demand) it stimulates and an ever increasing demand widens the gap between actual and desired capacity, forcing

capacity to grow without a significant impact on health benefits for the demand originators.

The system is depicted by a self-feeding or reinforcing feedback loop applying a causal loop diagram as the graphical tool that expresses the system dynamics logic. Feedback loops represent a cause and effect relationship between the key interconnected elements (Capacity--Utilization, Utilization—Population Health Index, and so on). A behavior such as goal seeking sets the processes to equilibrium while overshoot and collapse may do the same after a far longer period of time. The exponential growth behavior shifts rapidly and ultimately processes from equilibrium causing the system to collapse. When the system is composed of more than one active loop the system's behavior is determined by the dominant feedback loop operating in the system. Figure 4 graphically depicts the proposed hypothesis statement reflecting the relationship between supply and demand in U.S. healthcare from a feedback loop perspective. It illustrates that an increase in capacity leads to more demand/utilization.

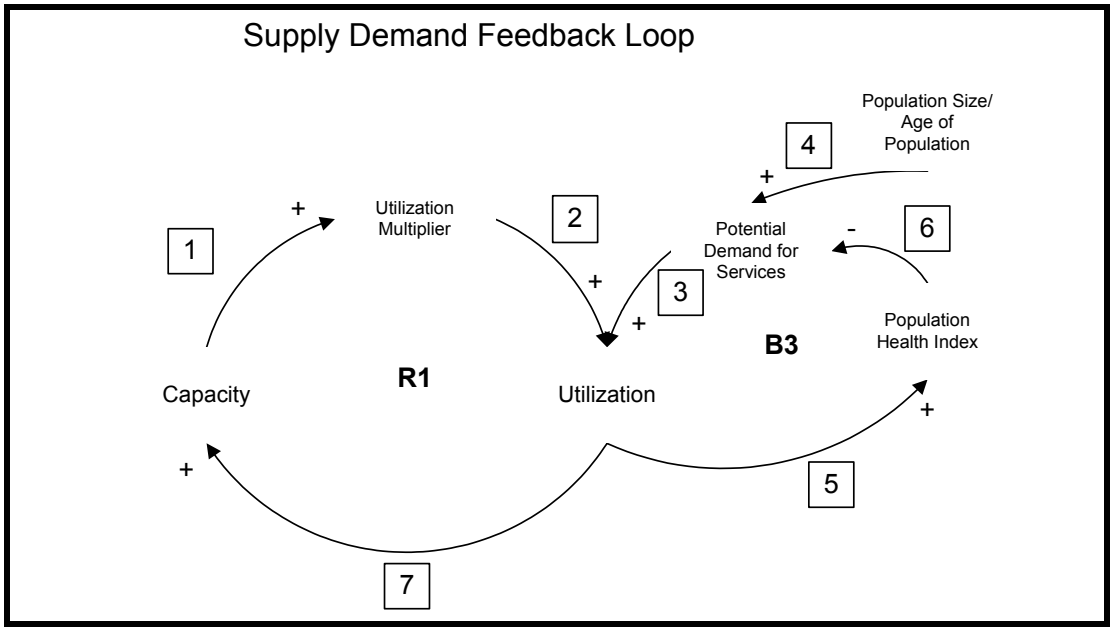


Figure 4. Feedback Loops of Key Elements of the U.S. Healthcare

A pair of key variables reinforcing or counterbalancing each other is called a link, numbered as shown on the hypothesis system diagram. The following sections will further explain and discuss the hypothesis, in particular illustrating how each link operates. First, the section discusses a balancing feedback loop (B3) comprised of Utilization, Population Health Index and Potential Demand for Services. Second, it explains how an increase in system Capacity leads to higher Consumption – Utilization and demonstrates how Utilization Multipliers impact this relationship behavior. Third, to complete the feedback loop, the discussion looks at to explain how an increase in Utilization leads to additional of Capacity and services. The Medical Arms Race (MAR) phenomenon helps to explain the closing link (link 7). Last, a look at the overall picture of the feedback loop perspective discusses the system sustainability.

3. Demand, Utilization and Population Health Index

Utilization in this context represents healthcare use. It is comprised of a set of empirical variables, such as number of days spent in a hospital, number of specialist visits, number of procedures used, number of days stayed in the Intensive Care Unit (ICU), to name the most significant ones. Furthermore, utilization captures essentially the percentage of capacity actually used as well as determining system productivity and efficiency. Utilization depends greatly upon demand of the system capacity.

As mentioned before, population size and age set limits on demand for services (link 4). When the population grows, or it is getting older, the entry rate increases (link 3). In contrast, a small population size with younger people should demand less capacity. Research confirms that a sicker population requires more services (The Dartmouth Atlas of Healthcare, 1999).

On the other hand, studies claim that demand varies due to various factors, such as availability of services and patients' health utility perception, expectation, and/or preferences, and also on local available capacity.[11]

[11] This finding is further discussed in the Dartmouth Atlas of Healthcare, online source, 2003

Uncertainty and variation of demand due to potential demand and forecasted demand can cause uneven utilization of the system. Patients' preferences varied greatly because they may seek to maximize their health utility. When their own perception or information favors ones' decision to utilize the healthcare system, there will be an increase in healthcare consumption. As a result of that, patients are willing to give up their own health security and personal savings to receive greater health utility. Nevertheless they personally pay only a fraction of the cost to receive the supplies and services.

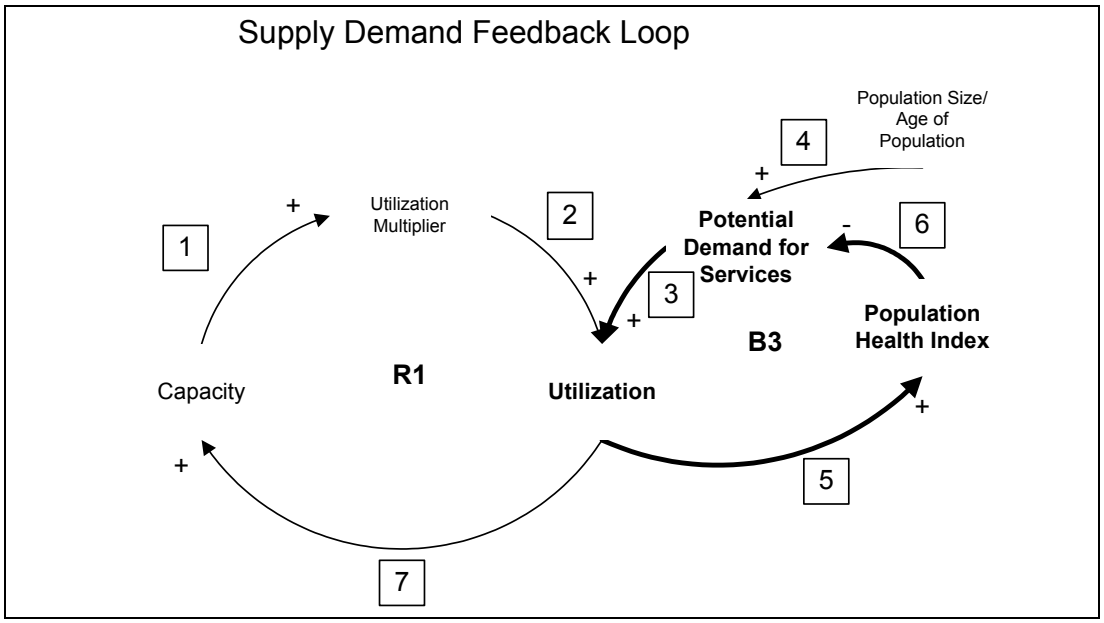


Figure 5. Emphasis on Demand, Utilization and Population Health Index

According to American Hospital Association, demand for hospital services is increasing (The Lewin Group, 2003). After sharp declines in the eighties and early nineties, current hospital inpatient days and admissions are consistently increasing. Furthermore, outpatient care volume has increased by 150 percent since 1980 (The Lewin Group, 2003). Effectiveness, efficiency and quality of services in healthcare seek to improve the population's qualitative health metrics - health index. Activities along links 5 and 6 of this feedback loop (Figure 5) facilitate a balancing process indicating that utilization improves health thus

causes demand to drop (loop B3). However, effectiveness and quality are questionable, not to mention population growth and the poor health habits leading to higher input rates to the system. Consequently, increased demand leads not only to increased utilization but also to higher internal pressure due to overcrowded medical facilities. Because of this, the same volume and quality of services are no longer guaranteed for the ever-increasing demand. Therefore, the service quality decreases as per capita resources utilization grows.

Because of a very small positive relationship between higher life expectancy and quality of life[12] the patients' actual benefits are few, if any. Since this balancing loop is not as effective as it should be, high utilization of the available capacity does not cause the desired improvement in the patients' health. Their perception, though, is that more healthcare is better. As a result, patients unsatisfied with little health improvement may seek to increase their utility by re-entering healthcare facilities. Re-entries represent an increase in demand, thus the healthcare system utilization increases causing potential system saturation such as not rationally manageable congestion in inpatient and outpatient facilities. Interestingly, the volume of capacity utilized follows a consistent pattern comprised from more diagnosis, more frequent specialist visits, and more needed workforce, thus more treatment actually consumed, and a higher potential error rate.

Empirical data, theoretical studies and a feedback loop perspective of the U.S. healthcare system challenge one to ask whether more healthcare consumed causes better health. Controversially, studies[13] concluded that there is no significant evidence of decreased mortality relevant to the Medicare

[12] Fisher argues that patients across the USA do not benefit from more healthcare that they consume in terms of lower mortality. Similarly they do not enjoy some other benefits. He supports his argument by findings of other authors such as Krakauer (1996) who argues that regions with higher per-capita supply of medical specialists have increased mortality, and Skinner (2000) who argues that regions with more aggressive use of end-of-life services have mortality rates no lower than any other regions.

[13] The most consistent set of studies provided by the Dartmouth Atlas of Healthcare scrutinizes a sample of Medicare program enrollees as a representative segment of the population in terms of both care consumption and care being offered by the care suppliers. Statistically significant results of the research draw very specific conclusions about the system effectiveness, patients' preferences and the forecast of the system's further behavior.

beneficiaries in the high healthcare system capacity regions nor does the relatively low capacity worsen the mortality rate. Similarly there is no evidence that marginal costs of the healthcare capacity are lower or equal to the marginal benefits the patients in the high capacity regions[14] would enjoy. The patterns of clinical practice in the high and low cost regions similarly do not identify any other significant benefits for the patients.

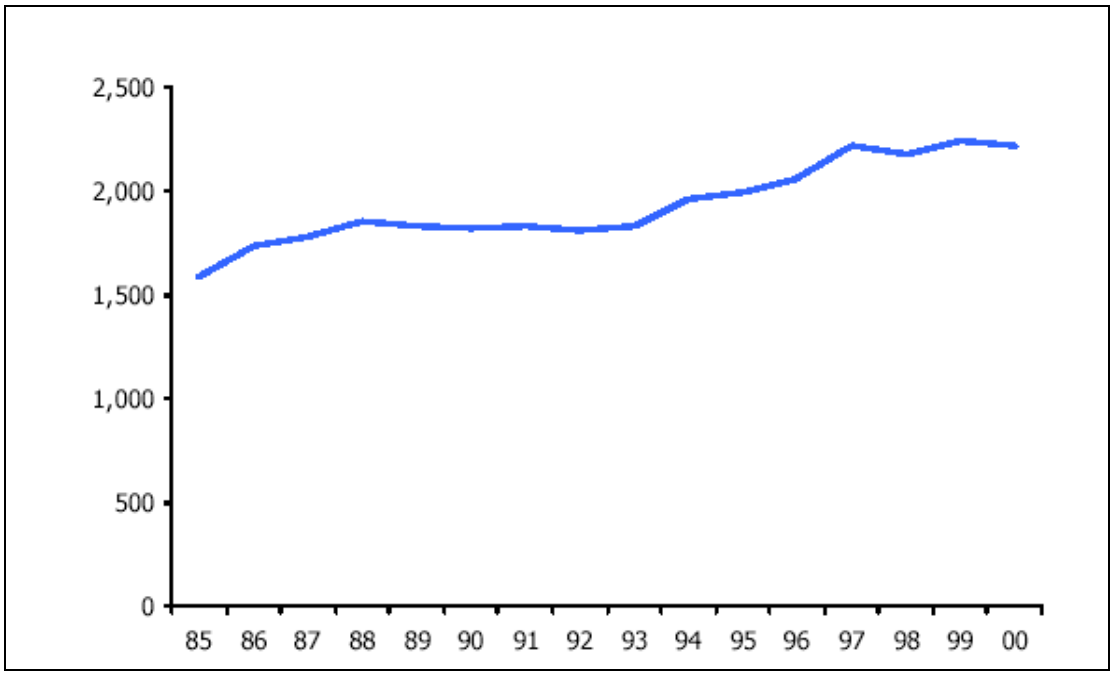
Over time, if the system cannot satisfy potential demand for services, it seeks to fill the capacity gap by augmenting actual capacity because the balancing process (B3) is inconsistent and is dominated by a stronger process from another loop (R1). This process of non-sustainable behavior seeks a new equilibrium. Therefore, other links will shape the behavior of the system. The next section explains how available capacity affects demand and utilization.

