3.6 Potential Effects of Health Care Policy Decisions on Physician Availability

Potential Effects of Health Care Policy Decisions on Physician Availability

Christopher Garcia [1], Michael Goodrich [2]

Engineering Management and Systems Engineering [1], Modeling and Simulation [2]

Old Dominion University

cgarc001@odu.edu mgood028@odu.edu

Abstract. Many regions in America are experiencing downward trends in the number of practicing physicians and the number of available physician hours, resulting in a worrisome decrease in the availability of health care services. Recent changes in American health care legislation may induce a rapid change in the demand for health care services, which in turn will result in a new supply-demand equilibrium. In this paper we develop a system dynamics model linking physician availability to health care demand and profitability. We use this model to explore scenarios based on different initial conditions and describe possible outcomes for a range of different policy decisions.

1. INTRODUCTION

Towards the end of the 1990's, researchers had taken note of a declining trend in the number of available physicians [1]. This trend continues into the present, and new research has linked physician accessibility with quality of healthcare and has also suggested a link to health outcomes [2]. Amidst this trend, new health care legislation has recently passed [3] which is aimed at dramatically increasing the number of Americans with access to health care through a government competitor to private insurance. A change of this magnitude can be anticipated to have a significant effect on the provision of health care services and may potentially have many unintended consequences. Many important decision variables come into play including the number of people to insure, the tax levels, and the physician reimbursement levels, to name a few. From basic economic principles it follows that as a profession's profit decreases while its labor workload increases, that profession becomes less and less desirable resulting in a decreased labor force. In this paper we examine potential effects for a number of possible health care policy decisions on physician availability. We developed a system dynamics model to describe the introduction of a government competitor to private insurance. Using this model we begin with a control scenario and proceed to explore six different scenarios obtained by modifying different input parameters. Each scenario reflects a different policy dimension. We report the results and provide a discussion of the dynamics observed.

2. METHODOLOGY AND SCOPE

We developed a system dynamics (SD) model to explore the effects of introducing a government competitor to private insurance. This model aims to describe the inter-relationships between public and private insurance levels to total health care demand, tax levels imposed on physicians, physician profitability, physician workload, overall desirability of the profession, and overall physician supply. SD [5] is a continuous modeling and simulation paradigm based on fluid flows between reservoirs. In contrast to more common simulation paradigms (such as agent-based or discrete-event) which model behavior in terms of the individual entities, SD models behavior at the aggregate level. This makes it a very suitable paradigm for exploring high-level policy decisions. SD has been employed on a wide variety of policy studies in diverse areas such as health care [6], [7],

supply chain management [8], and organizational management [9].

In this study we develop a hypothetical control scenario based very loosely on the legislated policy change. In particular, we assume that at the scenario start (Jan. 1 2010), 60% of the US population is covered under private insurance. We assume that starting Jan. 1 2020 the government will mandate that 95% of the population be covered, either via private insurance or via a newly introduced public option. We then test six different treatments in isolation against the control: 1) High Physician Tax, 2) Low Physician Tax, 3) Low Government Reimbursement, 4) High Private Turnover, 5) High Government Dissatisfaction, and 6) High Long-Term Private Insurance Affordability. These treatments correspond to different policy decisions or effects of particular policy decisions, and are obtained by modifying certain input parameters from the control levels. Only treatments in isolation are considered; treatment interactions are not considered. The simulation horizon in each scenario is over a 50-year period, beginning on Jan. 1 2010 and ending on Jan. 1 2060.

This study does not attempt to predict what will happen as a result of the policy changes. Rather, it aims to understand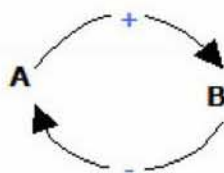 the dynamics that come into play by exploring a hypothetical set of scenarios loosely based on legislated policy changes. Furthermore, system dynamics by nature characterizes system behavior patterns at a very high level of aggregation. It is thus accurate, but not necessarily precise. As a consequence, the results of this study are not to be understood in terms of concrete quantities, but rather in terms of how the system will behave over time relative to the initial conditions.

3. SYSTEM DYNAMICS PRIMER

SD [5] is a continuous modeling and simulation paradigm based on fluid flows between reservoirs (referred to as stocks). Stocks are filled and emptied by inflows and outflows. Differential equations describe flow rates in and out of the stocks contained within the system. Two types of diagrams are commonly used in SD: 1) a causal loop diagram, and 2) a stock-and-flow diagram. The causal loop is purely a conceptual aid that identifies key system components and captures the positive or negative influences that different system components exert on each other. The stock-and-flow diagram is an executable simulation model that identifies the system stocks and flows, as well as specifies the different rates of flow. An example of each type of model is shown in Figure 1 and 2 below:
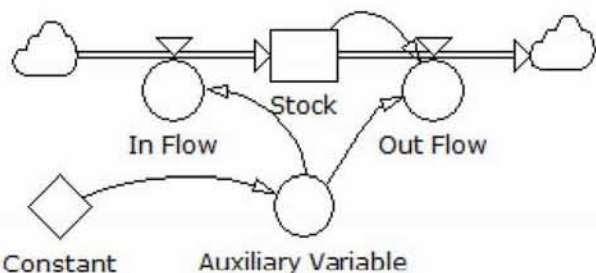

Fig. 1: A causal loop diagram

Fig. 2: A stock-and-flow model

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In Figure 1, the positive arrow going from A to B indicates that as A increases, B increases. Similarly, the negative arrow indicates that as B increases, A decreases. In Figure 2, stocks are symbolized by boxes and flows by the pipes going in and out of stocks. The clouds represent infinite sources (going in) and sinks (going out). The in- and out-flow rates are determined solely by the flow valves (represented as circles with triangles on top). However, the flow rates can be based on virtually any pertinent component, including stocks, auxiliary variables (represented as circles), and constants (represented by diamonds). This enables fully dynamic relations between system components to be modeled. Arrows represent input into flow rates or auxiliary variables, which are specified as rate equations based on the inputs. For example, 'Auxiliary Variable = Constant * 5/Year', or 'Out Flow = 0.5 * Stock * Auxiliary Variable/Year'.

