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Preface

I can trace the roots of this book back to 1969-1971, when I worked for the Suffolk County Department of Social Services. As well, in 1974, I worked on a health care feasibility study for the Town of Shelter Island, NY with Campbell T. Lamont and Steve Jonas, at the State University of New York at Stony Brook, while I was working on my masters degree in social welfare.

I realized, while working as a caseworker, that many clients did not get the services they were entitled to receive. While working on my masters degree in social work I wrote a paper: "Denial of Services in public agencies: A white collar crime," describing this phenomena.

While researching various health care finance mechanisms in 1974, I realized that the rationale for health maintenance organizations was flawed for the same reasons that I had addressed in the "Denial of services" paper. Just as clients of the department of social services could not rely on their caseworkers to provide all the services they were eligible to receive, patients cannot rely on health care providers to furnish all the diagnostic and treatment services we are entitled to receive.

Managed care organizations, insurers, and Medicare/Medicaid assume that providers will perform as required, meeting their patients' needs for care, regardless of how long they have been patients, or the cost to provide that care. I make no such assumption. Instead, I will show you that providers cannot do this, demonstrating through detailed analyses, that capitated health care providers cannot be relied upon to provide all the services their patients need.

I will show that it is a mathematical impossibility for all capitated health care providers to meet all the needs of their patients.

It has taken me many decades of work, and studies in many fields, to understand, and explain to others, the flaws in our current health care (finance) systems. I will help you understand how health insurance really works, and how it can never work. Someday, this knowledge may save your life, or the life of someone you love.

"Standard Errors", the book, explains how insurance works as a mechanism of collective risk management, and why capitation-like health care finance mechanisms can never achieve efficient risk management, nor can they steer our health care system toward efficiency.

Understanding insurance mechanisms is critical because the really good ones help us all. Flawed health insurance mechanisms, especially those that transfer insurance risks to health care providers, hurt us all. The worst health care finance mechanisms impact every aspect of patient care: from admitting clerks to neurosurgeons; from managed care organizations to home health aides; from the wealthiest patients to those relying on Medicaid, charity or unfunded services. All of us are affected because whether we are fabulously wealthy, or dirt poor, we could be walking across a street, get hit by a bus, and be taken away unconscious in an ambulance with tattered, blood soaked clothing.

If we arrive at a hospital, looking like a penniless, homeless person, we will get, at best, the level of care provided to the poorest person arriving at the emergency room, not the care we may have available through our premier high cost, health care plans!

Everyone has an opinion about how health care ought to be financed, how large insurers should be, even whether we ought to have health insurance at all. But these opinions are rarely grounded in clearly articulated assumptions, rigorous analysis or consideration of the human consequences of our health care (finance) policies. “Standard Errors” provides just the rigorous analysis needed for citizens, students and professionals to understand and discuss how we should finance health care services.

“Standard Errors” is far from perfect. I am sure there are many uncorrected errors, some theoretical, some typographical. Please do not let my imperfections dissuade you from mastering how our health care (finance) systems work.

Thomas Cox PhD, RN
Gainesville, FL
July, 2017

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Insurance Principles & Insurer Operations

1. Introduction

There are two insidious approaches to health care finance reform that this book tackles head on. One is the notion that more competition between health insurers will result in reduced costs, higher benefits, and lower premiums. At this time we have more than 1,000 entities selling health insurance, health benefit plans, catastrophic health plans or dread disease plans. If comptetition between health insurers could produce reduced costs, higher benefits, and lower premiums, I think it is safe to say we would already have lower costs, higher benefits and lower premiums. Instead we have quite the opposite: ever rising costs, lower benefits each year, and unaffordable premiums.

The second insidious approach is the suggestion that we can, or should, reduce the high, often excessive and inefficient, costs of health care by reducing the demand for, and provision of, what are deemed to be "non-essential" health care services. This book addresses the problems we face in doing this as well. While these goals seem laudable when applied to services for other people, we tend to be less pleased as those affected move closer to us: Ourselves, our children, parents, loved ones or friends.

The worst, most callous and indifferent mechanism for reducing the demand for, and provision of, non-essential health care services is called "capitation". Capitation transfers our health insurance risks, as patients, from our health insurers, to our health care providers. I will discuss this more fully in Section 4.4.