C. CAPACITY IMPACT ON DEMAND AND UTILIZATION

Capacity captures all available resources to satisfy perceived and actual demand. Capacity can be categorized into two variable groups—quantity and variety. In terms of quantitative analysis, for example, capacity comprises the number of hospitals, number of beds, number of physicians, and size of the workforce to name the most significant factors. Variety of services includes elements such as number of specialists and procedures. These capacity variables tend to dynamically change over time.

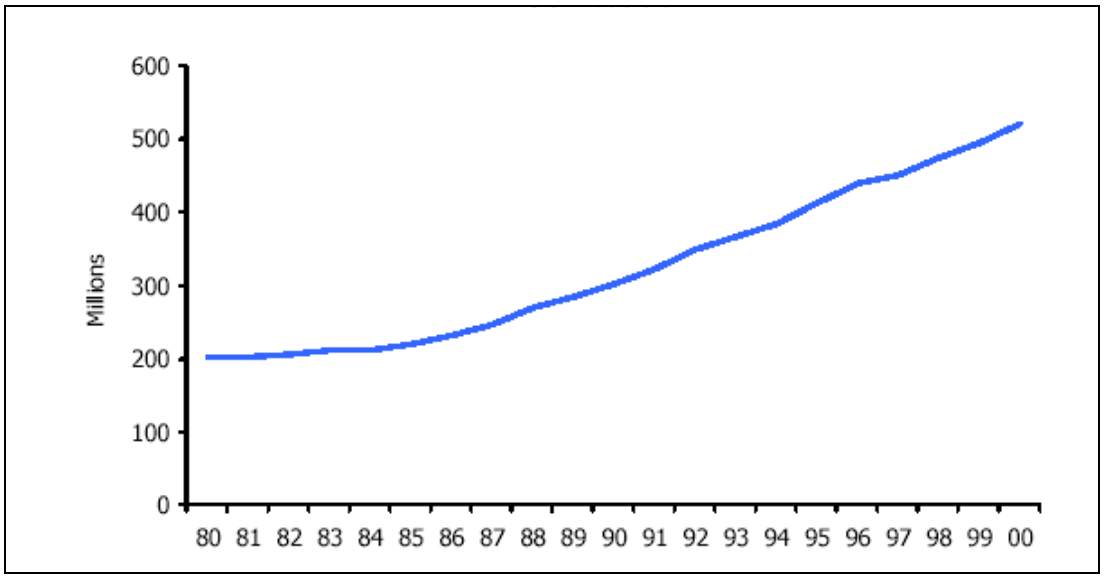
For example, even though the total number of community hospitals and hospital beds are still declining (shown in Figure 6), inpatient volume has begun to rise. Hospital outpatient volume expansion leads to more outpatient visits per 1,000 persons (Figure 7).

[14] Discerning between high- and low-healthcare capacity regions provides an insight into the patterns of demanding and supplying care to Medicare program enrollees. The available supply drives the spending patterns for Medicare program enrollees. The volume of supply-sensitive care that differs among the regions constitutes the only actual difference, when these regions provide care to the Medicare enrollees.
Fisher and Welch (1999) argue that the low-capacity regions' Medicare enrollees are not in fact under serviced but the high-capacity regions over consume the care volume. Nevertheless there is neither difference in the life expectancy nor in the quality of life among the Medicare enrollees across the regions.



Source: The Lewin Group analysis of American Hospital Association Annual Survey data, 1980 - 2000 for community hospitals, The Lewin Group: "Trend watch Chart book", 2002

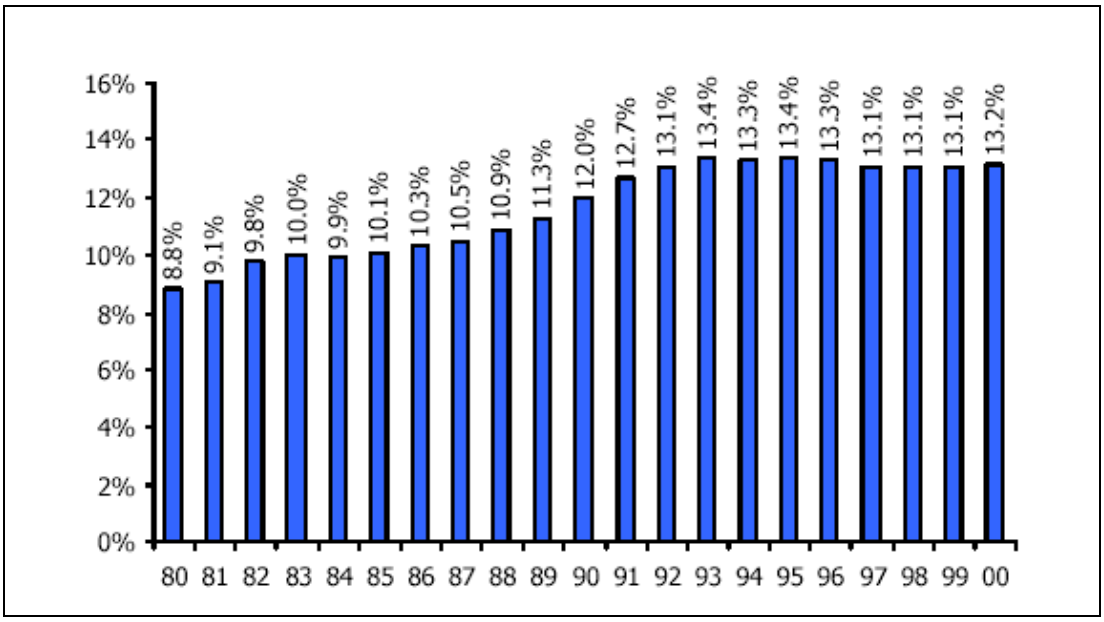
Figure 6. Number of hospitals in the U.S. health system, 1985-2000



Source: The Lewin Group analysis of American Hospital Association Annual Survey data, 1980 - 2000 for community hospitals The Lewin Group: "Trend watch Chart book", 2002

Figure 7. Hospital Outpatient Visits per 1,000 persons, 1980-2000

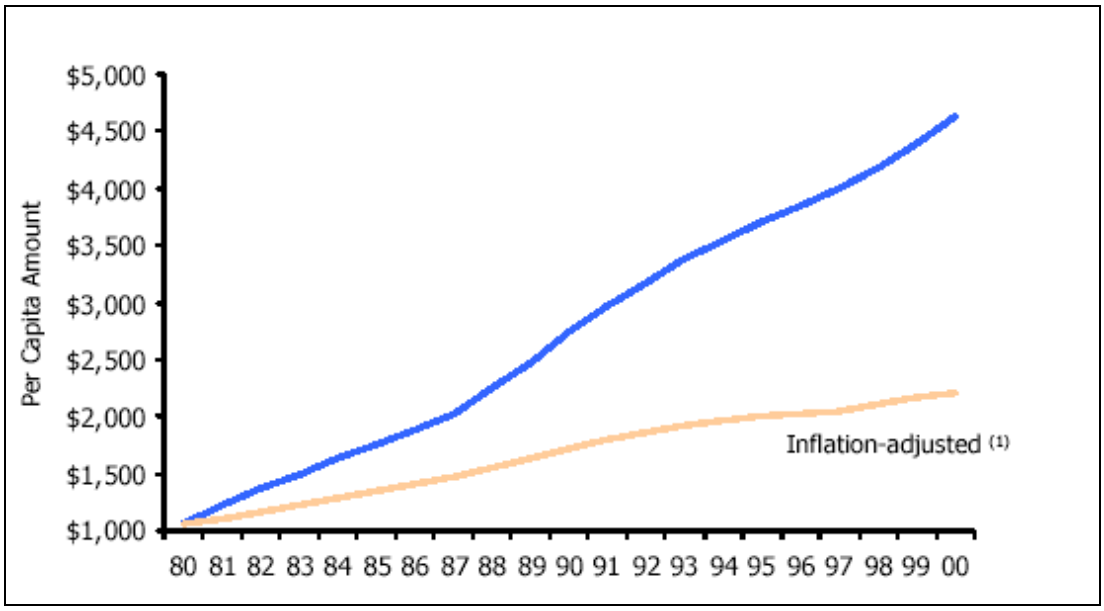
Expenditures constitute another set of variables that need to be taken into consideration.



Source: The Lewin Group analysis of American Hospital Association Annual Survey data, 1980 - 2000 for community hospitals The Lewin Group: “Trend watch Chart book”, 2002

Figure 8. U.S. Health Expenditures as a Percentage of Gross Domestic Product 1980 – 2000

Although the national healthcare expenditures as a percentage of the Gross Domestic Product have remained almost unchanged (Figure 8 & 9), the per capita expenditures have significantly risen both in monetary and inflation-adjusted terms during the past decade.

