Mathematical Modeling And Public Policy: Preparing Students To Participate In The Debate

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We hope to inspire students to use and develop math models by taking advantage of teaching opportunities associated with debates on contemporaneous policy issues. In the aftermath of the October 2013 government shutdown, we developed several applications centered on the themes of deficit spending, national debt, and the Affordable Care Act (heretofore referred to as ACA).[2] In this short paper, we highlight material that can be used to help students discover and model the issues related to health care reform. The applications focus on models of moral hazard and asymmetric information in insurance markets.

Introduction. We, along with several other members of our department, teach an introductory math class, Mathematical Modeling and Introduction to Calculus (MA-103), that is required for roughly three-fourths (850 students) of the entering freshman cohort. Last fall, the impact of the government shutdown was tangible to our students because civilian instructors were placed on involuntary furlough for two weeks. The furlough was the immediate consequence of sequestration, or mandatory spending cuts, imposed when Congress failed to pass a federal budget on time. The public debates related to the government shutdown gave us the unique opportunity to introduce students to some of the issues including deficits, national debt, and health care reform. Though the primary issue was whether Congress would pass its annual appropriation and authorization bills, the political actors often made arguments related to long-term drivers of deficit spending and national debt accumulation. Specifically, some claimed that implementation of the ACA would drive deficits, and thus the national debt, to unsustainable levels.

The philosophy of MA-103 is to introduce mathematical modeling tools while requiring students to solve problems they likely haven't seen before (and for which they aren't likely able to find approved solutions on the internet!). We like to think of our approach as "just-in-time" mathematics where we focus on applications in which students develop their understanding of math tools as they solve problems of contemporaneous value. The topical content of the course includes discrete math, matrix algebra, and an introduction to differential calculus. More important than the topics is the approach.

[1]The views expressed in this article are those of the authors and do not reflect the official policy or position of the US Military Academy, the Department of the Army, the Department of Defense, or the US Government.

[2]The ACA was signed into law in 2010, and was scheduled to be implemented beginning in October 2013.

In our experience, covering a list of topics in a course is usually not been the best method to engender student learning. Though we design our applications to (hopefully) draw out the math topics we would like to cover, our hope is to expose students to the practice of self-search and self-discovery of rational methods to understand and solve problems. We confront students with what we think are compelling issues, and then we help guide them through the development of tools to explore, analyze, and understand the issues. Since each student gets issued a laptop computer at the beginning of the semester, we are able to integrate the use of a spreadsheet software program and a computer algebra system to enable students the chance to rapidly iterate through various modeling choices.

We want to help students understand the role of health care reform in the context of debates about the federal budget. We highlight some of the rhetoric, explore some of the facts, introduce some models to explore the issues, and iterate by adding some complexity to the discussion. Our desire is to encourage students to pursue understanding rather than accept the rhetoric at face value. Technology is the enabler that allows us to attack these types of compelling problems while using real data and exploring the implications of making different modeling assumptions.

Grab Their Attention.

Figure 1. "Door Jam" by political cartoonist Randy Jones. Available at www.cagle.com.

Rhetoric from the right tends to focus on the "excessive" tax and spend preferences of liberals, which, the right argues, lead to the unwarranted expansion of government influence in private life. The right often argues that tax and spend policies create unsustainable financial burdens for future generations. Traces of these arguments can be seen in the following excerpts related to health care from the 2012 Republican Party Platform.

> "...Obamacare was never really about healthcare, though its impact upon the nation's health is disastrous...it was about power, the expansion of government control over one sixth of our economy, and resulted in an attack on our Constitution, by requiring that U.S. citizens purchase health insurance."

> "It [the ACA] was the high-water mark of an outdated liberalism, the latest attempt to impose upon Americans a euro-style bureaucracy to manage all aspects of their lives."

> "It [the ACA] would tremendously expand Medicaid without significant reform, leaving the States to assume unsustainable financial burdens."

Rhetoric from the left tends to focus on the non-egalitarian preferences of conservatives, which, the left argues, provide tax relief for the wealthy while granting unchecked power to corporate agglomerates. The left often argues these free-market preferences sometimes cause Americans to go broke because they get sick while allowing health insurance providers to cancel policies or deny coverage for unmerited reasons. Traces of these arguments can be seen in the following excerpts from the 2012 Democratic National Platform.