Capitation may sound great at first, evoking images of Dr. Galen Adams on the CBS Western series Gunsmoke. All the residents of Dodge, and the surrounding countryside, contributed what they could to keep Dr. Adams afloat. In return, Dr. Adams helped those in need of his care as they need him. Dr. Galen always seemed to have enough time to care for everybody's needs. Unfortunately capitation is actually not a very good idea, in our modern, high technology, high intervention health care system. It is a profoundly poor idea for how to pay our health care providers for the same reason that small health insurers are not a good idea: The loss of risk management efficiency as health insurance risks are borne by smaller insurers.

Capitation's fatal flaw, as a health care finance mechanism, is that it transfers our health insurance risks from our large and capable health insurers, to our much smaller, much less capable, health care providers. We pay insurers to manage our insurance risks, not to abdicate their roles as

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6. The Population Loss Ratio

Suppose we have an entire population, $\mathscr{P}$, of p policyholders. All the insurers I will consider randomly select their policyholders from population $\mathscr{P}$.

Suppose I combine all the policyholders' health care costs, and all the policyholders' premiums, for population $\mathscr{P}$. The Population Loss Ratio, *PLR*, is the ratio of all their combined health care claims costs divided by their combined health insurance premiums:

$$PLR = PLR_{\mathscr{P}} = \frac{\sum_{i=1}^{p} \text{Policyholder } i's \text{ Claims}}{\sum_{i=1}^{p} \text{Policyholder } i's \text{ Premiums}} \tag{6.1}$$

Although every population, $\mathscr{P}$, has a distinct population loss ratio, *PLR*, the factors that determine the population loss ratio vary greatly. I cannot deal with all the factors that determine the population loss ratio but I can describe four such factors, the:

1. Epidemiology of illness and injury in population $\mathscr{P}$
2. Health care system resources available to population $\mathscr{P}$
3. Health care services provided to population $\mathscr{P}$
4. Payments made for population $\mathscr{P}$'s health care services

6.1 Factor 1 - Population Epidemiology

Every population has a distinct epidemiological profile which varies over time. This profile may be known completely, in part or not at all. Our concerns are population $\mathscr{P}$'s illnesses and injuries, health and well being. How many people are ill? How ill? How many people will become ill during the year? How ill? How many people will recover from illnesses during the year? How many people will be born, or die, during the year?

Since I am only looking at one year, I am only concerned with soon to emerge illness and injury. I will not address long-term prevention activities. The focus on preventive care as the solution to our health care finance problems, is flawed.[1] We have seen what an emphasis on wellness and

[1] In efficient health care (finance) systems all the resources available are already allocated. Efficient health care

disease prevention can accomplish. It is what we have right now, a lot of older, sicker people. Our successes in vaccination programs, heart disease treatment and wellness promotion are the cause, not the cure, for high health care costs.

If we knew exactly who was, or would become ill or injured we would have a complete epidemiological profile for population $\mathscr{P}$, but we would not yet know the population loss ratio. Before illness and injury affects health care costs patients have to be diagnosed and treated.

6.2 Factor 2 - Health Care System Resources

If we had an epidemiological profile our next step would be knowing what health care resources are available to population $\mathscr{P}$. How many doctors, nurses, hospitals, clinics, operating rooms, mobile intensive care units and nursing homes serve population $\mathscr{P}$?

Are these resources distributed evenly across the population by age, race, income, geographic location or social status or do some people have difficulty getting care? Are most resources centralized and the people who need them distant or can everyone in population $\mathscr{P}$ get diagnosed and treated quickly?

Who will be treated, how they will be treated, whether they will recover, suffer unnecessary pain and incapacity, or die is determined by the availability of health care resources.

Cutting your finger at Harvard University and sustaining the same injury in Haiti, days after the earthquake, are entirely different things and the two types of treatment will produce very different costs.

At Harvard, you will go to an on-campus clinic staffed by brilliant doctors and nurses with state of the art knowledge, equipment and drugs. They will clean your wound with sterile solution, give you a tetanus shot, cover your wound with sterile bandages and send you away with antibiotics. Your cut will heal completely in 2 - 5 days and the minimal costs of your care will contribute to the population loss ratio.

If the same injury occurred in Haiti, after the earthquake, the outcome would be very different. With life threatening crush injuries common, your injury would receive little attention. You might enter a long line of people seeking attention. Some would be bleeding, some would have lost limbs, some would be unconscious and some near death. Your cut finger would probably not be treated at all. No treatment means no cost. Your cut finger contributes nothing to the population loss ratio.