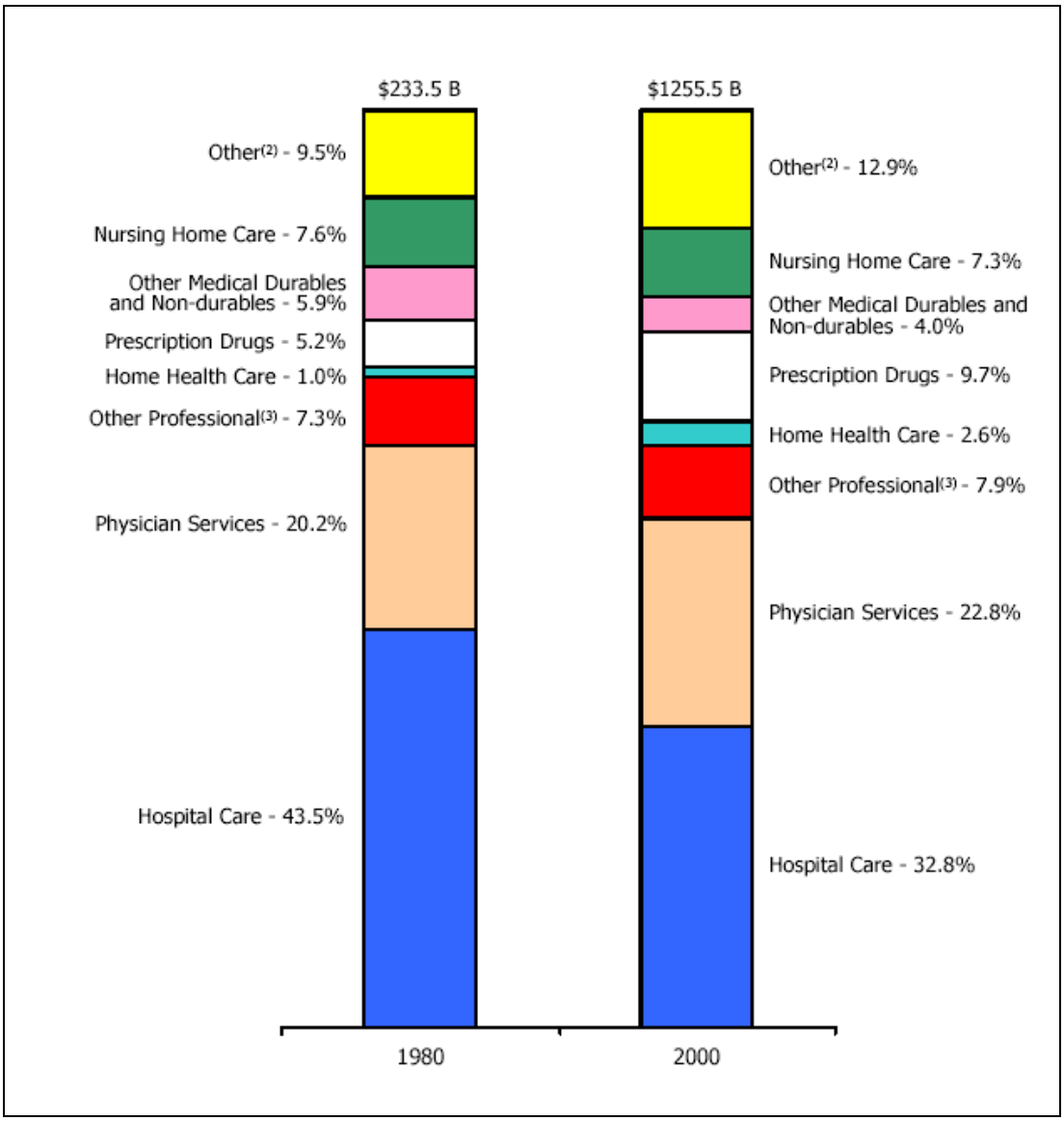


Source: The Lewin Group analysis of American Hospital Association Annual Survey data, 1980 - 2000 for community hospitals The Lewin Group: "Trend watch Chart book", 2002

(1) Expressed in 1980 dollars; adjusted using the overall Consumer Price Index for All Urban Consumers

Figure 9. U.S. per Capita Healthcare Expenditure, 1980-2000

Similarly healthcare suppliers' expenditures for supplies and services have varied both regionally and over time (Figure 10). Nevertheless desire of the healthcare suppliers' has always been to set the system capacity over actual and perceived demand. This was done to achieve acceptable utilization rates and comfortable profit margins over time. Any altering of patients' demand over time changes the system capacity offered to the patients.



Source: The Lewin Group analysis of American Hospital Association Annual Survey data, 1980 - 2000 for community hospitals The Lewin Group: "Trend watch Chart book", 2002

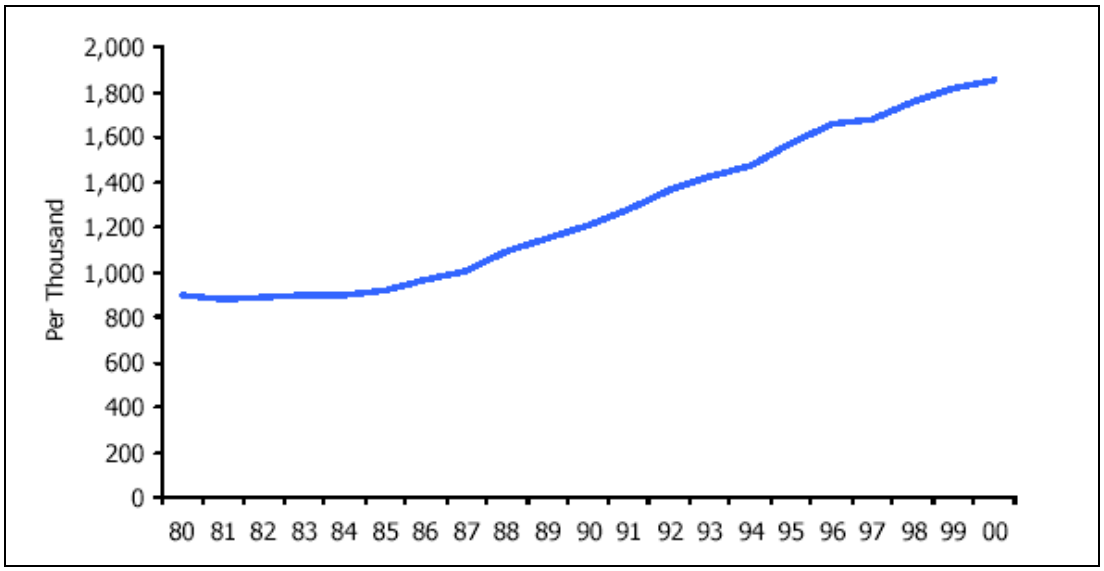
(1) Excludes medical research and medical facilities construction

(2) "Other" includes net cost of insurance and administration, government public health activities, and other personal healthcare

(3) "Other professional" includes dental and other non-physician professional services

Figure 10. U.S. Expenditures for Health Services and Supplies (1) by Category 1980 and 2000

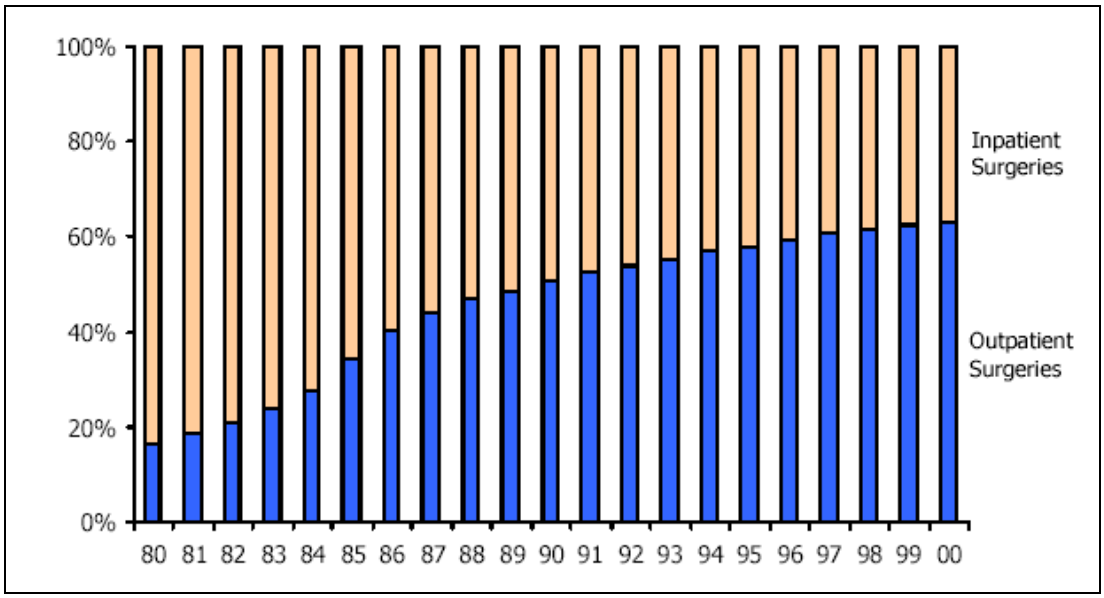
Research done by Fisher and Welch (1999) suggests that healthcare system capacity defined in term of the number of beds both for inpatient and outpatient (observation beds) care in specified Healthcare Referral Regions (HRR) is a relevant capacity metrics[15]. Number of beds could be used as an unbiased metric to measure healthcare system utilization and also as a driver of regional demand for care. This metric is suggested because the patients' needs for services have changed in the recent two decades. Additionally they reflect changes in inpatient versus outpatient ratio, significantly impacting health-care supply (Figure 11 & 12).



Source: The Lewin Group analysis of American Hospital Association Annual Survey data, 1980 - 2000 for community hospitals The Lewin Group: "Trend watch Chart book", 2002

Figure 11. Hospital Outpatient Visits per 1,000 persons, 1980-2000

[15] They provided relevant data in the Dartmouth Atlas of Healthcare.



Source: The Lewin Group analysis of American Hospital Association Annual Survey data, 1980 - 2000 for community hospitals The Lewin Group: "Trend watch Chart book", 2002

Figure 12. Percentage Share of Outpatient vs. Inpatient Surgeries, 1980-2000

The "utilization multiplier" in Figure 4 captures the processes explained earlier on how an increase in capacity causes the population to seek more services. The utilization multipliers (Figure 13, link 1 and link 2) affecting the care consumption are represented by the variety of variables ranging from technological advancement, reputation of physicians and specialists, and supply-sensitive care availability.

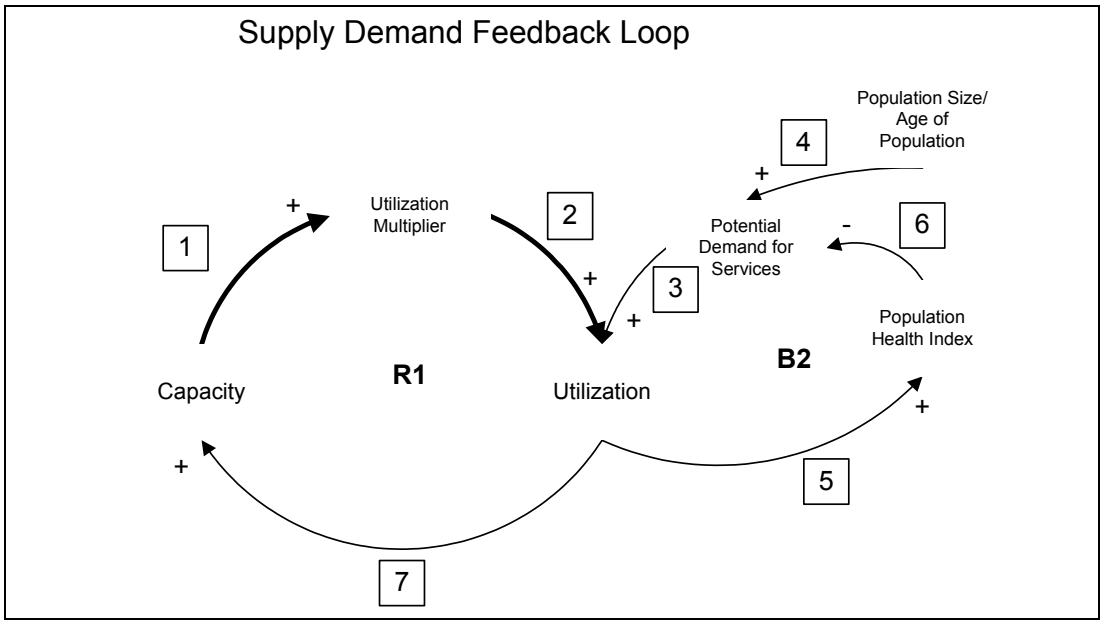


Figure 13. Capacity Impacts Utilization via Multipliers

Capacity by attracting patients to enter the healthcare system stimulates potential demand. Patients are attracted by availability of high quality services determined by modern technology diagnosis and treatment techniques, and highly reputable physicians and specialists. Additionally patients' retention represented by re-entries to the system implies further sustained demand growth. In particular, technological advances enable diagnosing health abnormalities with lower thresholds, thus patients accept a treatment they would not have sought before. Moreover, (Wardman, 1992) the demand represents, in fact, patients' expectation rather than actual care needed. Hospital expansion in specialized high-tech services and aggressive marketing raises consumers' expectations for the latest high-tech treatments. This perception boosts demand, in turn, fuels further investment in this segment of capacity. Figure 14 shows that an increased use of high-tech treatment results in a higher successful treatment rate. Based on the high number of potentially successful treatments people' expectations increase; leading to even higher demand for hi-tech services. Since elements in Figure 14 are mutually amplifying their interconnection, the feedback loop (R2) generates a reinforcing process resulting in endogenously increasing volumes of

each variable over time. The loop feeds on itself producing an increase in capacity and utilization.