4. SYSTEM MODEL

We begin the modeling with a causal loop diagram and proceed to use this diagram to develop a full stock-and-flow model. In reality there are a vast number of factors that may have an effect on the healthcare system. However, out of practical concern we restrict the scope of our modeling to capture the interaction of only the key variables we are interested in. The causal loop diagram is shown in Figure 3. In this model the government plan is assumed to be a competitor to private insurance; consequently, they negatively influence each other. However, an increase in either category will increase the demand for healthcare services. An increase in the government insured level will also presumably increase the level of taxes on physicians, which will decrease profits. An

increase in the government insured level may also directly decrease profits if the government limits physician reimbursement levels, as has been done with Medicaid [4].
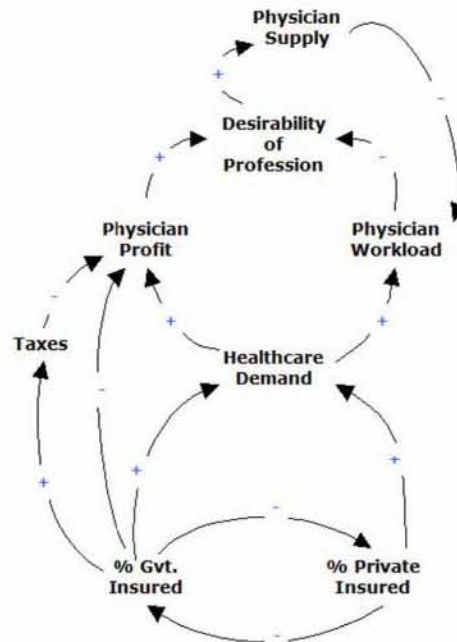

Fig. 3: Causal loop diagram

As healthcare demand increases physician profits will increase through increased revenues; however, their workload will also increase. Intuitively, an increase in profits will positively influence the desirability of the medical profession, while an increased workload will negatively influence it. Similarly, the desirability of the profession will positively influence the physician supply. Finally, an increase to physician supply can be expected to decrease physician workload through load balancing.

The stock-and-flow model is shown in Figure 4. As can be observed, this model has a fairly large number of variables and interactions. It is thus infeasible in this length-limited paper to provide a detailed

description of all components. Therefore, we provide a model overview emphasizing aspects most directly related to physician supply. More detail (including equations used for each variable) can be obtained by contacting the authors.
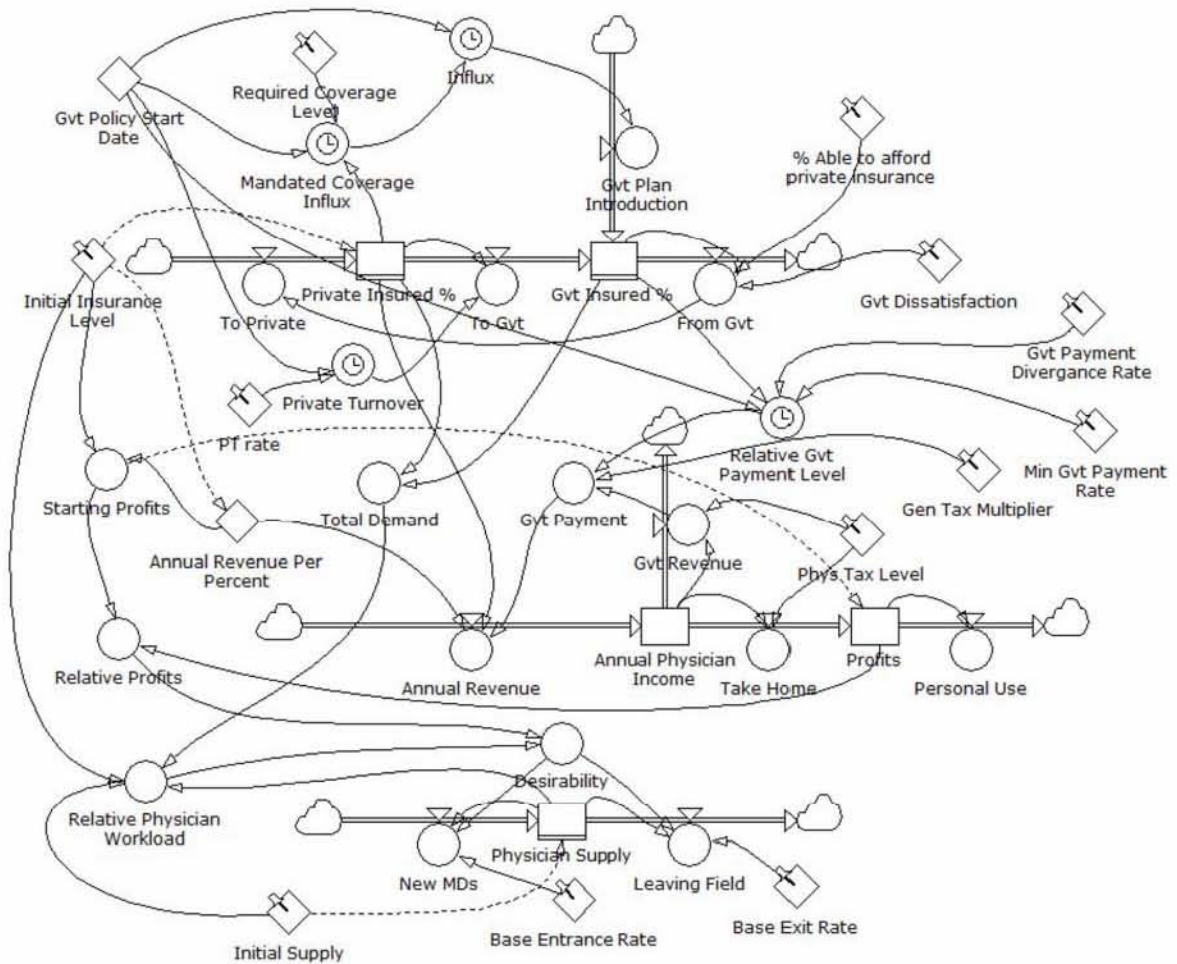
Fig. 4: Stock-and-flow model