Having health care resources means little if those resources are not used to diagnose and treat patients. If patients are not diagnosed and treated there are no bills for health care services and no claims to sum in the numerator of the population loss ratio (See Formula 6.1).

6.3 Factor 3 - Health Care Services Provided

In every health care system there are gaps between what can be done and what happens.

If you live in a rural area, far from the nearest emergency equipment, a minor heart attack is likely to be fatal. You would not be able to reach a health care provider nor could emergency vehicles reach you in time. You incurred no treatment costs because were not treated.

If the same minor heart attack occurs in the lobby of an emergency room you will survive and the costs will be very high.

You may live down the block from a private, proprietary hospital with no emergency room. If you cannot afford their services, they will do nothing more than stabilize you and arrange to transport you to some other facility.

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providers can only influence their patients' long term health, and reduce their patients' future costs for care, by diverting resources they are using to provide medically necessary and appropriate care to their patients. Diverting such resources, in efficient health care (finance) systems, *must* result in eliminating some medically necessary and appropriate patient care.

There are many other impediments to turning health care needs (i.e. Epidemiology) and health care resources into health care services.

Diagnosis and treatment by health care providers turn epidemiology and health care resources into provided health care services. But unless someone pays for these health care services, diagnosis and treatment will not contribute to population $\mathscr{P}$'s population loss ratio, *PLR*, through the numerator in Formula 6.1.

6.4 Factor 4 - Claims Settlement Policies And Procedures

Who will pay the costs of your treatment? Will you pay out of pocket? Do you have health insurance or some kind of benefit plan? Is your treatment covered under your health insurance or benefit plan? Is there a deductible associated with your health insurance or benefit plan? Are you a member of a health maintenance organization, on Medicaid or are you a senior citizen with a Medicare card? All of these issues influence the cost of your care and who pays.

The same illness or injury generates different costs for you, your insurer or benefit plan, and different payments to health care providers, based on your third party payer's claims settlement policies and procedures. Every insurer, every health maintenance organization and every managed care organization has a unique set of claims settlement policies and procedures. Some of the detail is listed in your subscriber information package which you may, or may not have read before you sought care.

Most of your third party payer's claims settlement policies and procedures are detailed in huge manuals or computer files used by your third party payer's claims department personnel. However, the most important details regarding your insurer's claims settlement policies and procedures are communicated through decades old "oral traditions." This is the information that is passed on, from one claims agent to another, but it is never written down. Paper trails on these details would expose the insurer to legal discovery, media scrutiny, regulatory review, and litigation.

Mary Johnson (See Chapter **??**), Jason's claims representative, shares this kind of information with other claims representatives at lunch, parties and in seminars for carefully screened attendees. Mary knows it is wrong to cheat policyholders out of their benefits but company loyalty and the rewards she gets for doing so, are greater than her concerns about fairness to claimants.

6.5 Four Factors And Health Care Costs

My concern is how much different insurers pay for care. If you have a top of the line health insurance plan, you can seek care anywhere, any time and of any type. Having cut your finger, you might want a plastic surgeon. If you are a neurosurgeon and the cut is on the index finger of your dominant hand, a plastic surgeon can carefully suture your finger and maximize your recovery. Your career as a neurosurgeon can be saved by a skilled plastic surgeon.

If you are a subscriber in a managed care plan, a member of a health maintenance organization, a senior on Medicare or a person on Medicaid, you will probably not have your finger sutured by a plastic surgeon. You will be treated by a far less qualified practitioner. Compared to a skilled plastic surgeon, they will do a terrible job. They will not do this maliciously. They do not have the knowledge, skills or time to do any better.

Plastic surgeons charge more for their services than less qualified practitioners. From the standpoint of a managed care plan, health maintenance organization, Medicare or Medicaid both the plastic surgeon and far less qualified practitioners meet minimal standards for practice. They will pay either practitioner to suture your hand. But the amount they will pay will not be sufficient to compensate a skilled plastic surgeon for his/her time. The reimbursement will only be attractive for a far less skilled physician.

Population $\mathscr{P}$'s population loss ratio is based on at least these four factors: The amount of illness and injury; The resources available; The services provided and The claims settlement policies and procedures of first and third party payers.

Population $\mathscr{P}$'s population loss ratio will be very high if many people are ill or injured AND the resources are available to treat them AND someone does diagnose and treat them AND someone pays for their treatment. Population $\mathscr{P}$'s loss ratio will be very low if few people are ill or injured OR there are few health care system resources available OR nobody diagnoses and treats them OR nobody pays for their treatment.