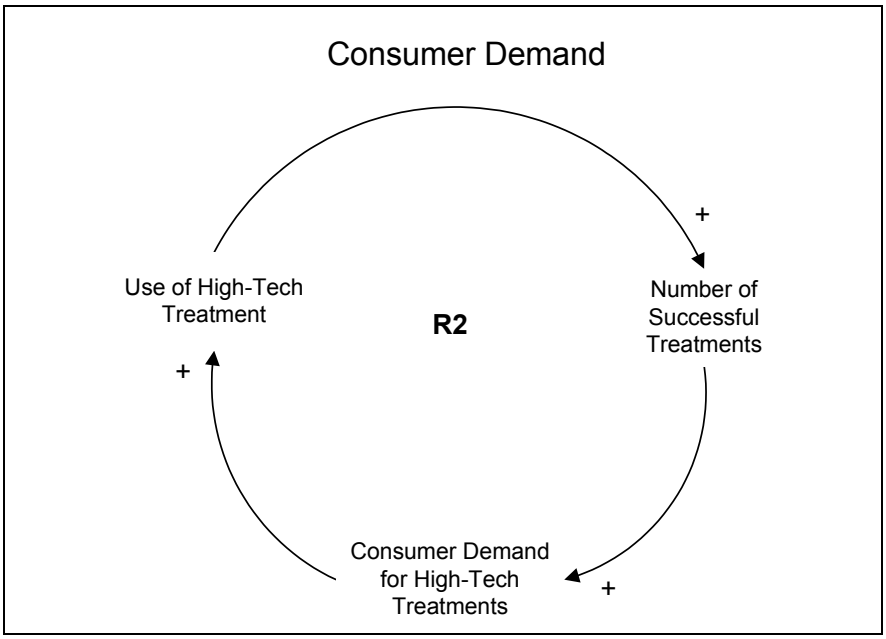


Figure 14. Consumer Demand[16]

Similarly growth in "stock" for reputable physicians and specialists is key when patients are attracted and retained to visit and re-visit the system facilities. Therefore, physicians and specialists constitute the loop multiplier explaining how increased capacity boosts the volume of patients utilizing the facilities.

Interestingly, studies show that certain capacity categories seem to affect utilization to a greater degree than the others.[17] Dartmouth Atlas of Healthcare discusses three categories of healthcare provided in the US healthcare system: effective care, preference-sensitive care, and supply-sensitive care. These three categories are distinguished by the relative roles of medical theory, medical

[16] Wardman, Kellie, No More Band-Aids for Healthcare Reform, 1992, P2.
[17] Long-term research of proven variation in volume and quality of healthcare in the United States stimulated the Dartmouth Atlas of Healthcare authors to further discern among care categories

empirical evidence, per capita supply of healthcare system capacity, and patients' preferences in terms of choosing a treatment option (Exhibit 1).[18]

	Factors that influence utilization			
	Medical Theory	Medical evidence	Per-capita supply of resources	Importance of patients' preferences
Effective care	Strong	Strong	Weak	Weak
Preference-sensitive care	Strong	Variable	Variable	Strong
Supply-sensitive care	Weak	Weak	Strong	Variable

Source: Wennberg, Fisher, Skinner, Geography and the debate over Medicare reform, 2002

Exhibit 1. Categories of Medical Services

Effective care comprises services whose use is supported by well-articulated medical theory and historically strong empirical evidence for efficacy, as determined by trials and valid studies. This category is further restricted to interventions that virtually all patients want to have as part of contract with their healthcare provider.[19] Wennberg, Fisher, and Skinner (2002) argue that utilization relevant to these services is, on average, lower than the projected one. Therefore this finding suggests that greater capacity does not purchase the infrastructure needed to ensure compliance with quality standards dictated by evidence-based medicine.

[18] Fisher and Welch (1999) screen and discus the United States healthcare system exploitation based on a known capacity upon a determined population sample comprised of Medicare program enrollees. The study examines the Medicare program data further broken down into HRR healthcare capacity. The capacity is analyzed with the actual consumption in determining similarities and variations among groups of healthcare beneficiaries.

[19] Dartmouth Atlas of Healthcare lists procedures such as vaccination for pneumococcal pneumonia, mammography screening for breast cancer, screening for colon cancer, eye examinations for diabetics, and HgAlc and blood lipid monitoring for diabetes to name a few.

Preference-sensitive care comprises clinical services where patients have at least two equally valued alternatives for treatment strategies. Since the risks and benefits differ, the choice of treatment involves trade-offs. Fisher and Welch (1999) argue that the actual choice of the treatment alternative appears to be determined largely by local medical opinion driven by the healthcare provider representatives.[20] Nevertheless, regions do not show a consistent pattern across surgical procedures and they are, according to Wennberg (2002), attributed to the "surgical signature" rather than to supply of surgeons in particular regions.

Supply-sensitive care has the greatest impact on the capacity utilization. This is due to a number of reasons. According to Fisher (2003), supply-sensitive services includes specific elements of care determined by the following common attributes:

- Weak or absent scientific evidence for providing service – scientists have rarely bothered to answer the question of how frequently patients should see physicians or whether they should receive care for such illness as pneumonia in hospital or at home
- Care is provided under assumption that more is better – or at least care cannot hurt
- Use of the service is strongly associated with the local supply

Supply–sensitive care tends to vary across regions (HRRs). Variations can be measured by spending in particular HRRs as shown in Exhibit 2. The exhibit compares regions with low capacity and high capacity illustrating that where everything else is equal, low resources cause low consumption while high resources cause high consumption. Moreover the consumption behavior over time indicates that the consumption in high capacity regions grows at a higher rate than that of the low capacity regions. This causes the utilization to rise even faster than in the low capacity regions. Consumption is relevant to spending, which reflects the actual demand for that regional capacity.

[20] For instance, the cardiac bypass surgery rate per thousands inhabitants is strongly positively correlated with the number of per capita cardiac catheterization labs in any given particular region. However, the surgery rate does not reflect the actual illness rates measured by the incidence of the heart attacks in the region.

Variations in resources and spending

Differences across Hospital Referral Regions (HRR) in 1996

	Lowest	Highest	Ratio
Hospital Beds	1.4	5.1	3.6
Primary Care Physicians	33.8	105.1	3.1
Specialist Physicians	53.3	227.0	4.3
Medicare Program Spending	$3,074	$9,033	2.9

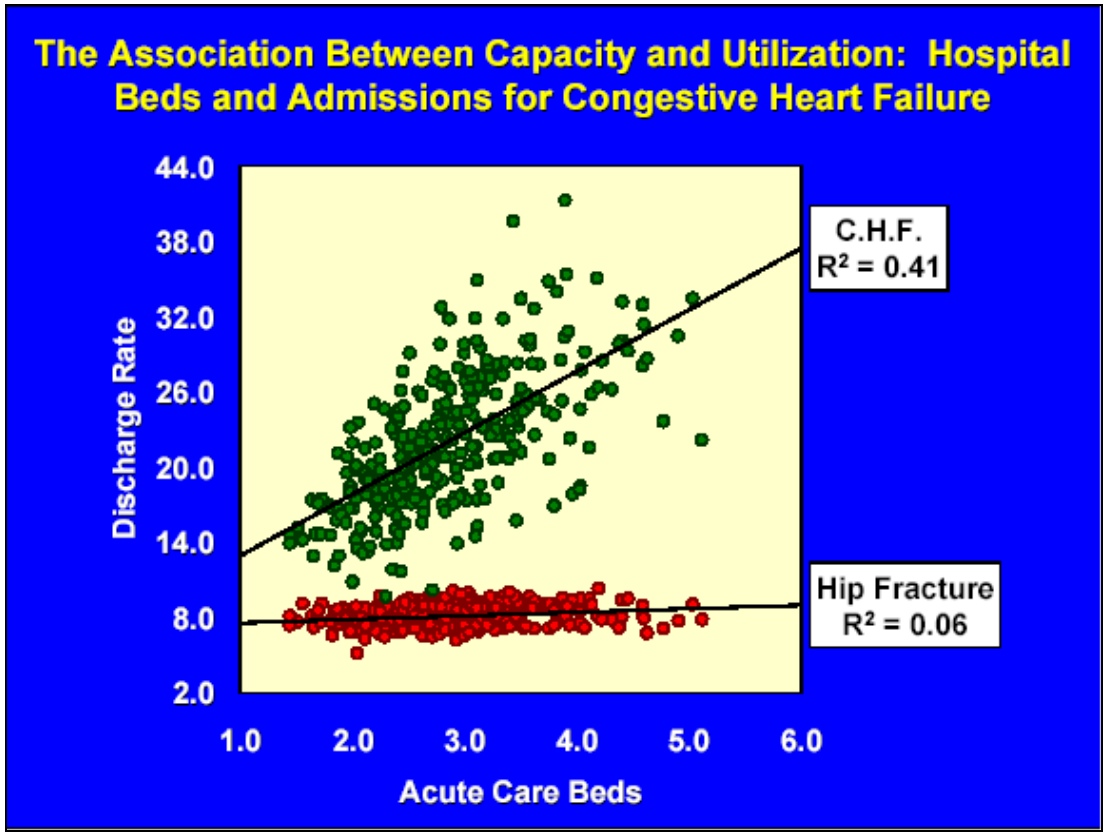
Source. Fisher: Is more Better? Dartmouth Atlas of Healthcare power point presentation, www.dartmouthatlas.org, 2003

Exhibit 2. Variation in Resources and Spending

Variations in discretionary treatments are explained by clinical decision making driven by strongly held medical opinions. However, the decisions that physicians make governing the frequency of provision of the supply-sensitive care are neither supported by well-articulated medical areas, nor by empirical evidence that influences the healthcare market forces (Fisher, 2003). Empirical studies conducted on the Medicare population sample show that these variations are particularly pronounced during the last six months of life, a period when many Medicare enrollees are quite sick and which accounts for more than 20 percent of total program expenditures (Wennberg John E., Fisher Elliot S., Skinner Jonathan S., February 13, 2002).

Significant regional differences are pronounced by a similar pattern that holds for admissions to intensive care units (ICU) in the last six months of life. To illustrate this fact, nearly half of decedents experienced an ICU admission in Miami, Florida, compared with only 14 percent in Sun City, Arizona. These variations cannot be reasonably attributed to differences in illness: during the last six months of life most people are ill, regardless of where they live. In terms of

the scrutinized sample of Medicare enrollees, the local supply of healthcare system specialists and acute care hospital capacity statistically explains 41 percent of variation in end-of-life care intensity across the United States[21] (shown in Figure 15). Figure 15 illustrates typical characteristics of supply-sensitive care, that capacity and service availability in a HRR affects utilization. In other words, the higher the capacity is in a HRR the higher the suppliers' incentive to increase demand in that HRR to utilize this capacity, no matter if the care is needed or not.



Source. Fisher: Is more Better? Dartmouth Atlas of Healthcare presentation, www.dartmouthatlas.org, 2003

Figure 15. The Association between Capacity and Utilization: Hospital Beds and Admissions for Congestive Heart Failure

[21] Wennberg places this argument based on regression analysis of collected date for Medicare enrollees such as hospital bed supply, primary care physicians, and specialists, all on per-capita basis. The multiple linear regression is weighted by a population age of sixty-five and older in each HRR. One could question whether the capacity is itself sensitive to greater demand for specific services. However, the regression results show that much of the capacity variation is the consequence of migration rather than health needs: people move away but the hospital beds remain, or people migrate to HRR, but relative few hospital beds are supplied.

Fisher and Welch (1999) distinguish between preference-sensitive and supply-sensitive care in degree rather than in an absolute difference. For example, while patients' preferences will not likely affect clinical decisions regarding stabilization of hip fractures, they may play a significant role in end-of-life care for the chronically ill.