> "We believe accessible, affordable, high quality health care is part of the American promise, that Americans should have the security that comes with good health care, and that no one should go broke because they get sick."

> "We are committed to defeating efforts that would return us to the failed economic policies of the past, in which tax relief for the wealthy explodes the deficit and asks the middle class to shoulder that burden."

> "We refuse to go back to the days when health insurance companies had unchecked power to cancel your health policy, deny you coverage, or charge women more than men."

The Republicans claim that Democrats are addicted to unaffordable and unsustainable spending. The Republicans further argue that widespread expansion of health insurance coverage, like that mandated by the ACA, will sustain deficit spending, increase national debt, and bankrupt future generations. The Democrats claim that Republicans want to cut programs that benefit children, the elderly, and the infirm and in the process suppress medical research and stifle economic growth.[3] In the fall of 2013, these differences came to a head when the Republican controlled House of Representatives held up the federal spending bills while demanding changes to the ACA.

Question 1 *How does the health care system in America impact deficit spending and the accumulation of national debt?*

Question 2 *Why are Republicans so concerned about deficits and the national debt?*

Question 3 *Are there any legal restrictions that prevent Americans from purchasing health insurance? Why do Democrats claim that all Americans don't currently have access to health care?*

[3] See *America the Beautiful*, by Ben Carson, p.108-109 , January 24, 2012.

Search for Facts. Each year, the Internal Revenue Service publishes a chart displaying the federal government's annual income and outlays. This chart can be found in the Form 1040 Instruction Booklet. In 2011, this chart showed that outlays exceeded income by nearly 57%, while spending on social programs, spending on programs for physical, human, and community development, and spending on entitlement programs like Social Security and Medicare accounted for approximately 68% of outlays. Thus, the deficit in 2011 was rather large and federal spending on things like health care may have been a significant contributor to the size of the deficit. The Form 1040 Instruction Booklet provides an easy-to-access annual snapshot of the federal budget. For a better long-term view, we encourage students to search for data from the non-partisan Congressional Budget Office (CBO). Students can create the following chart for themselves in Microsoft Excel using historical budget data downloaded from CBO's website.