6.6 Insurer Claims Settlement Policies And Procedures

If all policyholders pay the same premiums every year the denominator of the population loss ratio (See Formula 6.1) will not change. Only the numerator, total claims costs, will vary. For the same epidemiological profile, identical health care system resources and identical treatment decisions the population loss ratio will be very high if an indemnity insurer's claims settlement policies and procedures apply.

The population loss ratio will be more modest if the claims settlement policies and procedures of a managed care organization are applied, much lower if the claims settlement policies and procedures of a health maintenance organization are applied and significantly lower if the claims settlement policies and procedures of the stingiest state Medicaid program are applied. Population $\mathscr{P}$'s population loss ratio will be 0.0000, if nobody pays.

Population loss ratios, just as epidemiological profiles, health care system resources, health care services provided and claims settlement policies and procedures vary over time. Changes in population loss ratio patterns, as well as insurer loss ratio patterns, occur with economic change; social change; legislation, litigation and judicial rulings and technological change.

For the next few chapters I will assume that the population epidemiological profile, health care system resources, health care services provided and claims settlement policies and procedures will **not vary** during the next year. I assume that all third party payers use a single set of claims settlement policies and procedures. Under these conditions, the population loss ratio is a fixed, known quantity, *PLR*.

In Chapter 9 I describe a Paradigm Insurer and analyze the consequences of assuming that all insurers select policyholders, at random, from population $\mathscr{P}$ and use the Paradigm Insurer's claims settlement policies and procedures.

I will show that when insurers smaller than the Paradigm Insurer use its claims settlement policies and procedures they face considerable financial risk. I will describe what these risks are and I will calculate the degree by which smaller insurers must cut the Paradigm Insurer's benefits (i.e. alter the Paradigm Insurer's claims settlement policies and procedures) to match the Paradigm Insurer's operating results (i.e. Profitability, Loss avoidance and Solvency preservation).

All the results in this book are based on the fact that when insurers issue different numbers of policies than the Paradigm Insurer, these insurer's normally distributed loss ratios will vary around the population loss ratio by different amounts than the normally distributed loss ratios of the Paradigm Insurer.

Larger insurers produce loss ratios that are closer to the population loss ratio, and smaller insurers produce loss ratios that are further from the population loss ratio, than those of the Paradigm Insurer.

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7. Population Loss Ratio Estimates

Even when the population loss ratio is known, based on the four factors addressed in Chapter 6, almost no policyholders or insurers will have exactly that loss ratio during the next year. Instead, each policyholder and each insurer will produce a population loss ratio estimate (i.e. $PLRE_i$s and $PLRE_N$s), the ratio of their total claims costs to their total premiums.

Individual policyholders and insurers' population loss ratio estimates are somewhere "around" the population loss ratio. Some policyholders' $PLRE_i$s, and some insurers' $PLRE_N$s, will be very close to the population loss ratio and some will be very far away.

How high, or low, a policyholder's $PLRE_i$ is provides a measure of the intensity of their health care needs and the level of their use of paid health care services. Low policyholder $PLRE_i$s suggest minimal needs or minimal paid care. High policyholder $PLRE_i$s suggest extreme needs or high levels of paid care.

How high, or low, an insurer's $PLRE_N$ is provides a measure of the intensity of its policyholders combined health care needs and the level of its policyholders combined use of paid health care services. Low insurer $PLRE_N$s suggest low policyholder needs or minimal paid care. High insurer $PLRE_N$s suggest high needs or high levels of paid care.

I am particularly interested in the probabilities of high and low insurer "estimates" $PLRE_N$s, of the population loss ratio. This is because each insurer's "estimate," $PLRE_N$, determines that insurer's most interesting and important operating results.

Phrased another way, the "accuracy," or "inaccuracy," of insurers' population loss ratio estimates determine whether the insurers earn profits, incur losses, pay all of their policyholder's benefits (See Chapter 14), remain solvent and provide rewards for their investors.

The "accuracy," or "inaccuracy," of insurers' population loss ratio estimates also establish constraints on the highest level of aggregate policyholder benefits an insurer can plan to provide.

7.1 How Population Loss Ratio Estimate's Impact Insurer Performance

The year to year variation in any insurers' population loss ratio estimates, or the year to year variation in same sized insurers' population loss ratio estimates, determine how stable these insurers' operating results are over time.