Skinner (2001) argues that an incremental Medicare dollar spent in HRRs with higher than average spending tends to be for medical specialists visits (and re-visits), diagnostic tests and the use of intensive care and hospitalization for medical rather than surgical conditions (Skinner Jonathan S., Fisher Elliot S., Wennberg John E., 2001)

Therefore any incremental Medicare dollar spent in HRRs should be viewed not simply towards more specialist visits by the general elderly population but, more specifically, towards specialist visits concentrated among the population with chronic and ultimately life-threatening diseases (Dartmouth Atlas of Healthcare in United States, 2003). Furthermore, Wennberg (2002) adds that there is a statistically significant ($p < 0.01$) strong association between higher spending and greater use of supply-sensitive care. However, lack of association between more spending and more preference-sensitive care or even effective care, can be seen in the medical care spending patterns of regions representing either very high or very low levels of overall Medicare program spending.[22]

These show that Medicare enrollees in Miami, Florida spend 2.45 times more for consumed healthcare compared to the same segment of patients in Minneapolis, Minnesota. Moreover, the same segment of patients in Miami, Florida, during the last six months of life, consumes healthcare that in absolute terms represents 6.55 times more visits to medical specialists, 2.13 times more hospital days, and 2.16 more admissions to ICU than the same segment of patients in Minneapolis, Minnesota. In contrast, the preference-sensitive care rates are slightly lower in Miami than in Minneapolis (Wennberg John E., Fisher Elliot S., Skinner Jonathan S., 2002).

[22] Rates are age-, sex, and race- adjusted

1. Supply-Sensitive Care Impact on Demand/Utilization

Fisher and Welch (1999) explain utilization of supply-sensitive services in terms of (1) hospitalization for medical conditions, (2) days stayed in Intensive Care Unit (ICU), (3) visits to physicians, and (4) referrals to specialists. This section discusses how supply-sensitive care drives the dynamics of its consumption.

Supply-sensitive care settings encompass a significant increase of both diagnosis and treatment. Diagnosis is a critical point of entry to medical decision-making that determines all consequent actions. An increase in volume of diagnosis can be explained by promotion and by the use of state-of-art diagnostic test equipment. Advanced diagnostic equipment has improved capability to detect relatively subtle abnormalities of physiology or anatomy long before they manifest their clinical signs or symptoms that would have provided the basis for diagnosis in the past (Fisher Elliot S., Welch Gilbert H., February 3, 1999). Consequently, developing medical technology promises that physicians will increasingly have the capacity to identify individuals who may develop abnormalities at some point in the future. Not only have advances in imaging changed physicians' perspectives on the prevalence of any particular disease but also they have distorted their perceptions on the natural history of that disease and on its likely response to medical intervention.

New diagnostic tests and lower diagnostic thresholds not only have increased the observed prevalence of disease but also shifted the spectrum of detected disease. Even without treatment, this shift in spectrum of detected diseases would lead to some improvements in actual or potential patients' health status, mainly in terms of prevention. Indeed, the combination of enhanced capability and lower diagnostic thresholds means that yield gained from tests substantially increases. This mechanism creates an immediate positive feedback for clinicians to pursue further testing thus utilizing the system capacity even more. However, in terms of diagnosis there is still an ambiguity about what constitutes a disease; more frequent testing tends to produce more abnormalities

and thus more diagnoses. Furthermore, the problem also exists with the frequent use of diagnostic tests in general. Physicians who frequently obtain tests are undoubtedly more likely to make diagnoses. In addition, more tests leads to more errors and more errors require rework; thus increased resource consumption.

Black and Welch (1993) and Fisher and Welch (1999) argue that, undoubtedly, patients have benefited from technological advances in diagnostic imaging, particularly those that permit the faster and safer diagnosis of symptomatic, treatable disease. However, these advances can create confusion and many patients may have been labeled with a disease they do not really have, thus being treated unnecessarily. Moreover, when diagnostic tests show some subtle findings physicians tend to consider them relevant also. Such a pseudo disease may not be just a function of the lesion but also of the host even though it would never be apparent to the patient during the life-time without a diagnostic test (Fisher Elliot S., Welch Gilbert H., 1999). Consequently a population with an occult disease is much larger than the population destined to become sick from it. Since abnormalities revealed by testing lead to increasing effort to start treatment, pseudo disease leads not only to unnecessary patients' worry and disability but also to unnecessary treatment.

On the other hand, Verrili (1996) admits that more diagnoses may be explained also by an increased detection rate. Because there is a large reservoir of clinically occult disease, how much is actually diagnosed is a function of how hard one looks. Because there is little consensus about what defines the diagnosis of clinically important disease, even small abnormalities evoke a therapy.

More treatment is predominantly a reflection of the increased number of diagnoses obtained because physicians rarely stop with a diagnosis.[23] Then however, when more ICU capacity is available, patients are admitted with illness

[23] Fisher (1999) states that during 1980s, both the number of surgical procedures and spending on prescription drugs (price adjusted) increased by more than 70%. The number of revascularization procedures among elderly with coronary artery disease recently increased by more than twofold, while the number of visits for children for which stimulants were prescribed to treat attention – deficit hyperactivity disorder increased from 0.3 to 2.4 million.

with on average less severity increasing the volume of treatment unnecessarily. Again, when in a particular HRR the numbers of hospitals and surgeons providing coronary artery bypass graft (CABG) surgery are doubled, the rate of treatment for 1- or 2- vessel disease increases 9-fold (Fisher Elliot S., Welch Gilbert H., 5 February 3, 1999). This finding supports Black (1993) with his finding that despite the physicians' best intentions, many patients may have been labeled with diseases they did not really have causing follow-on therapy they did not need.

The most significant risks associated with a higher volume of treatment are relevant to underestimating the lower threshold of disease or perceived disease symptoms diagnosed as a result of testing. The spectrum of disease plays an important role in the treatment selection and the potential benefit of treatment for patients whose untreated prognosis is good. Fisher and Welch (1999) argue that treatment risk, however, is relatively less responsive to the severity of illness, where patients with relatively mild disease still face substantial risks from interventions included in the therapy. Furthermore, if people are treated for inconsequential disease, the risk of treatment will exceed the benefits.

Overall more diagnoses compounded with more treatment increase the system volume of operations in absolute terms. Even if a disease's progress is slow, each diagnosis requires more attention and more resources to be utilized from any given healthcare system facility. More diagnostic tests lead to more disease prevalence, which require more interventions. Except for serious cases, the spectrum of diseases includes a number of mild cases, leading to apparent treatment outcomes that improve even if efficacy of the treatment is unchanged (Black William C., Welch Gilbert H., 17 April 1993).

Furthermore Verrilli (1996) argues that although the risks of the diagnostic tests themselves may be relatively small, the cascade of subsequent events may quickly spiral out of control, exposing patients to significant unforeseen risks, thus additional entries to the system.

Since a certain non-negligible portion of the volume is provided unnecessarily just to increase system utilization, patients would hardly enjoy

better health and, in turn, the capacity suppliers may argue that they have a reason to increase capacity.

D. UTILIZATION/DEMAND IMPACT ON CAPACITY

In this section, we argue that the relationship between capacity and utilization is not only a one-way linkage but also mutually interconnected elements. It is not only an increase in capacity that leads to more demand (Figure 16, link 7), but also an increase in utilization that stimulates adding more capacity to the system. Since the causal loop is a closed feedback structure we will follow with an explanation of the processes in which demand affects supply. The mechanism stresses operational management as a key field to reduce the system congestion pressure, competition among health providers in a highly competitive environment, and financial incentives for sustainability.

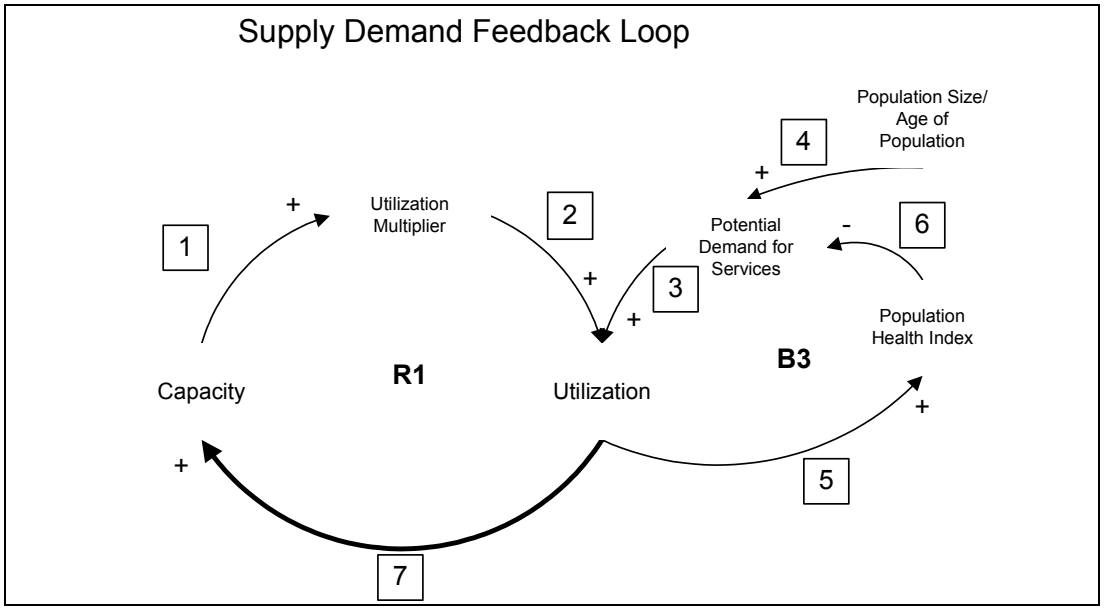


Figure 16. Emphasis on Utilization Leads to More Capacity

1. Managing Utilization Pressure

When the utilization rate increases as a result of increasing demand a hospital becomes congested and the quality of services to drop. The manager

focusing on hospital profitability and reputation will seek to add more capacity to reduce the tension and regain the desired utilization rate as well as quality of services. Increasing demand needs to be managed by augmenting capacity over time so that the pressure on system utilization rate is relieved.

Not all hospitals, though, encounter a congestion problem. An interview with a hospital manager (see Appendix 1) supports an assumption that operational management is an effective management tool for managers to cope with ever-increasing demand. When the utilization rate goes above a certain threshold, a manager will tend to add additional capacity, otherwise, they would risk a profitability downturn.

New technology along with adopted hospitals' business strategies has encouraged hospitals to restructure the ratio between inpatient and outpatient care segments, shifting operations to the later one. This strategy facilitates alleviating the pressure of hospital congestion. However, even when these precautions were adopted the volume of Emergency Department (ED) visits has increased by about 19 percent since 1990. More specifically, 62 percent of hospitals reported that their EDs were at or over capacity and 33 percent reported having to divert ambulances (The Lewin Group, 2003).

Overcrowding persistently contributes to the system imbalance. To find a new equilibrium, the system has some options. Because the ever-increasing demand is considered a viable stream of revenues, the capacity suppliers usually decide to increase the system capacity rather than rationing care. Processes inherent to the discussed dominant self-feeding (reinforcing) feedback loop depict the most critical events that form dynamics in the US healthcare system.[24]

[24] Gauthier (1995) argues that the US healthcare system can be figuratively labeled as "the first trillion dollar industry" that stimulates the population to use it at a higher rate than desirable because it induces repeated unnecessary visits to the system. On the other hand it does not prevent the population unhealthy habits causing frequent health defaults thus forcing people to enter the system on the other.