In this model, the diamonds with a thumb tack on them are user-adjustable input parameters. The percentages of private and government-insured Americans are modeled as stocks. A certain percentage of the population flows between the private and government insured; however, this does not begin to occur until the policy enactment date (Jan. 1 2020 in this simulation). At this time there will be an influx of newly insured (equal to the difference in mandated insured percentage minus the current private insured level), presumably into the government plan. The auxiliary variables shown with clocks designate that they utilize the start date as input.

Physician incomes and profits are also represented as stocks. In this study we are not interested in the actual amounts of revenues or profits; we are only interested in the changes in these quantities relative to the starting level. We thus use a normalized value for physician income and profit,

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initially set to 1. As can be seen, physician revenues have two basic sources: public and private insurance. In order to model the potentially limited level of government reimbursement (compared to private insurance) we utilize a "Relative Government Payment Level" variable. This starts the government reimbursement level at 100% of the private level at the start of the policy enactment, and gradually decreases it by a specified percent each year (specified by the "Gvt. Payment Divergence Rate" constant) until the terminal level is reached (specified by the "Min Gvt. Payment Rate" constant). In this model we are only concerned with the effects of taxes on physicians (as opposed to the general population). Thus, we use two constants, "General Tax Multiplier" and "Annual Revenue per Percent" to initialize the normalized revenue to 1. Ultimately, the physician tax level is an independent variable that can be set directly by policy makers. Consequently, we model this as an input constant rather than something determined by emergent system behavior.

Finally, the physician supply is determined by the profession desirability. It is difficult to objectively quantify desirability. However, increased desirability must increase the number of incoming and decrease the number of outgoing physicians. Thus, in terms of this study desirability is defined as the relative profit divided by the relative workload. The relative profit is defined as the current profit level divided by the starting profit level, and the relative workload is defined as the current workload divided by the starting workload. The notion of desirability only makes sense when compared to a starting frame of reference. As a consequence, starting profit and workload levels are set to 1, which initializes

the desirability to 1. Values higher than 1 thus indicate a higher-than-starting desirability; values less than 1 indicate a lower-than-starting desirability. Physician supply is represented as a stock, initially set to 300,000. Physician supply inflow and outflow is determined by desirability, a constant base entrance/exit rate, and current physician supply level, where

(1) New MDs = Physician Supply * Desirability * Base Entrance Rate

(2) Leaving Field = Physician Supply * (1 / Desirability) * Base Exit Rate

Base entrance/exit rates were set to 2% per year. Thus, an increase in desirability will increase the rate at which new physicians enter the field and slow the exit rate, while a decrease will have exactly the opposite effect.

5. EXPERIMENT DESIGN

We used the Powersim software package to build our simulation model and execute a sequence of scenarios. Using our model, we first developed a relatively stable control scenario. We then proceeded to test six different treatments individually and compare them against the control: 1) High Physician Tax, 2) Low Physician Tax, 3) Low Government Reimbursement, 4) High Private Turnover, 5) High Government Dissatisfaction, and 6) High Long-Time Private Insurance Affordability. These treatments were obtained by modifying certain input parameters from the control levels. We only considered treatments in isolation rather than considering treatment interactions. The parameters for each scenario are shown in Table 1. In non-control scenarios, only parameters that differ from control levels are specified.

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| | Scenario | | | | | | |
Parameter	Control	Hi Tax	Low Tax	Low Gvt Payment	High Private Turnover	High Gvt. Dissatis-faction	High Affordability of Private Insurance
Required Coverage	0.95						
Initial Insurance Level	0.6						
Private Turnover	0.52				0.8		
Gvt. Dissatisfaction	0.52					0.7	
% Able to afford private insurance (Long term)	0.15						0.5
Min Gvt. Payment Rate	0.9			0.6			
Gvt. Payment Divergence Rate	0.15						
Phys Tax Level	0.4	0.6	0.2				
Gen Tax Multiplier	0.5						
Base Entrance Rate	0.02						
Base Exit Rate	0.02						

Table 1: Experiment parameter settings

In each scenario the same values were used for mandated (required) coverage level, initial insurance level, general tax multiplier, government payment divergence rate, and base entrance/exit rates. Additionally, the normalized revenue and profit levels were set to the initial values of 1, and the physician supply stock was initialized to 300,000. The private insured stock was set to the initial coverage level of 0.6 (corresponding to 60% of the population) and the government insured was initialized to 0. Each scenario had a start date of Jan. 1 2010, with a policy enactment date of Jan. 1 2020. Finally, each scenario had a simulation horizon of 50 years, ending on Jan. 1 2060.

6. RESULTS AND DISCUSSION

The simulation results are summarized in Table 2. As can be seen in the results, a common feature of each scenario is a spike in both the number of physicians and the physician workloads at the onset of the new policy enactment. Because in each scenario the government reimbursement begins at 100% of the private rate, there is a corresponding increase in profits at the start of the policy change. This appears to be due to sheer increase in revenues resulting from the increased demand.