III

Comparing Insurer Operations

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10. Standard Errors & Distribution Functions

10.1 Standard Errors

I will compare the operating characteristics of five insurers: *NHI*, *B*, *PI*, *D* and *E*, selecting 325,000,000; 10,000,000; 1,000,000; 100,000; and 10,000 policyholders, at random, from population, $\mathscr{P}$.

At year end, each insurer calculates its population loss ratio estimate (loss ratio). These five loss ratios are estimates of the population loss ratio, based on each insurers' randomly selected policyholders.

Because each insurer issues different numbers of policies, the degree of "accuracy" of each insurer's estimate of the population loss ratio will be different. Some years their estimates will be lower than the population loss ratio. Some years their estimates will be higher than the population loss ratio. But over many years the larger insurers' estimates will be closer to the population loss ratio than the estimates of smaller insurers.

We measure the degree by which insurers' loss ratios are likely to miss the mark, using each insurer's *standard error*.

The Central Limit Theorem (CLT) (See Chapter **??**) asserts that each insurer's population loss ratio estimates will be normally distributed and specifies how to calculate each insurer's *portfolio size adjusted* standard error as described in Formula 10.1.

The "mean values" of all these insurers' population loss ratio estimate "sampling distributions" are equal to the population loss ratio, *PLR*, unless these insurers are selecting policyholders non-randomly, selecting them from different populations than $\mathscr{P}$ or if the insurers have altered *PI*'s claims settlement policies and procedures.

The standard error of Insurer *N*'s population loss ratio estimate sampling distribution is:

$$\sigma_{e_N} = \sigma_{e_{PI}} * \frac{\sqrt{1,000,000}}{\sqrt{n}} \tag{10.1}$$

when Insurer *N* has *n* policyholders and *PI* has 1,000,000 policyholders.

Row/Col	Operating Characteristic (1)	NHI (2)	B (3)	**PI (4)**	D (5)	E (6)
(1)	Portfolio Size (N) (1,000s)	325,000	10,000	**1,000**	100	10
(2)	Standard Error (σ_{e_N})	0.00277	0.01581	**0.05000**	0.15811	0.50000

Table 10.1: Portfolio Adjusted Standard Errors

Portfolio Size Adjusted Standard Errors

Table A Row 1 shows insurer portfolio sizes in thousands (1,000s) of policyholders. Table A Row 2 shows each insurer's portfolio size adjusted standard error.

Insurer E's standard error, σ_{e_E} = 0.50000, is ten times larger than PI's standard error, $\sigma_{e_{PI}}$ = 0.05000, and 180 times larger than $\sigma_{e_{NHI}}$. The population loss ratio estimates of insurers the size of Insurer E, will lie far further from the population loss ratio than almost all of NHI's population loss ratio estimates.

PI's standard error, $\sigma_{e_{PI}}$ = 0.0500, is almost 18 times larger than NHI's standard error, $\sigma_{e_{NHI}}$ = 0.00277.

PI's population loss ratio estimates, as are all population loss ratio estimates produced by insurers with 1,000,000 policyholders, are spread out, around the population loss ratio, more than 18 times further than NHI's population loss ratio estimates.

Although NHI could produce higher, or lower, population loss ratio estimates than an insurer the same size as PI, in any given year, over long periods of time, NHI's population loss ratio estimates will lie closer to the population loss ratio, than the population loss ratio estimates of any smaller insurer.

10.2 Loss Ratio Density Functions By Portfolio Size

While all these insurer's loss ratio density functions are normally distributed, with the same mean values, PLR, they each have different standard errors.

Table 10.2: Portfolio Adjusted PLRE Density Functions

PDF_{NHI}	$\sim$	$\phi_{NHI}(0.75000, 0.002774)$
PDF_B	$\sim$	$\phi_B(0.75000, 0.015811)$
PDF_{PI}	$\sim$	$\phi_{PI}(0.75000, 0.050000)$
PDF_D	$\sim$	$\phi_D(0.75000, 0.158114)$
PDF_E	$\sim$	$\phi_E(0.75000, 0.500000)$

Using Equation 10.1 I can calculate both of the parameters I need to specify each insurer's normally distributed population loss ratio estimate density functions (See Table 10.2).

NHI's population loss ratio estimate "sampling distribution" density curve is very narrow and very high, much narrower and much higher than the green normal curve in the top set of curves in Figure **??**.