2. Increases in Supply through Medical Arms Race Phenomenon (Escalating Archetype)

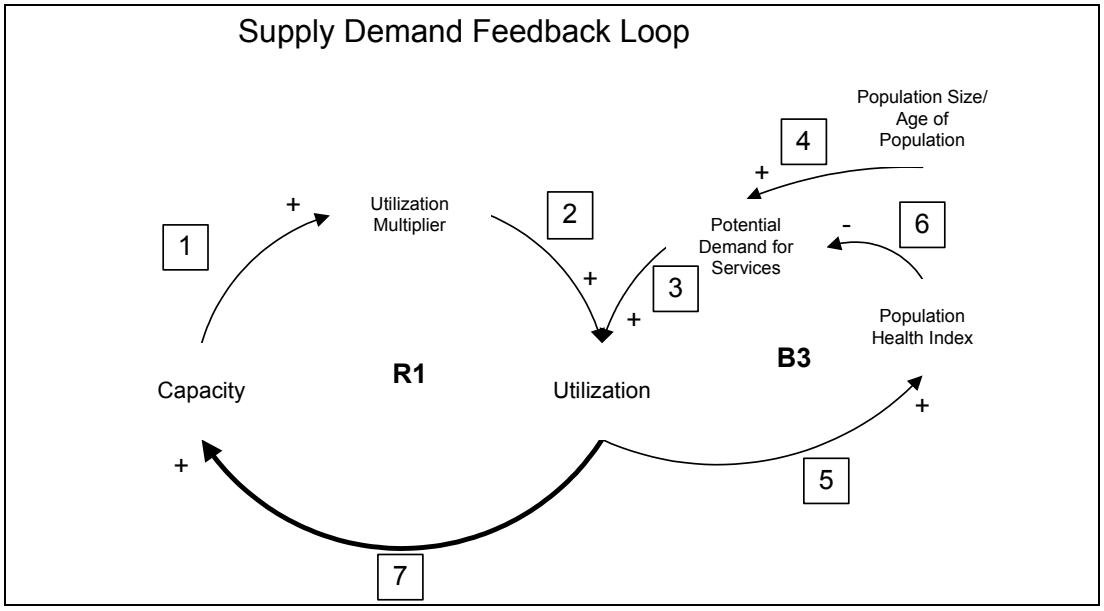


Figure 17. Emphasis on Utilization Leads to More Capacity: Medical Arms Race

One of the patterns explaining how utilization affects capacity (Link 7, Figure 17) is the escalating archetype. This escalation dynamics is labeled in the medical literature as the Medical Arms Race (MAR) whereby hospitals escalate their resources as they engage in a competition for physicians and through them for patients in the market by providing high-tech services. The sequence of these events constitutes a self-amplifying behavior depicted by a positive reinforcing feedback flow (Figure 18). When the loop's principal elements reinforce each other's action, the elements' quantity is expressed by an exponential growth function over time. The competitive environment, anticipated demand and the management mental model are the most important factors contributing to the behavior of the loop's principal elements. Apart from capacity increase that will exceed the desirable benchmark volume, the MAR phenomenon leads to

unreasonable high healthcare costs, duplicated services and high quality services where they are not required. This section will highlight the MAR archetype, its characteristics, and factors affecting behavior of the loop's principal elements as observed in U.S. healthcare during the past two decades. Furthermore it stresses the likely behavior results in a contemporary setting.

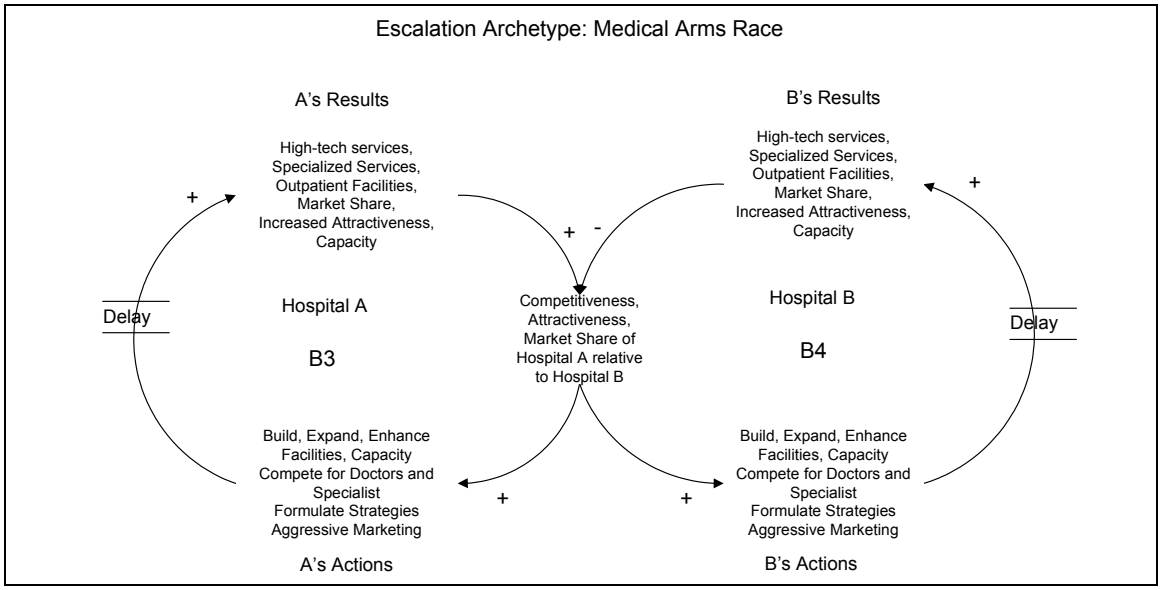


Figure 18. Increase in Supply Through the Medical Arms Race (Escalating Archetype)

3. System Scheme

The competitive environment of the healthcare market shapes the way hospitals choose their strategies to compete and adjust their services. However, if the organizations see that their welfare depends on is relative advantage, then whenever one party gains a competitive advantage position, another one is threatened by the potential loss of the necessary stream of revenues resulting in a market share drop. For example, when a neighboring hospital builds sophisticated service facility, the local one assumes a potential outflow of patients and, consequently revenue drops. Since the local hospital desires to survive the competition, it is forced to take a responsive action to regain its

position. Although hospitals' owners often consider their own actions as defensive ones when responding to the competitors' capacity, an aggressive expansion action taken by the first hospital stimulates an adequate capacity growth on the side of the competitors. This self-feeding process is apparently irrelevant to either party's inherent desire or even the community's need

4. Factors Affecting the Behavior

Devers, Brew and Casalina (2003) analyzed data relevant to hospitals' strategies in two distinct periods—1996-1997 and 2000-2001. They argued that hospitals have engaged in apparent MAR behavior during both periods applying different strategic orientations. In terms of the care suppliers' reimbursement patterns, they found that during the earlier period hospitals' actions were predominantly affected by prospective payment and managed care environment qualities. The Health Maintenance Organization (HMO) and the Preferred Provider Organization (PPO) have been alternative cost-saving approaches. In the later period health providers adopted a retailing strategy that competes in specialized services.

Except for the commercial forces affecting the hospitals' strategies, the government has been a major player in the healthcare system running a relatively large volume of Medicare and Medicaid programs. These programs generally focus on some healthcare coverage provision for the elderly and the poor at the proclaimed lowest expense to taxpayers.

When more organizations adopted cost-cutting approaches, hospitals have had to compete on price by leveraging the concept of large volume contracts instead of the latest technology approach or number of amenities (Devers, Brew and Casalina, 2003). Therefore, hospitals would aim to provide services attractive to managed care plans that provide an incentive to purchase large care volumes for their program enrollees. Hospitals offered limited services packages labeled as organized delivery of services (ODS) to attract large contract volumes. This general model would ensure that hospitals could compete

in the managed care environment while taking an acceptable financial risk when managing care for healthcare demand.

The cost-cutting structure has an advantage both in reducing the escalation of the healthcare cost and increasing society's benefits. On the other hand, cost-cutting strategies have forced more people from paying healthcare insurance premiums thus enlarging the uninsured pool of citizens (Wardman, 1992). Wardman also explained that businesses have tried to cut costs by shifting from traditional insurance plans to the more feasible PPO, HMO, and Medicare and Medicaid programs. To compete in the managed-care environment and to attract large volume contracts, doctors, namely specialists, have engaged in activities affiliated with hospitals' services. They intended to cut deals with managed-care organizations by passing cost to small business and individuals. When the cost of care could not be absorbed, more of the population would stop paying the healthcare insurance premiums. Therefore this creates a pool of uninsured population whose healthcare was subsidized at the expense of the other taxpayers through the federal budget.

Figure 18 (Escalation) illustrates reinforcing feedback loops operating under the competitive strategies adopted by hospitals A and B. Since consecutive actions of both amplify each other, the loop behaves as self-feeding until a behavior threshold is reached; then the interaction slows down over time.

Hospital A's incentive is to operate with a positive profit margin, stimulate growing demand, and, supposedly, provide supply and services demanded by the market. Therefore it offers a desirable care capacity in terms of volume, quality and workforce reputation (such as physicians). Hospital A must undergo a set of actions to achieve the strategy's outcomes. For example, it can build new modern facilities, expand the current capacity of supply and services, introduce high-tech equipment and IT solutions to enhance its current capacity and services, and market its capacity more aggressively.

Hospitals have been using a variety of techniques to increase the volume of inpatient specialty services. They tended to focus on service provision in most sustainability leveraged areas, such as cardiology, oncology, and orthopedics.

For example, 20 out of 43 hospitals in the Community Tracking System report completed building of outpatient (remote) centers that provide additional service of hospital care and generate additional diagnostic testing for inpatient care (Devers, Brew and Casalina, 2003). These outpatient centers, specializing in cancer screening, cardiology and neurosciences have not only complemented the volume of operations in any particular region but have consolidated and concentrated more demand in the HRR by collaborating with a hospital (or more hospitals) in an HRR.

Hospitals have used these inpatient and outpatient specialty care facilities to increase their revenue as well as the profit margins. It is obvious that when these additional capacities have lead to greater profitability, the management adds even more capacity as long as they would be operating within desirable margins. Moreover, these programs served as a stimulus for specialists' incentives to compete; hence attracting even more patients. Newly built modern inpatient and outpatient facilities were both means to attract new highly skilled specialists and to strengthen hospitals' relationships with specialists who still contribute to generating the majority of hospitals' revenue.

Interestingly, specialty care programs have been packaged into a more limited set of services with higher prices, thus relatively lower desirability, but with satisfactory internal rates of returns. Finally, specialty services have been aimed at those who have increased choice due to changes in health plan products and broader supplier networks.

Hospitals expanded the ICU and operating room capacity in order to reduce tentative cancellations and backlogs in the ED due to potentially full ICU occupation. Similarly, the hospital managers realized that patients' satisfaction has been one of the expansion and enhancement goals. Hospitals wanted patients to feel the experience of a "hotel-like" environment inside the hospitals. Another example of the increase of services and capacity was building or reconstructing facilities required by relevant public policy (California's Law S.B. 1953) that has mandated compliance with earthquake building structure standard beginning in 2008. Monterey Community Hospital is currently (2003 - authors'

remark) undergoing construction to its major new facilities that will be in compliance with the law.[25]

Next, hospital A can seek doctors and specialists through aggressive marketing techniques. Aggressive marketing techniques ranging from targeted advertisement to a mass media approach. Moreover, creating more access points to services has made it easier for patients to use hospitals' services. More customers' convenience in using the system features facilitates the process of attracting a growing number of patients who require extra care and referral to the main hospitals' facilities as well as to affiliated specialists' facilities.

This structure has created an extra reinforcing process when some excessive supply induces additional demand. The more people get exposed to the pool of services, the more they want to have done for them and the more they use "word of mouth" to stimulate the entry rate of the system. Indeed, more testing leads to more diagnoses and potentially to more diseases to treat. Once minor diseases are detected because of the more sophisticated equipment, more specific treatment procedures can be done. Physicians having a stake in their workplace performance would certainly have a great influence on patients' preferences whether to undergo new procedures or a set of complex services. A greater volume of procedures likely generates a greater error rate. More potential errors stimulate the volume of rework. The positive polarity between the healthcare capacity demand and supply explains why hospitals have crafted their retailing strategies through effective marketing.