As time moves forward into the future, the diverging effects of different treatments can be seen. The control results in a relatively stable increase in physician supply corresponding to the increase in demand. High physician taxes, low government reimbursement, and high private turnover result in increased physician workloads and decreased physician supply. Of these three, a low government reimbursement rate appears to induce the strongest decline in physician availability. By contrast, low physician taxes, high government

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dissatisfaction, and high private insurance affordability lead to increases in physician supply and decreased workloads, with the last of these producing the strongest effect.
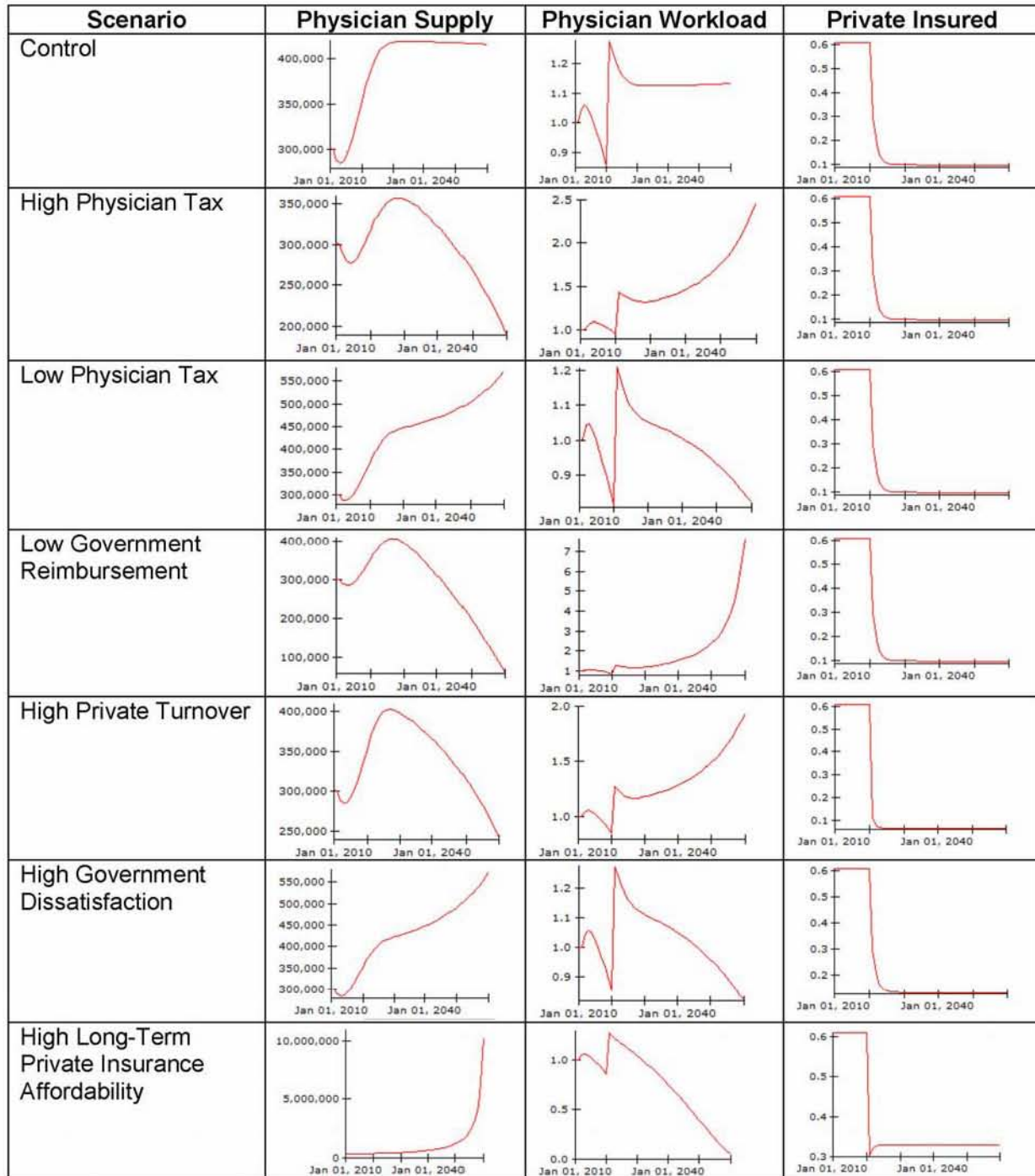
Scenario	Physician Supply	Physician Workload	Private Insured
Control			
High Physician Tax			
Low Physician Tax			
Low Government Reimbursement			
High Private Turnover			
High Government Dissatisfaction			
High Long-Term Private Insurance Affordability			

Table 2: Summary of simulation results

Several of these results appear to be counterintuitive, particularly 1) the high government dissatisfaction leading to increased physician supply, and 2) the disproportionately strong effect of high long-term private insurance affordability. High government dissatisfaction results in a larger number of people able to afford private coverage that choose that option. This increase in privatization leads to higher profits from lower numbers of government-limited reimbursements. The disproportionately strong effect of private insurance affordability is probably due to the control calibration of the "General Tax Multiplier" and "Annual Revenue per Percent" constants, as well as not including other limiting factors (e.g. medical school capacities) in the model. Although the numbers shown are not necessarily precise, they do give a reasonable indication of the emergent system behavior.

In summary, the results indicate that decisions which increase physician profits will increase physician availability, while those that decrease profits will decrease physician availability.