Insurer E's population loss ratio estimate "sampling distribution" density curve is very broad and very flat, much broader, and much flatter, than the blue curve in the top set of curves in Figure **??**.

10.3 Cumulative Distribution Functions By Portfolio Size

The loss ratio density functions in Table 10.2 correspond to Figures **??**, **??**, **??** and **??** but calculating probabilities using normal density functions is fairly difficult.

The probabilities I need can be evaluated far more easily using cumulative distribution functions. The population loss ratio estimate distribution functions I need are displayed in Table 10.3.

The implications of the differences in these insurers' normally distributed population loss ratio estimate density and distribution functions are profound as I will detail by calculating the probabilities of important insurer operating results in the next few chapters.

Table 10.3: Portfolio Adjusted PLRE Distribution Functions

CDF_{NHI}	=	$\Phi_{NHI}(0.75000,\ 0.002774)$
CDF_{B}	=	$\Phi B(0.75000,\ 0.015811)$
CDF_{PI}	=	$\Phi PI(0.75000,\ 0.050000)$
CDF_{D}	=	$\Phi D(0.75000,\ 0.158114)$
CDF_{E}	=	$\Phi E(0.75000,\ 0.500000)$

10.4 Complementary Cumulative Distribution Functions By Portfolio Size

The last formulas I need are the formulas I will use to calculate probabilities that an insurer's loss ratio is higher than some specific evaluation point. These are the Portfolio Adjusted Complementary PLRE Distribution Functions, or CCDFs. I could do all these calculations using the Portfolio Adjusted PLRE Distribution Functions, or Φ_Ns, but that may be more confusing than defining these new functions.

The important thing to remember is that these two different ways of evaluating probabilities always sum to 1.00000 at the same evaluation point (x) as shown in Equation 10.2 and Table 10.4:

$$CCDF_N(PLR,\sigma_{e_N})(x)+\Phi_N(PLR,\sigma_{e_N})(x)=1.00000 \tag{10.2}$$

Table 10.4: Portfolio Adjusted Complementary PLRE Distribution Functions

$CCDF_{NHI}(PLR,\sigma_{e_{NHI}})(x)$	=	1 - $CDF_{NHI}(PLR,\sigma_{e_{NHI}})(x)$	=	1 - $\Phi_{NHI}(0.75000,0.002774)(x)$
$CCDF_{B}(PLR,\sigma_{e_{B}})(x)$	=	1 - $CDF_{B}(PLR,\sigma_{e_{B}})(x)$	=	1 - $\Phi_{B}(0.75000,0.01581)(x)$
$CCDF_{PI}(PLR,\sigma_{e_{PI}})(x)$	=	1 - $CDF_{PI}(PLR,\sigma_{e_{PI}})(x)$	=	1 - $\Phi_{PI}(0.75000,0.05000)(x)$
$CCDF_{D}(PLR,\sigma_{e_{D}})(x)$	=	1 - $CDF_{D}(PLR,\sigma_{e_{D}})(x)$	=	1 - $\Phi_{D}(0.75000,0.15811)(x)$
$CCDF_{E}(PLR,\sigma_{e_{E}})(x)$	=	1 - $CDF_{E}(PLR,\sigma_{e_{E}})(x)$	=	1 - $\Phi_{E}(0.75000,0.05000)(x)$

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11. Profit Probabilities By Portfolio Size

We have done our work well in the last few chapters and we are now in a position to calculate probabilities that these five insurers will earn profits during the year. Since all insurers' distributions are centered at the *PLR* they all have half their probability below loss ratios of 0.7500.

11.1 Probabilities Of Profits > 10%

Table 11.1 Row 3 (See Page 52), shows that all insurers have probability, $[\Phi_N(0.7500, \sigma_{e_N})(0.7500)]$ = 0.5000, of loss ratios less than 0.7500, where Φ_N is each insurer's normally distributed population loss ratio estimate *cumulative* distribution function from Table 10.3.

Insurers earn profits greater than 10% ((0.8500 - 0.7500) * 100%) when their loss ratios are less than 0.7500, so these insurers all have the same probability of earning profits greater than 10% of their premium revenues.

If I look no further I might conclude that portfolio size does not affect insurer profitability. I would be wrong. However, it is precisely this flawed thinking that underlies the overwhelming majority of literature on health care finance reform, leading to disastrous public policy positions.