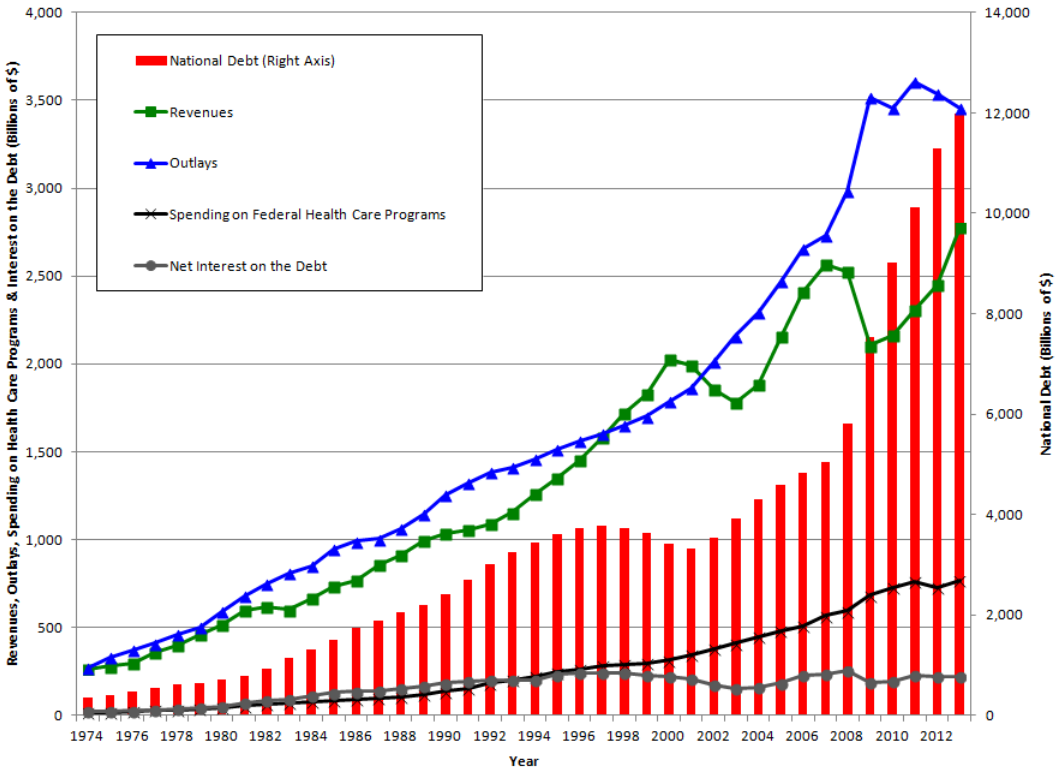

Figure 2. The federal budget and national debt since 1974 (not adjusted for inflation). Source: Congressional Budget Office (www.cbo.gov), Historical Budget Data, April 2014 Release.

Students can observe several facts from this data. First, spending has exceeded revenues since 1974 in every year except a four-year period in the late 1990s. Deficit spending has been common under both Democratic and Republican administrations. Second, the national debt has been growing since 1974, and the rate of growth seemed to accelerate after 2008. However, interest payments on the national debt have remained relatively constant since the early 1990s. Third, federal spending on health care programs, including Medicare (net of offsetting receipts), Medicaid, and the Children's Health Insurance Program has

grown substantially, in levels and as a proportion of overall spending, since 1974.

Question 4 *How do you think the trends observed in Figure 2 might be different if the data were adjusted for inflation? How do you think the trends observed in Figure 2 might be different if we graphed the series in terms of percent of Gross Domestic Product (GDP)?*

Given the observed trends in historical data and projections about the aging of the population (see Wattenberg and Yankovich, "The Government Shutdown and Sequestration: Making Lemonade Out of Lemons"), we might want to estimate what will happen with deficits, the debt, and health care spending in the future. Out-of-sample predictions can be fraught with estimation and interpretation challenges; nonetheless, we ask students to explore some of the projections that exist. For example, the Government Accountability Office (GAO) Citizen's Guide from 2007 projects that mandatory spending will exceed government revenues sometime between 2030 and 2040 with most of the growth in mandatory spending coming from projected increases in health care spending and for interest payments on the debt.[4] If this projection turns out to be valid, then the threat of default and bankruptcy is plausibly realistic. CBO's projection as reported in *The 2013 Long-Term Budget Outlook* predicts that by 2038 spending to cover net interest on the debt will comprise 4.9% of GDP, up from 1.3% in 2013, and federal spending on major health care programs will comprise 8% of GDP, up from 4.6% in 2013. Though this projection suggests continued growth in outlays on interest and health care, the threat of default and bankruptcy seems less imminent according to the CBO.

Question 5 *How has the amount of spending per person on health care changed over the last 40 years? How do you think the amount of spending per person on health care will change in the next 40 years? Identify the types of information you would like to gather and assumptions you might need to make to estimate a reasonable prediction.*

There are several other interesting facts about health care in the United States that students might want to explore. For example, the federal government is not the only entity that spends money on health care. In 2011, approximately 53% of total spending on health care was made by individuals as out-of-pocket expenses or by private health insurance companies.[5] Also, future growth in total spending on health care is not likely to be solely explained by changing demographics. Studies of data on health care spending between 1940 and 1990 suggest that aging of the population only accounted for two percent of growth in real per capita spending on health care whereas changes in third-party payment systems, increases in personal income (and thus demand for health care services), prices in the health sector, and administrative costs accounted for roughly 10 to 13, 5 to 18, 11

[4]Mandatory spending includes outlays required by existing law. For example, payments to cover interest on the debt and funding to pay for the major entitlement programs like Medicaid, Medicare, and Social Security are considered mandatory spending items. Discretionary spending, which must be authorized annually through appropriation bills passed by Congress, includes outlays on things like national defense, transportation, agriculture, and other enforcement and regulatory programs.