5. Relative Competitive Advantage

Hospitals have been challenged to assume a greater risk of being involved in fierce competition. By implementing competitive strategies they have either added facilities or expanded and enhanced them. Services and facilities have focused on both specialty care, such as outpatient centers, hospital-physician joint venture outpatient centers, niche specialty services and centers of

[25] Based on the information from the interview in Appendix A

excellence (COE) and heart hospitals; and general acute care such as inpatient capacity, general hospitals and emergency rooms.

Successfully combining services and marketing through retailing strategies, hospital A has become more competitive than hospital B within the same competitive environment. Therefore, hospital A appears to be more attractive than its competitors. It exploits its market position advantages to increase inflow of volume of referral services. Moreover, hospitals have been extending their outpatient facilities – the affiliated care retailers across a wider geographic area (Devers, Brew and Casalina, 2003). Targeted marketing as well as mass advertisement in the globalization era penetrate traditional market boundaries of other hospitals' both regional and specialty determined areas of operation. The competitors react to hospital A's leading market position by their increased capacity either in terms of volume or specialty to regain the market share fragment already lost to hospital A. The competition is intensified.

6. B's Actions

Hospital A's actions cause hospital B to lose its market share of patients – the source of revenues. To counterbalance the actions of its competitor, hospital B is forced to take similar actions to maintain its competitive position and re-gain its market share. As to the business strategies, hospitals have taken retailing strategies instead of wholesaling ones in an effort to compete, to attract and to retain specialists, patients and consumer sub-markets (Devers, Brew and Casalina, 2003). Interestingly, most of hospital B's actions are centered on duplicating services that had already existed. For example, if hospital A builds a freestanding diagnostic center, hospital B will likely build a similar facility.

7. Results from the Behavior

The MAR phenomenon as an Escalation Archetype represents two loops feeding on each other. The actions of the loop's principal elements' mutually amplify each other, generating an exponential growth function as a result of this behavior. The U.S. healthcare system's behavior simplified by this phenomenon

causes an excessive capacity as a result of the capacity's endogenous escalation. Hospitals have consolidated and rearranged their excess capacity to increase utilization. Similarly, capacity and services expansion can partly explain skyrocketing costs. Costs are transferred to small businesses, individuals, and insurance companies. Then the cost is passed further to insured customers, the government (covers some of uninsured population) and ultimately the taxpayers. If healthcare costs continue to grow at a higher rate than the rate of inflation, there is a significant threat that resources may be shifted from other projects to support the access to healthcare. This structure resembles the Tragedy of the Commons Archetype meaning that since resources are limited and the community has equal rights members – the commons, in which every member tries to apply various strategies to maximize their objectives and minimize cost, the commons can never come up with a viable solution for their resources exploitation (Wardman, 1992), thus the community will sooner or later collapse.

We assume, though, that this "vicious circle" behavior would not be in effect forever; otherwise it would drain resources and pull down the entire economy. Somehow, limits have to be set. In other words the system's reinforcing behavior would have to slow down, reach an inflexion point and then counterbalance to reach equilibrium representing a new level of demand and supply. Certainly, there is a need for more effective management of medical reforms and the implementation of a learning organization concept. In these terms the managers, physicians and board members solve the non-sustainability problem collaboratively pursuing a common equity vision. Continuous Quality Improvement (CQI), and shared-vision are suggested tools to facilitate a creative approach to a learning organization concept.[26]

In addition to competition explaining an increase of capacity, the financial aspect needs to be discussed.

[26] Gauthier A., The Challenge of Stewardship: Building Learning Organizations in Healthcare, Productivity Press, 1995.

8. Financing Perspective

Hospitals' managers are paid to run businesses profitability and with a positive rate of return. The CEOs and other decision-makers follow a mental model to provide desirable volume and quality of healthcare services while mitigating the risk of a long-term loss. Managers would add more capacity if they anticipated the extra services generating higher profit for sustainable operation and satisfying customer demand (Figure 19). A procedure is added providing that the return on investment is positive, meaning, in other words, a reinforcing process as depicted by a loop denoted R3.

However, adding capacity is not done alone since it reflects the overall status of the US economy. The recent economy downturn has significantly impacted hospital managers' business decisions. Currently, hospitals operate with a lower average margin than in the early 90s (AHA Annual Survey, 2002). Managers having an incentive to increase margins adopt strategies enabling them to leverage services with the highest return possible. They generally introduce specialized high-tech services to compensate a small or even negative profit margin of managed-care services that their facilities provide. Running quite profitable outpatient centers compensates the cost increase of inpatient services. The total hospital outpatient visits in community hospitals has increased exponentially since 1980 as shown in Figure 11. (AHA Annual Survey, 2002). Moreover, the ratio of inpatient to outpatient surgeries tends to favor the inpatient ones (Figure 12).

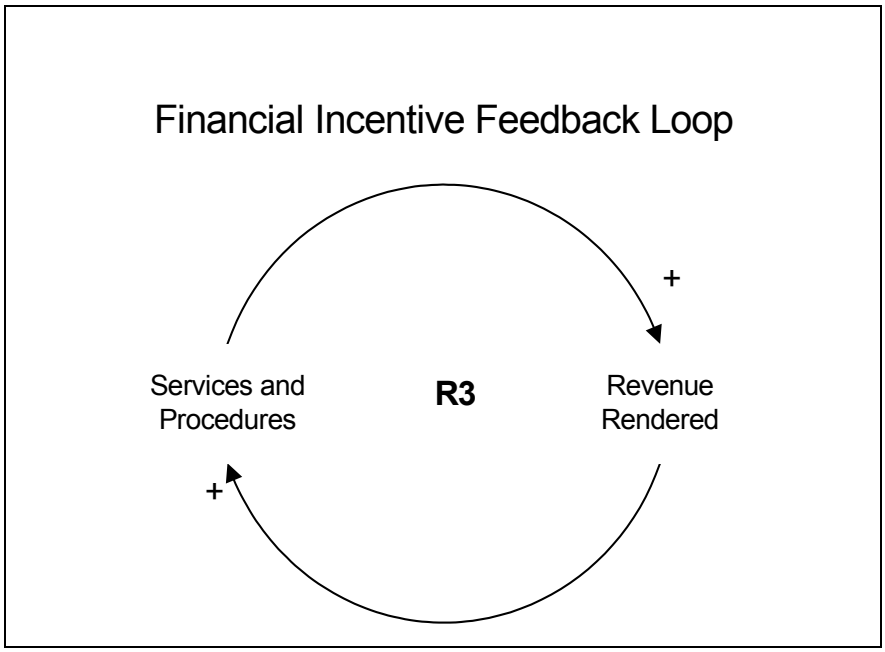


Figure 19. Positive Feedback Loop Illustrates Managers' Mental Model Pursuing High Return Services.

a. Competing for Talent and Profits

Hospitals also tend to expand capacity by attracting and retaining their best physicians and surgeons to work in state-of-the-art facilities and lately affiliated medical centers. Many hospitals have designed specialized for-profit entities to run the surgery centers with affiliated doctors who share the profit.

The most heated race is centered on cardiac care. John Birkmeyer, as associate professor of surgery at Dartmouth Medical School says, "insurers nationally pay hospitals, on average, $29,300 for every coronary bypass performed. Out of that, hospitals net an average $68,000 in profit."[27] He further argues that without considering the fixed cost, for every surgery performed the profit is $18,000 on average. This is about 61.14% return on investment (ROI) suggesting to hospitals' managers that a cardiac center investment is extremely

[27] Additional data from medical suppliers' survey to be found at http://www.usatoday.com/money/health/2002-02-20-hospitals.htm, USA TODAY, online source, Hospitals fight for turf in medical arms race, P5

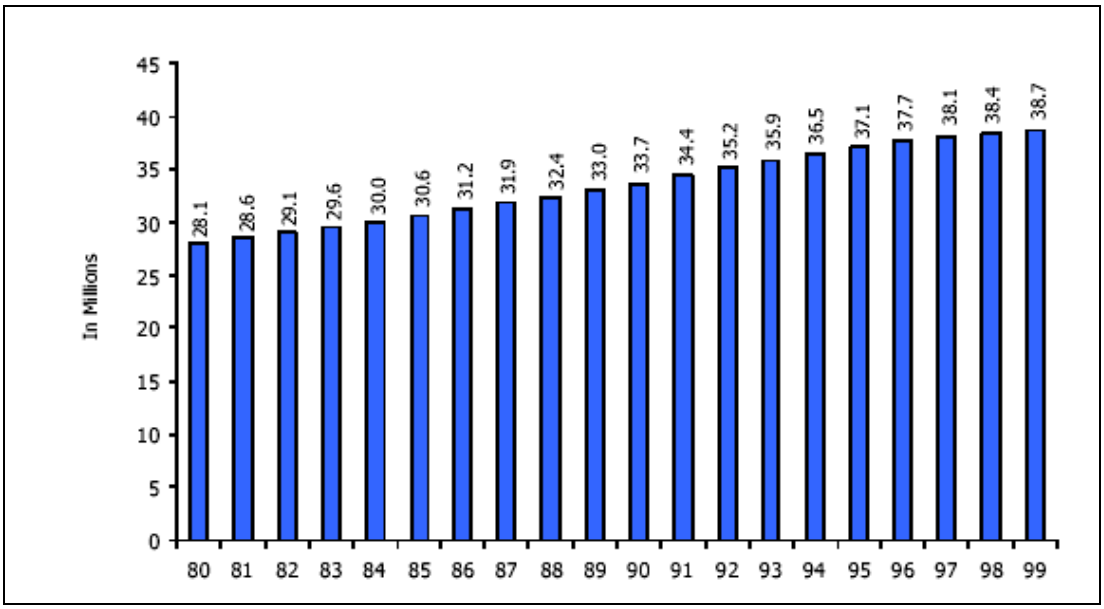
profitable. As a result, these high-tech services tend to be duplicated and aggressively marketed to encourage use, which is, in fact, overuse.

E. BEHAVIOR OF KEY VARIABLES OVER TIME

A feedback loop perspective suggests that there are two interconnected feedback loops operating within the U.S. healthcare system in pursuing a supply and demand relationship. The first loop expresses a counterbalancing process, stabilizing the system to equilibrium. On the other hand, the second one, – reinforcing between capacity and utilization, is endogenously self-feeding.
Providing that the continuous processes' behavior of the two loops creates a function maintaining equilibrium over time, the system behavior should not generate negative repercussions, such as under-servicing care, care rationing, and skyrocketing costs. However, the capacity multipliers and various other disturbing factors discussed above cause the reinforcing loop to eventually dominate the system's behavior; hence the system shifts from equilibrium.

If the proposed hypothesis is right, what would be the behavior of the system in general? We argue that both supply and demand variables will continue to increase irrespectively until the system qualities are changed or the system reaches its limits — denominated by available resources. The following figures support our proposed hypothesis' principal assumptions. They graphically illustrate the U.S. healthcare system's key variables behavior over time in the feedback loop perspective.

More demand is expected with the aging population. Figure 20 graphically shows increased demand for care relevant to the Medicare program segment of the market. It is expected to grow as the "baby-boomer" generation becomes eligible for program enrollment.