7. CONCLUSIONS

In this paper we have developed a system dynamics model of a government competitor to private insurance. We utilized this model to explore a potential outcomes based on different types of policy decisions or effects. This was accomplished by developing a set of hypothetical scenarios very loosely based on the newly legislated policy changes. We found that in general, decisions that result in increased physician profits will increase physician availability, while those that decrease profits will have the opposite effect.

8. REFERENCES

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[3] H.R. 4872 (2010). *The Reconciliation Act of 2010*.

[4] H.R. 3962 ENR (2010). *Preservation of Access to Care for Medicare Beneficiaries and Pension Relief Act of 2010*.

[5] Sternman, J.D. (2000). *Business Dynamics: Systems Thinking and Modeling for a Complex World*. New York: McGraw Hill.

[6] Sardiwal, S. (2007). "Conceptualization and formulation of a UK health and social care system using System Dynamics", Proceedings of the 25th Annual Conference of the System Dynamics Society, Boston, MA, July 29-August 2, 2007.

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[8] Bijulal, D. and Venkateswaran, J. (2008). "Closed-Loop Supply Chain Stability under Different Production-Inventory Policies", Proceedings of the 26th Annual Conference of the System Dynamics Society, Athens, Greece, July 20-24, 2008.

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Potential Effects of Health Care Policy Decisions on Physician Availability

Christopher Garcia
Michael Goodrich
Old Dominion University

Agenda

- Introduction
- Study Scope & Methodology
- System Dynamics Primer
- System Model
- Experiment Design
- Simulation Results & Discussion
- Questions

Current Trends in Physician Availability

- Late 1990's
  - Researchers noticed that physician levels were declining [1]
- More recently
  - Trend has continued into the present (2010)
  - Shown to affect the quality of care [2]
  - Suspected to negatively affect health outcomes [2]
- Bottom line
  - Trend appears to be problematic

Changes to Health Insurance Legislation

- New health care bill signed March 2010
  - HR 4872
- Major changes to health care system
  - Extend coverage to 32 million individuals
  - Mandate approx. 95% of population coverage
  - Create public insurance plan
    - Competitor to private insurances
  - Tax "Cadillac" private plans
- What might new policies do to physician availability?

Scope and Methodology of Study

- Purpose
  - Investigate potential effects of (relevant) policy decisions on physician availability
  - Demonstrate how to model a system for high-level policy analysis using system dynamics
- Approach
  - Build simulation model of public plan introduction
  - Devise set of scenarios reflecting different policy decisions or effects
  - Run model under each scenario

Study Limitations

- NOT intended to predict what will happen
  - Just understand how different policies/effects can affect physician availability
- Scenarios are PURELY hypothetical
  - Very loosely based on legislation
- Understand general system behavior rather than precise numbers
  - Relative to starting conditions

System Dynamics Primer

- SD is a continuous, macro-level M&S paradigm

Agent-Based	Discrete-Event	System Dynamics
Highly Discrete	Discrete	Continuous
Micro, Agent-Level	Mid, Interaction Level	Macro, Aggregate Level
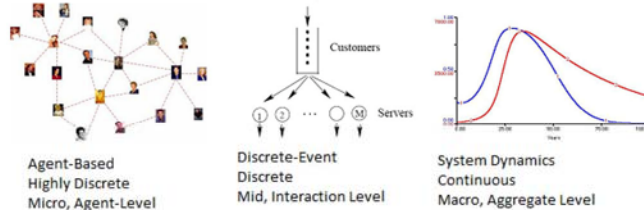
- Model a system of differential equations
- Basic Constructs:
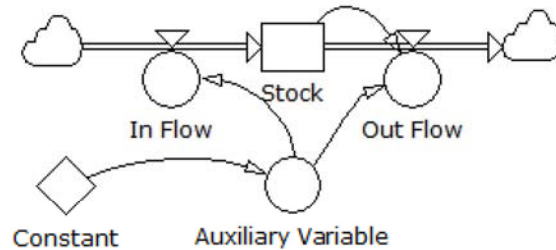 - Stocks (Reservoirs)
  - Flows (Pipes going in and out of stocks)

Causal Loop Diagram

- Preliminary, purely a conceptual aid
  - Identifies important system components
  - Identifies positive & negative mutual influences
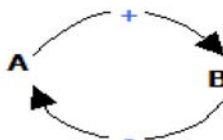
- Increase in A ➜ Increase in B
- Increase in B ➜ *Decrease* in A

Stock-and-Flow Model

- Executable simulation model
- Simulate a system as "Fluid Flows" over time
- Model flows & auxiliaries with equations
  - Auxiliary Variable = Constant * 5
  - Out Flow = 0.5 * Stock * Auxiliary Variable/Year
  - Etc.

Health Care System Modeling

- Basic Considerations
  - Concerned ONLY with effect of policy decisions on physician availability
  - Identify MAIN factors at play
  - Many things affect outcome, but DO NOT clutter model with non-key pieces
- Basic Assumptions
  - Would-be doctors have many career possibilities
  - Insufficiently rewarding profession will cause them to go elsewhere

# Health Care Model: Causal Loop
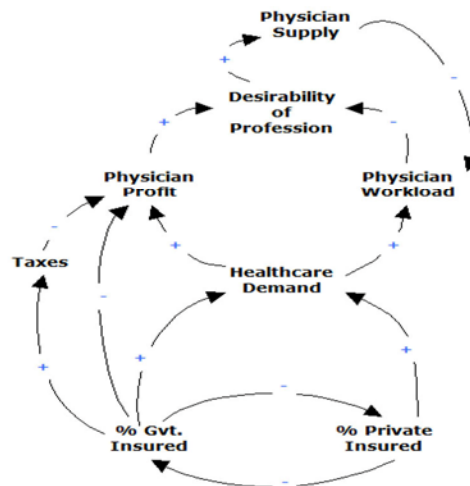
HC Stock-and-Flow: Main Aspects

- Three basic "subsystems":
  - Private/Government Insurance Levels
  - Revenue & Profit Flow
  - Physician Supply & Desirability
- All subsystems influence each other
- Fairly complex model