[5]Congressional Budget Office, *The 2013 Long-Term Budget Outlook*, September 2013 release, available at http://www.cbo.gov/publication/45308.

to 22, and 3 to 13 percent of growth, respectively. These studies indicate that a significant proportion of spending growth was unexplained by observed variables.[6] Another study of similar data indicated that unexplained factors accounted for at least 65 percent of the growth in per capita health care spending.[7] Newhouse characterizes these unexplained factors as technology-related changes (improvements?) in medical practice.

Cost growth in health care spending is not just a U.S. phenomenon. Between 1960 and 2007, health care costs as a percent of GDP nearly doubled in most European and Anglophone nations.[8] However, health care spending as a percent of GDP nearly tripled over the same time period in the U.S. Further, health outcomes in the U.S. lag those of most of the other developed nations. For example, per capita spending on health care in the U.S. is about $7,437 while the infant mortality rate is 5.9 (deaths of infants under one year old for every 1,000 live births) and life expectancy is 78.1 years. In Australia, per capita spending is $3,353 while the infant mortality rate is 4.5 and life expectancy is 81.4 years.[9]

Question 6 *Explore the data on health statistics at the OECD website. Select 5 to 10 countries, including the U.S., Canada, England, and construct a table listing the life expectancy, infant mortality rate, per capita expenditure on health, health care costs as a percent of GDP, health care spending as a percent of government revenue, and percent of total health costs paid by the government for each country. What observations can you make from differences in the observed data across countries?*

The health care debate isn't just about budget deficits and national debt. Another relevant fact is that a significant portion of the U.S. population does not have health care insurance. Polling data from Gallup for the years 2009 to 2013 indicates that an average of roughly 18% of adults aged 18 and older were not insured between 2009 and 2013.[10] In 2010, approximately 47.5 million Americans under the age of 65 did not have health insurance. Individual choice is likely to be a contributing factor. However, Census Bureau estimates indicate that nearly 31% of the population with incomes at or below 138% of the poverty line are uninsured.[11] This suggests that poverty, or affordability, likely plays a significant role in explaining why so many people don't have health insurance.

[6] See Sheila D. Smith, Stephen K. Heffler, and Mark S. Freeland, "The Impact of Technological Change on Health Care Cost Increases: An Evaluation of the Literature (working paper, 2000) and David M. Cutler, "Technology, Health Costs, and the NIH" (paper prepared for the National Institutes of Health Economics Roundtable on Biomedical Research, September 1995).

[7] Joseph P. Newhouse, "Medical Care Costs: How Much Welfare Loss?" Journal of Economic Perspectives, vol. 6, no. 3 (Summer 1992), pp. 3-22.

[8] See the Organisation for Economic Co-operation and Development (OECD) website on Health Policies and Data, Health Statistics, available at http://www.oecd.org/els/health-systems/healthstatistics.htm.

[9] The reported per capita spending figures have been adjusted for purchasing power parity to account for differences in exchange rates and cost of living.

[10] See Gallup's "Percentage Uninsured in the U.S., by Quarter: Do you have health insurance coverage?" in the Gallup-Healthways Well-Being Index, Quarter 12008-February 2014. A summary of results is available at http://www.gallup.com/poll/167798/uninsured-rate-continues-fall.aspx.

[11] See http://www.census.gov/did/www/sahie/data/index.html.

Question 7 *Go to the Census Bureau's website and download data from the Small Area Health Insurance Estimates page. What percent of the population under the age of 19 is uninsured? What percent of the population between the ages of 18 and 64 is uninsured? What percent of the population over the age of 64 is uninsured? What accounts for the differences across these major age groupings? How does the percent of people uninsured vary by gender? race? income level?*

To summarize, we present an issue: the government shutdown due to Congress's failure to pass a budget largely as a result of one party's demand for changes to the 2010 ACA. We identify the rhetoric: Republicans say the ACA will bankrupt America while Democrats say the old system of health care was inadequate because it was expensive and left many people uncovered by health insurance. We explore some facts: federal spending on health care has been, and is projected to be, a substantial component of deficits and growth in the national debt; health care costs have been increasing, and at an especially accelerated rate in the U.S. relative to other developed countries; a large proportion of the U.S. population is not covered by health insurance, and those left uncovered are more likely to be poor or minorities; and the U.S. spends more on health care than other developed nations yet has higher infant mortality and shorter life expectancy. Next some modeling.