The regions to the far left of the population loss ratio, or to the far right of the population loss ratio, in our *LPRE* normal density curves are commonly referred to as "tails."

Small insurers have more of their probability concentrated in the tails of their population loss ratio estimate *density* curves than large insurers because they have larger standard errors. More probability in their tails means higher probabilities of extreme operating results.

Small insurers incur high losses, or earn high profits, far more often than large insurers because they have more probability of population loss ratio estimates that are far from average.

11.2 Probabilities Of Profits > 5%

Table 11.1 Row 4 (See Page 52), shows insurers' probabilities of earning profits greater than 5%, $\Phi_N(0.7500, \sigma_{e_N})(0.8000)$), at loss ratios below 0.8000. *NHI* earns such profits with probability 1.0000, Insurer *B* with probability 0.9992, and *PI* with probability 0.8413, as specified in Chapter 9.

Insurers D and E have much lower probabilities of earning profits greater than 5%, 0.6241 and 0.5398, respectively. Insurer D earns profits greater than 5% about six years in ten. Insurer E earns such profits about every other year.

11.3 Probabilities Of Profits > 8.89%

Section 11.2 revealed that $\Phi_{NHI}(0.7500, \sigma_{e_{NHI}})(0.8000)) = 1.0000$. This is very misleading. NHI's normal curve falls very sharply, immediately before, and immediately after, the population loss ratio, because NHI's standard error, 0.00277, is so small.

I can highlight the advantage of large insurer size if I compare these insurers' probabilities of earning profits greater than 8.89%. I chose this level of profitability because the loss ratio at which this occurs, 0.7611, will help me demonstrate a severe flaw in capitation-like health care finance mechanisms and small, competing health insurers.

A loss ratio of 0.7611 is four standard errors above the population loss ratio for NHI. I know (See Table A.8 Column 2) that the probability that NHI has a loss ratio below 0.7611 is:

$$\Phi_{NHI}(PLR, \sigma_{e_{NHI}})(0.7611) = 0.99997 \tag{11.1}$$

NHI almost always earns profits greater than 8.89%!

Insurer B's probability of earning profits greater than 8.89%, $\Phi_B(0.7500, \sigma_{e_B})(0.7611)$ is 0.75860 because 0.7611 is 0.70179 standard errors above the PLR for Insurer B.

Insurer B earns profits higher than 8.89% about seven years in ten.

PI's probability of earning profits greater than 8.89% is 0.58781 ($\Phi_{PI}(0.7500, \sigma_{e_{PI}})(0.7611)$). PI earns profits greater than 8.89% almost six years in ten because 0.7611 is 0.22192 standard errors above the mean for PI.

But when we turn our attention to Insurers D and E, the situation changes dramatically. Insurer D's probability of earning profits higher than 8.89% ($\Phi_D(0.7500, \sigma_{e_D})(0.7611)$) is only 0.52797. Insurer E's probability of earning profits higher than 8.89% ($\Phi_E(0.7500, \sigma_{e_E})(0.7611)$) is 0.50885. Insurers D and E only earn profits greater than 8.89% about once very two years.

The fortunes of large and small insurers are very different as shown in Figure 11.1 and Table 11.1.

11.4 Insurer "Break-Even" Probabilities

Insurers incur operating losses at loss ratios exceeding 0.8500. I can calculate the probability that these five insurers avoid operating losses (i.e. Break even or earn profits) by evaluating their cumulative distribution functions for loss ratios below 0.8500 ($\Phi_N(0.7500, \sigma_{e_N})(0.8500)$).

At loss ratios that are below 4 standard errors above the PLR, NHI earns profits greater than 8.89%, and Insurer B earns profits greater than 3.68%, almost every year (Probability = 0.99997), so they will almost certainly break even every year.

In fact, since the portfolio loss ratio estimates for both NHI and Insurer B are very close to the PLR, they have no measurable probability of incurring extreme operating results: They will almost never earn excessive profits nor will they ever incur extreme operating losses. Both NHI and Insurer B will almost always avoid operating losses.

PI will break even on its insurance operations with probability, $\Phi_{PI}(0.7500, \sigma_{e_{PI}})(0.8500)$, or 0.9772. PI breaks even, at worst, about 98 years in 100.

Identical procedures (See Table 11.1 Row 5 on Page 52) show that Insurers D and E have much lower break even probabilities, 0.73646 and 0.57926, respectively. Insurer D breaks even