# Full HC Stock-and-Flow Model
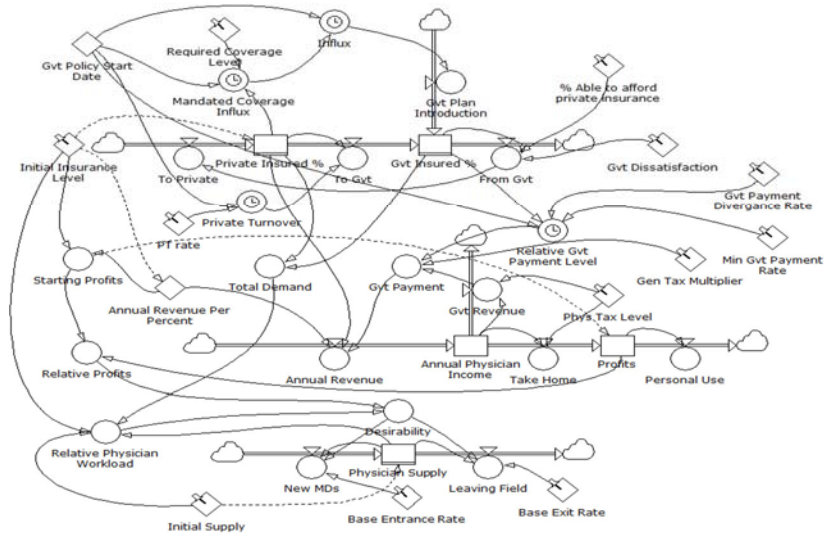
Insurance Level Subsystem

- Mandated 95% of population flows back back & forth starting at policy enactment date
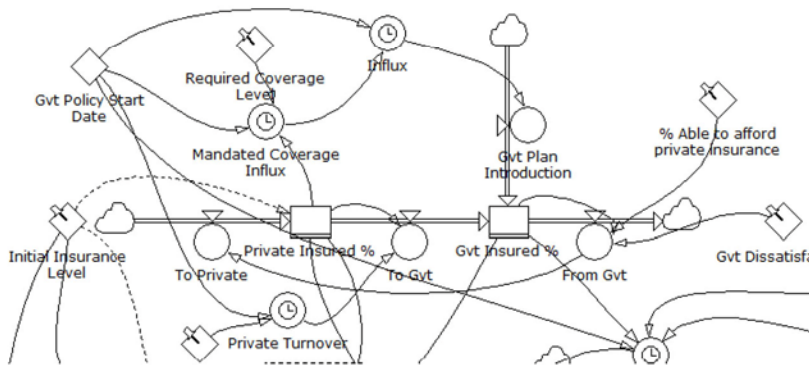
Revenue Subsystem

- Physician income has 2 sources: public, private
- Consider only effect of *physician* taxes in this model
  - Controllable input, not emergent behavior
- Phys. tax level affects Profits & Amt. that goes back to government
  - Use "General Tax Multiplier" to represent rest of population, get sustainable tax revenues
- Government may limit reimbursements
  - Medicare-style limitations
  - Assume that Government starts out at 100% reimbursement at policy start
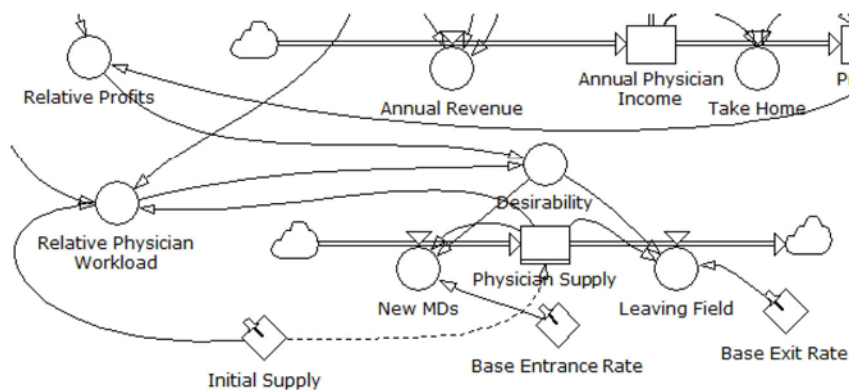 - Gradually decrease until terminal level reached

Revenue Subsystem (cont.)
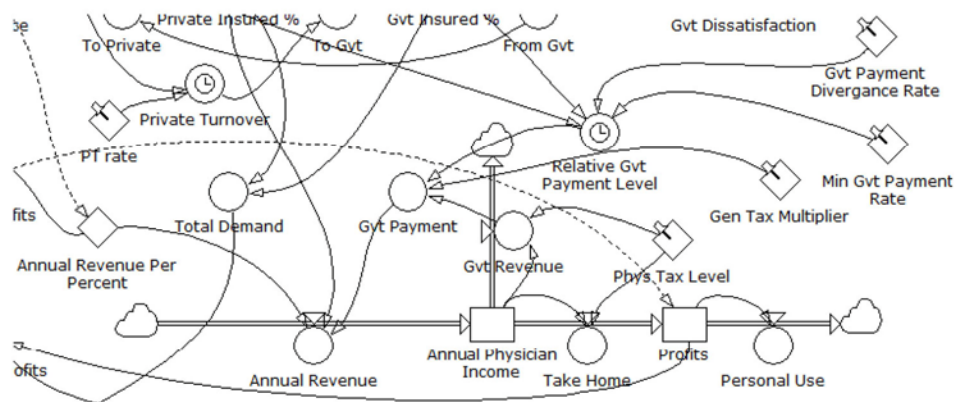
Revenue Subsystem (cont.)