Health Care in the U.S. There are three sets of actors in health care markets: consumers (otherwise known as patients), providers (e.g., doctors, hospitals, etc.), and insurance companies. Most consumption of medical services is mediated by health insurance companies. Rather than consumers (patients) and providers (doctors) negotiating directly with each other over prices, insurance companies enroll consumers in insurance plans and then negotiate with providers as to what services should be made available and at what price. The federal government, through the Medicare program, is the primary supplier of health insurance services for the elderly and disabled. The federal government, working with state governments, supplies health insurance services for qualifying low-income Americans through the Medicaid program. Many employers provide access to subsidized health insurance for their workers. Those not eligible for coverage under Medicare, Medicaid, or their employer can join private health insurance plans, self-insure by paying out-of-pocket using income, savings, or debt, or remain uncovered. Those who remain uncovered can receive emergency medical care in public hospitals, but are generally unable to consume on-going or preventative care unless it is donated or paid for through philanthropy.

A distinguishing feature of the American health care system, prior to the adoption of the ACA, is that people were not required to have health insurance. The market for health insurance, though tightly regulated by the government, could essentially be characterized as a free market. The challenge to having a free market for the provision of a service like health care insurance is the possibility of asymmetric information. It is difficult for suppliers of health insurance services to completely understand quality differences among providers of health care or interpret diagnostic as well as treatment options. As a result, it can be a challenge for insurance companies to determine the most efficient way to compen-

sate health care providers so as to simultaneously control costs and ensure consumers get access to quality services. It is also difficult for suppliers of health insurance to understand the amount or type of health care that individuals will consume. As a result, it can be a challenge for insurance companies to determine the appropriate price to charge individuals for the opportunity to join an insurance program. We can help our students understand the challenges of having a (nearly) free market for health insurance by modeling two specific types of information asymmetries: moral hazard and adverse selection. Our tools of analysis will include the concepts of expected value and expected utility.

All people face the risk of experiencing medical problems. Whether a particular medical problem will occur is uncertain. If a medical problem arises, the consequences of experiencing the problem are also uncertain. Individuals often respond to uncertainty through risk reduction measures. They can make lifestyle choices in attempt to lower the risk of getting sick. They can purchase insurance to lower the risk of becoming indigent should they become sick and have to confront the high costs of medical care. People who are risk averse are willing to pay to avoid or reduce uncertainty. Insurance is a form of risk-pooling. A group of individuals, each facing a risk that is (hopefully) independent of the risks faced by the others in the group, agree to share any losses among themselves.

For example, consider the case where there are two possible states of the world for an individual: sick or healthy. Let's assume the individual's wealth is \$50,000. If the person remains healthy, he keeps \$50,000. If the person becomes sick, let's assume he will have to pay \$5,000 for the cost of medical care and as a result he will only have \$45,000 to spend on other items. If the probability that he becomes sick is 20%, then we can calculate the expected value of the wealth available for consumption (call it x) as \$49,000. We calculate the expected value of consumption $E(x)$ as the sum of the payoff in each possible state of the world weighted by the probability that each possible state will occur.

$$E(x) = 0.8(\$50,000) + 0.2(\$45,000) = \$49,000$$

Question 8 *Develop a general formula for expected wealth in which there are n independent states of the world.*

Economists often make models using a concept called utility, which is an ordinal measure of satisfaction or value obtained from consumption. The basic reason why economists use this concept stems from the notion that not every dollar has the same value to different people or to the same person in different circumstances. For example, a single dollar is probably more highly valued by somebody who has no wealth than somebody who has one million dollars. Likewise, the first dollar that a person earns is likely more valuable to him than the 51st dollar earned.[12] We assume utility is a function of the amount of wealth available for consumption, which is equal to a person's wealth less any expenditures he has