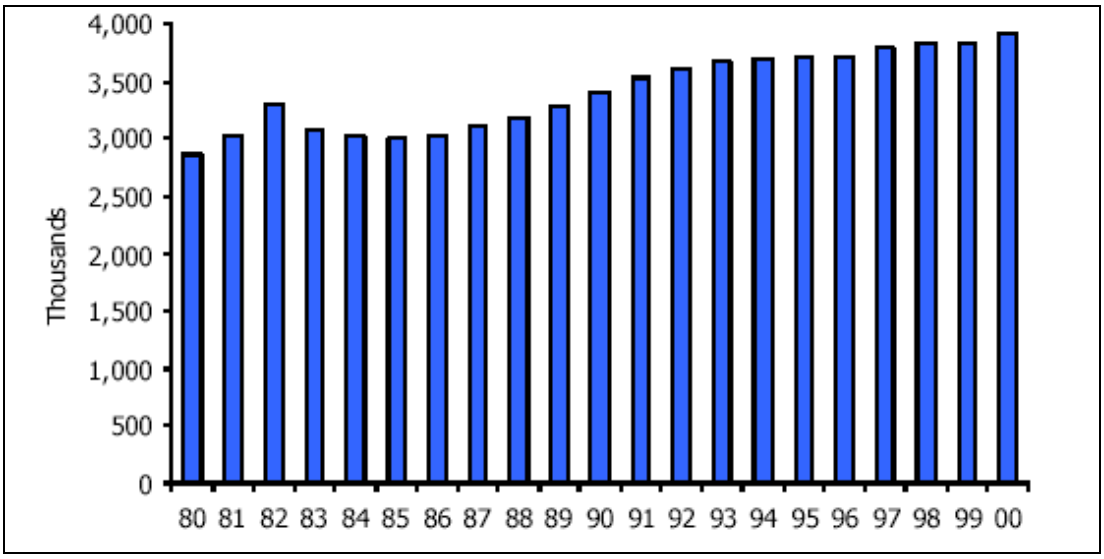


Source: The Lewin Group analysis of American Hospital Association Annual Survey data, 1980 - 2000 for community hospitals The Lewin Group: "Trend watch Chart book 2002"

(1) Hospital insurance (Part A) enrollees only; includes all persons (aged and disabled)

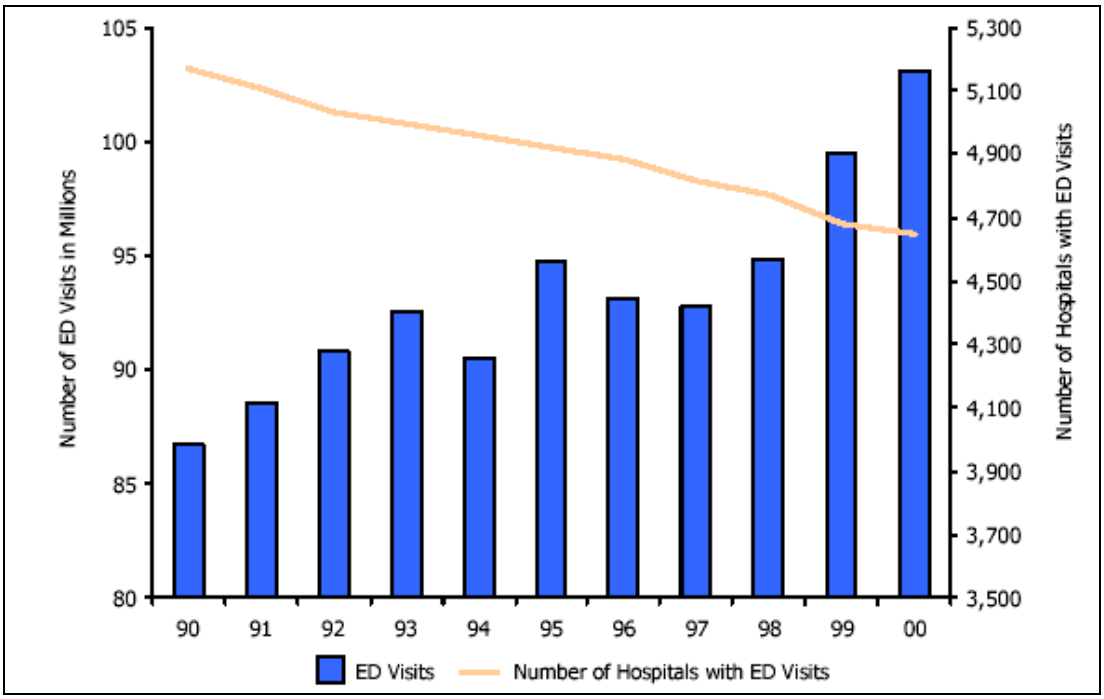
Figure 20. Medicare Program Enrollees, 1980 – 1999

Next, Figure 21 illustrates a gradual increase in total full time equivalent employees working in hospitals. Although increasing, it cannot keep up with ever-increasing demand. According to AHA survey, 62 percent of hospitals reported their EDs were at or over capacity (The Lewin Group, 2003). Figure 22 illustrates the trend of achieving capacity.



Source: The Lewin Group analysis of American Hospital Association Annual Survey data, 1980 - 2000 for community hospitals The Lewin Group: “Trend watch Chart book 2002”

Figure 21. Total Full Time Equivalent Employees Working in Hospitals, 1980-2000



Source: The Lewin Group analysis of American Hospital Association Annual Survey data, 1980 - 2000 for community hospitals The Lewin Group: "Trend watch Chart book 2002",

Figure 22. Emergency Department Visits and Number of Emergency Department in Community Hospitals[28] (1990 – 2000)

[28] Recently according to AHA survey, 62 percent of hospitals reported that the EDs were at or over capacity (The Lewin Group, AHA, 2003).

III. DISCUSSION AND CONCLUSION

Although researchers tend to discuss effects of demand on supply, the reverse relationship and its impact on supply is frequently overlooked. We focused our discussion of the US healthcare system on its dynamic behavior over time based on mutually determined interactions. This approach provides a system dynamics insight to all critical processes influencing each other within a deterministic causal loop. Having realized that the process constitutes a feedback loop facilitates full understanding of mutual interactions as well as outlining the character of detected problematic behavior caused by demand and supply distorted interaction.

A. SYSTEM WHEN EXPOSED TO SHOCK: THE ENTERING OF BABY BOOMER

Although this work examined distortions in healthcare supply and demand relationships in the US healthcare sector, it does not avoid discussing more traditional causes that analysts have identified—such as increased societal wealth and an aging population. In fact, the confluence of an increasingly wealth society, aging society, and the supply-demand dynamics represent an extremely burdensome combination. The dynamics of the supply and demand interaction and escalating costs pose particularly threatening consequences in an era in which the so-called baby-boomer generation is rapidly approaching retirement age. The baby-boomer generation encompasses approximately 67 million Americans, born in the years after World War II. Since 20 percent of Medicare program expenditures are spent in the last six months of life, the prospect of a rapidly growing elderly population imposes an unprecedented burden on the system's capacity of organizing and financing healthcare.

The effects have already been felt. Healthcare suppliers have already begun aggressively expanding their capacity in high-cost treatment areas that they realize will be abundantly utilized with a baby-boomer demand, such as

cardiology, orthopedics, gynecology, oncology, and neurology. Unless the vicious circle of the supply-demand relationship is understood, the baby-boomer retirement will place a possibly unsustainable burden on the U.S healthcare system. The hypothesis suggested here is, therefore, important. However, more work needs to be done to verify this.

B. FURTHER RESEARCH DIRECTION

A feedback loop perspective approach to diagnose distortions in the US healthcare system offers a further opportunity to explore the system behavior through software modeling and simulation. Building a SD model to capture logical stocks and flows of the structure and to simulate the system behaviors will enable managers, policy-makers and users to see the problem from a "big picture" graphically showing synthesis of the most significant fragments and their interactions over time. Moreover, a controlled experiment can be conducted to generate "what if" scenarios for deeper understanding of the system's behavior and the model validation. In addition, various policies can be developed and tested by running the SD model before it is implemented by way of "trial-and-error".

The model facilitates "double loop learning" where representing a "micro-world" facilitates the managers' learning process by means of conducting and assessing controlled experiments. Micro-world and double loop learning give managers more accurate feedback so that the managers can apply appropriate strategies, policies and business rules to meet the environment. The time and space issue can be reduced if not eliminated. The experiment time dimension can be accelerated or frozen as needed. This will be greatly beneficial for learners to capture dynamics of the problem within a limited amount of time.

C. RECOMMENDATIONS FOR MODELERS

A modeling process as outlined in Figure 1 serves as a guideline for a modeler to take further exploration of the scrutinized problem. By implementing a SD model, modelers must capture cause and affect structure within the

problematic system. Causal loop diagrams indicating stocks and flows of the system variables are created to reflect a causal relationship among variables. The diagram must cover principal system elements necessary to model the system structure. This report serves as a foundation for further development of a SD model. There are particular steps we recommend the modeler to approach.

Based on the Dartmouth Atlas of HealthCare data, researchers and modelers should select a particular region with a determined consistent set of data relevant to the healthcare provided. Next they should define the regional system capacity in terms of total volume available and variety of selected services provided. Furthermore they should define utilization of the available capacity in terms of volume consumed as well as variety of services offered. Third they need to come up with a rational model based on a causal relationship of principal elements in the healthcare causal loop diagram.

The next step should test behavior of quantitative and qualitative variables in the loop over time emphasizing the most significant forces that shape the dynamics of the loop processes. The behavior variables should be depicted on a diagram contrasting mutual interdependencies and progress of the variables' behavior over time considering delays. Dependence of the demand change based on change in the system capacity should be evaluated to find out whether there is a consistent pattern in mutual interactions of these two behaviors. Then a software model depicting a stock and flow structure of the healthcare system in the particular region could be built.

D. CONCLUSION

Discrepancies between high and low healthcare spending regions in the United States provides empirical evidence of a system behavior distortion. As the system's capacity increases over time the population tends to use it more, but, at the same time, they do not realize the stagnating level of potential benefits when using it. Patients being offered a higher volume and perceived quality of services create additional demand that over time stimulates capacity to increase even more. Research outcomes we based our report on did not prove that increased

utilization of the available capacity has prolonged the life span of the patients' in the Medicare sample. Since the range of potential life span of the current population is empirically determined, an ever-increasing healthcare capacity would not increase the life span alone; this would require adopting a healthier life style.

Indeed finding the right level of servicing the population would be a complex task even when assessing the results of modeling the healthcare market's most critical processes. Research suggestions tend to label regions with low spending and thus low demand as care benchmarks, therefore the above benchmark spending regions are service quantity multipliers. Different methods of premium payments, such as PPO, may decrease the demand burden in over the benchmark regions offering a negative incentive to the patients to use services (Glied and Remler, 2002). This approach, though, may encounter a serious resistance from the healthcare service suppliers arguing that consequent diminished demand would lead to patients' fear of care rationing. Additionally, regulatory approaches dealing with excess capacity have not succeeded, neither in terms of curbing the capacity excess nor in moderating ever-increasing demand.

Accountability for offering and utilizing capacity may be another option to balance the supply offered to the patients. Accountability means predominantly focusing on quality of clinical processes relevant to curing error and omissions and the establishment of shared decision-making. These should reduce unwarranted variations in care provision and lower pressure to increase capacity and thus widening the capacity gap.

Since an increase of provided healthcare has not shown any quantitative improvements in patents' lives except for more frequent re-entries to healthcare system facilities, the ever-increasing supply of capacity should be adjusted to the population's real needs rather than unrealistic expectations. Patients on the other hand should realize that their freedom to consume healthcare is limited by both their health utility and willingness to live a life style that may prevent excessive entries to the healthcare system.

Unfortunately, in achieving the optimal mutual interaction of supply of healthcare system services and demand for them, a causal loop structure seems to be an extremely complex problem. The problem's complexity involves the quantity and quality of the loop's principal variables and the momentum of the variables' interaction to achieve the balancing processes.

Despite recent advances, the problematic system complexity and a desperate need to find a viable solution provides healthcare researchers, economists, and system thinkers a fruitful field for further theoretical and empirical research. The Systems Thinking Approach outlined above provides a feasible tool to understand the dynamics of the US healthcare system processes in their logical and functional causal relationship.

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APPENDIX A

INTERVIEW

Interview, Steve Packer, M.D.-President/CEO Community Hospital of the Monterey Peninsula, Monterey, California, April 28, 2003.

Interview Questions:

- What would be your decision if you saw an increasing utilization in your hospital?
- What is your benchmark or matrix to determine whether the utilization is too high or too low?
- What are the mechanisms to add capacity in term of the financial aspect/ funding?
- How long does it take to add capacity/ law/ resources/ cost?
- Who decides to increase capacity? What is the decision making process?
- Do you see any competition in this region? What is your strategy for the market competition?
- Do the “baby boomers” have an influence on your decision to increase “capacity” in your hospital?

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