- Interested only in *relative* change in income/profits over time
  - ▫ Do levels go up or down over time?
  - ▫ Not interested in actual numbers
- Set initial revenue & profits to normalized value of 1
  - ▫ > 1 ➜ Higher than start
  - ▫ < 1 ➜ Lower than start

Physician Supply/Desirability

Physician Supply/Desirability (cont.)

- Desirability = Relative Profit / Relative Workload
- Rel. Profit = Current Profit / Start Profit
  - Same for Relative Workload
  - Starting Profit & Workload = 1 (Normalized)
- Increased Desirability → More inflow, Less outflow
  - Supply Inflow = Desirability * Base Entrance Rate * Current Physician Level
  - Supply Outflow = (1 / Desirability) * Base Exit Rate * Current Physician Level
- Start with 300,000 physicians
- Interested in *behavior over time*, not numbers

Experiment Design

- Begin with relatively stable control scenario
  - Reasonable guess to determine input parameters
  - OK because we are comparing to treatments, not estimating or predicting
- Investigate 6 different treatments (i.e. policy decisions or effects) in isolation
  - Each obtained by modifying single input parameter from control level
  - Each treatment in its own scenario
  - No treatment interactions/combined effects
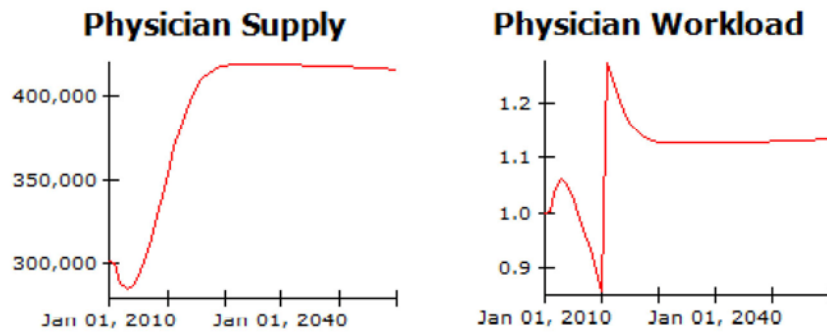
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Hypothetical Base Scenario

- 60% of Americans with private insurance now
- Mandated 95% coverage, starting Jan. 1 2020
- Government-based insurance
  - Competitor to private insurance
- 50-year simulation horizon
  - Start on Jan 1. 2010
  - End on Jan. 1 2060
- Modify base scenario to reflect different policy decisions, see what happens
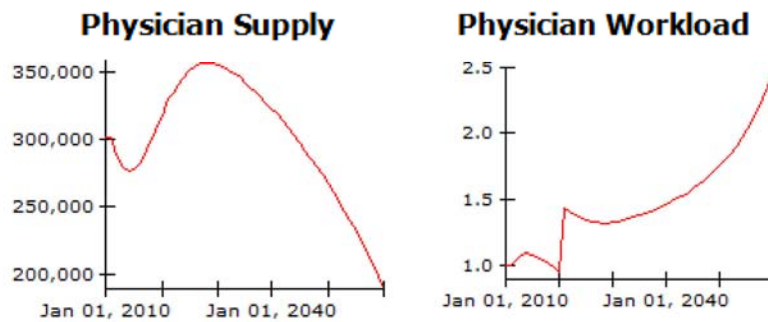
Experimental Treatments

- High Physician Taxes
- Low Physician Taxes
- Low Government Reimbursement
- High Private Insurance Turnover
  - Also mimics low private affordability at start
- High Government Dissatisfaction
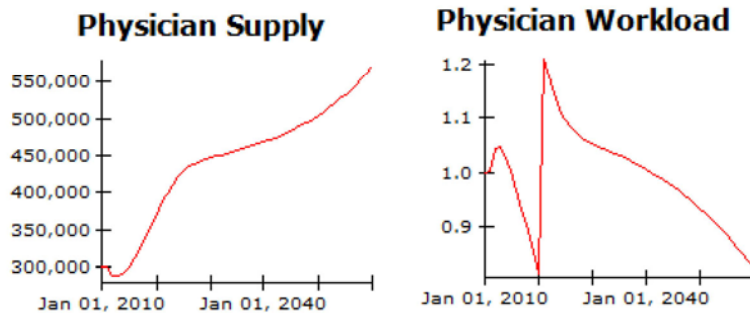- High Long-Term Affordability of Private Insurance

Control Scenario

Physician Supply

400,000
350,000
300,000
Jan 01, 2010   Jan 01, 2040

Physician Workload

1.2
1.1
1.0
0.9
Jan 01, 2010   Jan 01, 2040

High Physician Taxes

- Phys. Tax Level = 0.6 (60% vs. 40% control)

Physician Supply

350,000
300,000
250,000
200,000
Jan 01, 2010   Jan 01, 2040

Physician Workload

2.5
2.0
1.5
1.0
Jan 01, 2010   Jan 01, 2040

Low Physician Taxes

- Phys. Tax Level = 0.2 (20% vs. 40% control)

Physician Supply

Physician Workload

Low Government Reimbursement

- Min Gvt. Payment = 0.6 (60% vs. 90% control)