[12]When modeling value using the concept of utility, economists assume people have ordered preferences (they can rank order from most preferred to least preferred all the possible combinations of goods and services they could afford to consume), non-satiable preferences (they prefer more of something to less of something), diverse preferences (they prefer a mix of goods and services rather than a whole lot of one thing and none

to make for medical care. If we index potential states of the world by i, then we can say a person's utility in state i is:

$$U_i = U(x_i) = U(Wealth_i - MedicalCosts_i)$$

The concept of diminishing marginal utility implies the second dollar I earn is worth less to me than the first dollar I earn. When people are risk averse, that is they have preferences that exhibit the characteristic of diminishing marginal utility, they prefer avoiding the loss of \$100 more than winning \$100. Under risk aversion, it is more appropriate to calculate welfare using the concept of expected utility rather than expected value. The expected utility of a risky situation when there are s possible states of the world is the sum of the resulting utility $U(x_i)$ in each possible state i weighted by the probability (p) that state i will occur:

$$E(U) = \sum_{i=1}^{s} p_i \cdot U(x_i)$$

Let's consider the example of two people each with wealth of \$50,000, each with a probability of getting sick of 20%, and each facing costs of medical care of \$5,000 should they get sick. The expected value of this situation for both individuals is \$49,000. Assume both individuals are risk averse and thus have utility functions that exhibit the characteristic of diminishing marginal utility. One example of a function with this property is the following:

$$U(x_i) = -e^{-ax_i}$$

where a is a parameter that measures the curvature of the utility function.

Question 9 *Assume $a = 0.0001$.*[13] *Graph this utility function for values of x_i between 0 and 50,000. Describe the shape of this graph. What is the first derivative of this utility function? What is its second derivative? Graph both the first and second derivatives of the utility function for values of x_i between 0 and 50,000. Describe the shapes of these graphs. Change the value of a and explore how the shapes of the graphs change. Provide at least one example of another function that exhibits the property of diminishing marginal utility.*

Question 10 *Calculate the value of the utility function when $x_i = 45,000$ and when $x_i = 50,000$. Calculate the expected utility of this risky situation. Next calculate the value of the utility function when at the expected value of the risky situation (i.e., when $x_i = 49,000$). Compare the expected utility to the utility of the expected value. Which is greater? Why?*

You should notice that the expected utility of the risk is less than the utility of the expected value. Thus, the two individuals in this example would both prefer having a certain \$49,000

of everything else), and are rational (they are informed about the choices available to them and will make choices in their best self-interest).

[13]There are surveys or games that you could use in class to estimate the value of a with students in your class. For one example of how to do this, see Hartley et al, "Who Really Wants to be a Millionaire? Estimates of risk aversion from gameshow data," available at http://www.kent.ac.uk/economics/documents/research/seminars/2012-13/ian-walker.pdf.

than face the uncertain prospect of having \$50,000 with an 80% chance or \$45,000 with a 20% chance. We can actually put a dollar value on the amount of money that these two individual would be willing to pay to avoid the risky situation. The certainty equivalent (CE) is the level of wealth at which utility matches the expected utility of the risky situation. Solve for CE from the following expression:

$$0.2U(45,000) + 0.8U(50,000) = -e^{-0.0001 \cdot CE}$$

You should find $CE = \$48,782.92$. Thus, our two individuals would be just as happy having \$48,782.92 with probability 100% as facing the risk of having \$50,000 with probability 80% or \$45,000 with probability 20%. The cost of uncertainty, or the amount that these individuals would be willing to pay to avoid the risk, is \$1,207.08. To reduce the cost of risk, these two individuals could form a risk pool. They could jointly agree to split the cost of medical care if either or both get sick. In one possible state of the world, neither would get sick in which case they both would have \$50,000. The probability that neither gets sick is 64%. In another possible state of the world, they would both get sick in which case total medical costs would be \$10,000, which after splitting evenly they would both end up with \$45,000. The probability of them both getting sick is 4%. In the third and final possible state of the world, one person gets sick while the other does not. Medical costs would be \$5,000, which after splitting evenly they would both end up with \$47,500. The probability that one or the other gets sick is 32%. We can calculate each individual's expected utility from joining the risk-sharing pool as:

$$E(U) = 0.04 \cdot U(45,000) + 0.32 \cdot U(47,500) + 0.64 \cdot U(50,000)$$

We can then calculate the certainty equivalent from the following expression:

$$E(U) = -e^{-0.0001 \cdot CE}$$

We find $CE = \$48,893.92$. Thus, when the individuals pool their risk, they reduce the cost of risk by about 8.4% to \$1,106.08. One could easily imagine that it would be difficult for an individual to find somebody with the exact same level of wealth, preferences, and morbidity risks with whom to form a risk pool, and even if such a person could be found it might be difficult to enforce the obligation to share medical costs, especially in the case where one partner gets sick while the other does not. Insurance companies play the role of inter-mediation among people looking to pool risk. In our scenario with two individuals, each would be willing to pay up to \$1,106.08 to avoid the uncertainties associated with the probability of getting sick and facing large medical bills. An insurance company could form the risk pool, charge each individual \$1,106.08 to join the risk pool, and then be the party responsible for paying any resulting medical costs. The insurance company would collect total revenue of \$2,212.16, while the expected value of the medical costs it would have to pay would equal only \$2,000 (expected medical costs for each person individually are $0.2 \cdot \$5,000 = \$1,000$). As such, the insurance company makes an expected profit of \$212.16.

Once students understand how to use the basic tools of expected value, expected utility, and certainty equivalents, we ask them to explore how the cost of risk changes as more people enter the risk pool and how the insurance company's expected profit changes as the degree of risk aversion (a) changes.[14] We can also increase the complexity of the analysis by asking students to consider how things might change if there are variations in risk aversion by level of wealth or if there are idiosyncratic probabilities of illness and costs of care across individuals. Consider the case where there are variations in the probability of getting sick across individuals. Let's assume there are low risk types with probability of getting sick of 10% and high risk types with probability of getting sick of 25%. Assume again that both types still have \$50,000 in wealth and that the cost of medical care when sick amounts to \$5,000.

Question 11 *Calculate the certainty equivalent for the low risk types as well as the certainty equivalent for the high risk types. How much should the insurance company charge people to join the risk pool?*

The challenge for insurance companies in this scenario is that they generally cannot tell low risk types from high risk types. Certainly they can make some headway on the problem by asking applicants to provide their age, family medical history, and to even have a physical exam. However, even with these available screening mechanisms, it's impossible for an insurance company to know with certainty whether an individual is a high risk or low risk type. As a result, it's difficult for insurance companies to figure out the right premium to charge people for joining the risk pool. If they set the premium based on the amount that low risk types are willing to pay, then everybody joins but the insurance company doesn't collect enough revenue to cover the expected costs of medical care. If they set the premium based on the amount that high risk types are willing to pay, then only the high risk types join. If they set the premium at some average level, the low risk types still find the premium to be too high relative to just self-insuring.

This problem is called adverse selection, which is a type of information asymmetry involving outcome-affecting, hidden action take prior to contracting. Any level of premium that the insurance company charges that allows it to stay in the black is too high for low risk types consequently the low risk types drop out (or don't join in the first place), only high risk types join the risk pool, average costs of medical care among those in the pool increase, and the insurance company has to increase premiums to stay solvent. Because insurance companies can't distinguish between low and high risk types, the level of premium

[14] Introducing the binomial distribution is helpful when asking students to consider what happens when more people enter the risk pool. If there are N total people who join a risk pool then the probability that exactly n of them get sick is given by:

$$\frac{N!}{n!\,(N-n)!} \cdot (p_s)^n \,(1-p_s)^{N-n}$$

where p_s is the probability that an individual gets sick. This formula assumes there is no correlation in the probability of sickness among individuals in the risk sharing pool.

they need to charge to remain solvent incentivizes the relatively high risk types to join but discourages low risk types from joining.

In practice, insurance companies try to price discriminate by charging premiums based on a person's age, gender, geographic location, or family history. Insurance companies also attempt to exclude high risk types from joining risk pools, if they are able to successfully categorize somebody as a high risk type based on their personal medical history. Recall the rhetoric from the left, "We refuse to go back to the days when health insurance companies had unchecked power to cancel your health policy, deny you coverage, or charge women more than men." This language from the 2012 Democratic National Platform is a direct challenge to methods employed by insurance companies prior to the ACA to address the problem of adverse selection.