Physician Supply

Physician Workload

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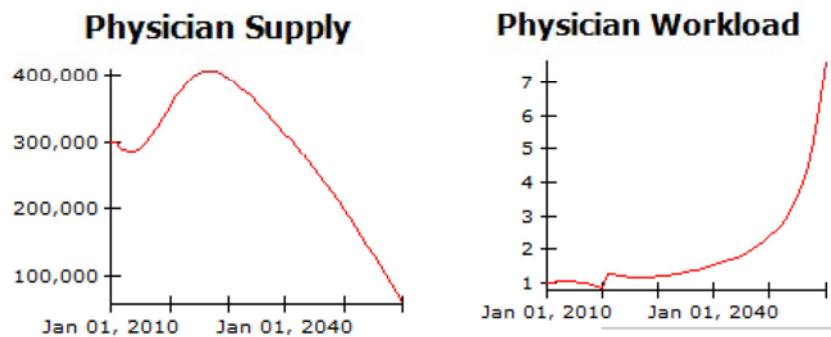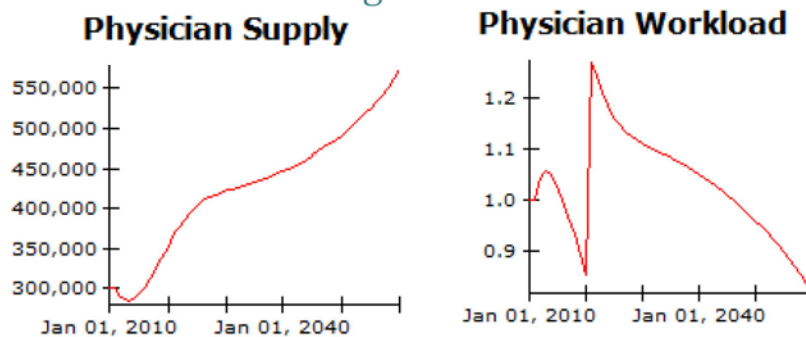
High Private Turnover

- Private Turnover = 0.8 (80% vs. 52% control)
  - Mimics effect taxing "Cadillac" plans, etc.

Physician Supply

Physician Workload
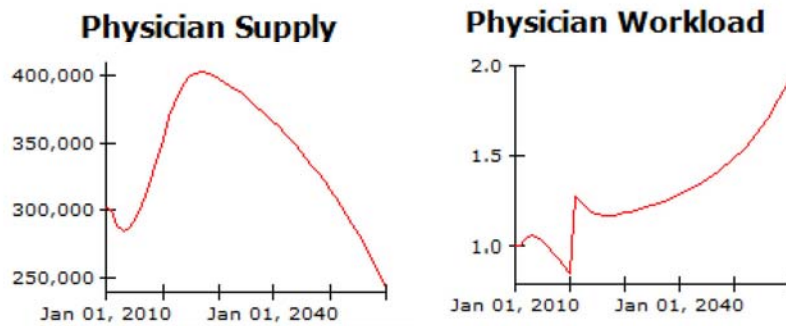
High Government Dissatisfaction

- Gvt. Dissatisfaction = 0.7 (70% vs. 52% control)
  - Dissatisfaction enough to sacrifice for Pvt. Ins.
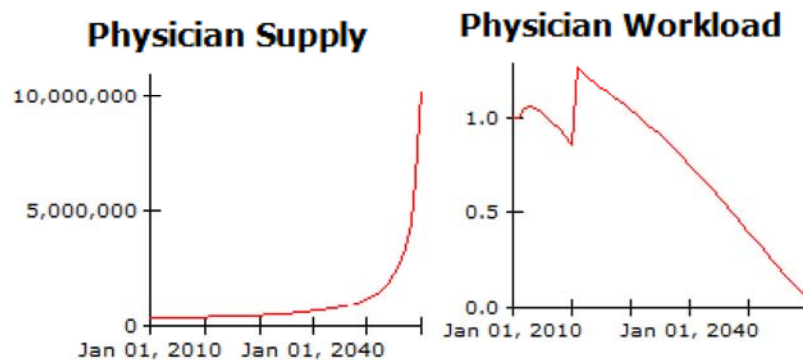
Physician Supply

Physician Workload

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Explanation: High Gvt. Dissatisfaction

- Counterintuitive result
- Assumes government limits reimbursement to 90% in long run
- More Gvt. Dissatisfaction → More Private
- More Private → Lower levels of limited reimbursement
- Bottom line:
  - Increase in supply linked to limited reimbursement

High Private Insurance Affordability

- Able to Afford Private Insurance = 0.5 (vs. 15%)

Physician Supply

Physician Workload

Explanation: High Private Affordability

- Clearly unrealistic increase in Physician Supply
- Model does not include many relevant limiting factors:
  - Number of eligible candidates
  - Medical school capacities
  - Etc.
- More Private → Lower levels of limited reimbursement → More Profit → More Physicians

Discussion

- Results in More Doctors :
  - Low Taxes (1), High Gvt. Dissatisfaction (2), High Private Ins. Affordability (3)
- Results in Less Doctors:
  - High Taxes (4), Low Gvt. Reimbursement (5), High Private Turnover (6)
- (2) & (3) increase is accounted for by reduction in number of limited reimbursements
- (5) & (6) decrease trace to increased reimbursement limits

Conclusions

- Positive or negative outcomes are both possible
- Expected spike in demand & physician workload
  - Increased demand will persist
  - Workload will go up or down based on Dr. supply
- Limiting reimbursements has strongly negative effect on physician supply
- Policymakers should aim to:
  - Find ways to increase physician profits
  - Decrease physician workloads

Questions?

- Thanks everybody!

Appendix 1: Control Parameter Settings

Parameter	Control Setting
Required Coverage	0.95
Initial Insurance Level	0.6
Private Turnover	0.52
Gvt. Dissatisfaction	0.52
% Able to afford private insurance (Long term)	0.15
Min Gvt. Reimbursement Rate	0.9
Gvt. Payment Divergence Rate	0.15
Phys Tax Level	0.4
Gen Tax Multiplier	0.5
Base Entrance Rate	0.02
Base Exit Rate	0.02