Question 12 *What types of people are more likely to pay to join a health insurance program if health insurance companies are allowed to charge different premiums based on observable characteristics like age, gender, and personal medical history?*

Now consider the case where there are variations across individuals in the cost of care. Once an individual joins a risk sharing pool by paying a premium equal to their willingness to avoid risk, the price of getting treatment, from the individual's perspective, is essentially \$0. If the individual gets sick, goes to the doctor, and receives a diagnosis, the cost of care should be \$5,000. However, the doctor and the patient might jointly agree to some form of additional treatment, which might cost a little more than \$5,000. The doctor passes the additional cost to the insurance company, and the insurance company pays the bill. If this type of activity occurs across many patients in the same risk pool, then the solvency of the insurance company could be threatened. Further, once an individual joins a health insurance plan, they might be budget constrained and not have enough money left after paying the premium to pay for other risk-reducing measures. They might also be more willing to engage in behaviors exposing them to increased chances of getting sick knowing that any medical bills will be paid for by the insurance company.

This problem is called moral hazard, which is a type of information asymmetry involving outcome-affecting, hidden action taken after contracting. Once individuals pay a premium to join an insurance risk pool and the insurance company agrees to pay the cost of any resulting medical treatment, the price of treatment to the individual is \$0, the incentive for individuals to engage in risk avoiding practices is diminished, and there is little incentive for doctors to limit treatment to that which is just sufficiently necessary. This leads to excess use of medical services and cost growth. Recall the rhetoric from the right, "It would...[leave] the States to assume unsustainable financial burdens." This language from the 2012 Republican Party Platform is a direct challenge to the notion of making everybody enroll in health insurance plans because the problem of moral hazard suggests that inappropriately priced insurance plans lead to over use of medical services.

In practice, insurance companies attempt to mitigate the problem of moral hazard by in-

stituting forms of co-insurance via deductibles and co-pays. Insurance companies often charge lower upfront premiums to join the risk group, but then require members to pay for a small percentage of actual health care costs as they occur. This confronts users with a non-zero cost of medical treatment, which could serve as an incentive to take pre-cautionary measures against getting sick and to limit the amount of treatment to that which is just necessary to get healthy again.

Question 13 *Some health insurance reform efforts have attempted to contain cost growth by reforming the way that doctors and hospitals get paid. Spend some time exploring the differences between fee-for-service and capitation plans.*

Pursue Understanding Rather than Accept the Rhetoric. Our relatively simple models, which are plausible if we believe that people are risk averse and know their risk type better than insurance companies, can help us analyze some of the issues associated with health care insurance. Further, we make use of common software programs to simulate what happens when we make slight modifications to our models or assumptions. In doing so, we discover that variations in income mean that some might not be able to pay to join a private risk pool or self-insure. We also learn that variations in the degree of risk aversion among consumers of health care can affect the profitability of being a supplier of insurance services, and that variations in the probability of getting sick or cost of care also complicate the financial decision making abilities of suppliers of insurance services.

The ACA is an attempt to reform the American health care system by addressing some of the challenges arising from information asymmetries in the market for health insurance. The ACA is composed for three major components: an individual mandate, means-tested subsidies, and no exclusions on coverage. The individual mandate means that the ACA requires all Americans to join a health insurance risk group. Means-tested subsidies means that the federal government will provide assistance to qualifying low-income Americans to help them pay the premiums required to join risk groups. No exclusions on coverage means that if an insurance company learns that an individual is a high risk type, it can't exclude the person from joining the risk group.

Question 14 *The individual mandate in the ACA should bring more people as well as relatively more low risk types into risk-sharing pools. How would you expect this to impact the average level of premiums charged to join health insurance plans?*

Question 15 *When people get insured, the actual cost to the individual of getting treatment decreases and moral hazard indicates they will be more likely to use medical services. How would you expect this to impact the trends in health care cost growth? What additional policies could be considered to address potential issues with cost growth associated with moral hazard?*