Standard Errors: Statistical Consequences of Health Care Provider Insurance Risk Assumption

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Abstract

Many health care finance mechanisms transfer health insurance risks to health care providers. Global capitation is the best known example but bundled and episode payments, Diagnosis Related Groups payments, the Medicare/Medicaid Prospective Payment Systems for Physicians, hospitals, nursing homes, and home health agencies, and contractual agreements between health care providers, and other third party payers, also transfer insurance risks.

Calculating actuarially correct health insurance premiums is difficult, while analyzing the impact of transferring insurance risk portfolios to health care providers, once the correct premiums are known, is easy. I use portfolio size adjusted standard errors, to compare how portfolio size affects insurers' financial results, including: Profitability, Operating losses; Insolvency; Surplus requirements, and Maximum sustainable benefits for policyholders/patients to reveal what happens when insurance risks are managed by smaller, less capable insurers, such as risk assuming health care providers. These analyses will reveal multiple flaws in the rationale for capitation financed health care. Capitation, contrary to the assertions of its advocates, must reduce health care (finance) system efficiency and the quality and quantity of patient care.

Key Words: benefits, capitation, health care finance, health insurance, insolvency, insurance, loss, managed care, maximum sustainable benefits, profitability, profits, prospective payment systems, reinsurance, risk, risk theory, solvency, solvency protecting loss ratio, standard errors

1. Introduction

Many authors believe that we can reduce high, often excessive and inefficient, costs of health care by transferring insurance risks to health care providers. I usually call such transfers "Professional Caregiver Insurance Risk" but use "capitation" in this paper, though many different insurance risk transfers exist. Capitation replaces frequency and intensity related, fee for service payments, with fixed provider payments (Bourdon, Passwater, and Priven, 1997; Bourdon, 1998; Cox, 2001, 2006, 2010, 2011). Capitation supporters (Arrow, 2009; Gapenski and Pink, 2011) find capitation appealing; simple; easy to explain to politicians, the public, and health care providers. I will show that capitation is far too deeply flawed to accomplish these goals.

Capitation is about magical thinking. Advocates suggest that insurance risk assuming health care providers do not become their patients' insurers, managing "performance risk" rather than insurance risk. This is untrue. Advocates incorrectly imply that insurance risk assuming health care providers will manage patients' claims for health care services more efficiently than those transferring these risk. This is not true. Capitation turns health providers into their patients' inefficient insurers and we lose health care (finance) system capacity in the process. I show that all small insurers, including risk assuming health care providers, must cut benefits or risk financial ruin, compared to larger, more efficient insurers.

Capitation health care finance mechanisms are common in the United States (Gold, Hurley, and Lake, 2001; Mayes, 2005) and evolving in Great Britain and Canada. The exchange of amounts close to the average cost, per patient, is the basis for all health provider

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risk sharing/bearing models. Unfortunately, this approach works best in only one direction, as risks move to, and are managed by, entities larger than the entity transferring the risks. Most health care finance literature fails to properly analyze insurance risk transferring health care finance mechanisms that fix health providers' revenues, while provider costs vary from patient to patient, encounter to encounter, and year to year.

2. Insurance Risk Transferring Health Care Finance Mechanisms

Every few years, new and supposedly different mechanisms that transfer insurance risks to health care finance mechanisms are introduced. Eventually their flaws are recognized by health providers, financial analysts, and health services researchers. Despite forty years of negative capitation experiences many authors (Arrow et. al, 2009; Gapenski and Pink, 2011) ignore capitation's abundant flaws and suggest that capitation can reduce costs without sacrificing quality or quantity. This is not true.

Insurance risk transferring health care finance mechanisms, include: Global and partial capitation, carve outs, provider risk/profit sharing, episode/bundled payments, Diagnosis Related Groups payment systems, and the Medicare/Medicaid prospective payment systems for physicians, hospitals, nursing homes, and home health agencies. Case mix adjustments are a common effort to cover the flaws in capitation (See Section 14). These approaches transfer insurance risks to different degrees, but the critical issue is the difference in size between entities transferring, and assuming, insurance risks.

Insurance risk transfers from individuals, and small insurers, to large insurers are efficient and effective when: Claims are relatively infrequent; Most policyholders have no, or modest, claims; and Few large claims exist (Borch, 1974; Hogg and Klugman, 1984; Bowers, Gerber, Hickman, Jones, and Nesbitt, 1997). Transfers of similar risks from large insurers to individuals, or small insurers, *almost always* results in less efficient risk management.

While capitation contracting parties are usually corporations, all clinically efficient health providers, including: Hospitals, Nursing Homes, Home Health Agencies, Physicians, Nurses, and Emergency and Operating Room personnel are affected, as facilities try to avoid adverse financial outcomes, such as: Missed profit goals, Operating losses, or Insolvency. I will show that when capitation is implemented in *clinically efficient* settings, individual staff members must cut medically necessary and appropriate patient care or their facilities will miss reasonable financial goals of earning profits, and avoiding operating losses and insolvency. The assertion that capitation creates more efficient health care (finance) systems is a myth.

These, more appropriate, analyses will show that small insurer portfolio size has a severe impact on insurer (Risk assuming provider) operating results (clinical and financial efficiency). Capitation impairs, not improves, provider clinical efficiency. Capitation advocates assumed, but never showed, that capitation works in efficient health care (finance) systems, a critical logical, mathematical, and statistical failing. When appropriately conceptualized and analyzed, capitation induced, insurance risk disaggregation, reduces post-transfer risk management efficiency, forcing insurance risk assuming health care providers to become less efficient, clinically and financially.

By comparing the impact of portfolio size on: Loss Ratio variability, Profitability, Operating losses, Insolvency risk, Surplus requirements, and Maximum Sustainable Benefits (MSBs), I show that insurance risk transferring, health care finance mechanisms increase health care costs, decrease health system capacity, and decrease health care (finance) system efficiency. Inefficient provider insurance operations lead to volatile financial outcomes, inefficient and negligent care, increased costs, and delayed and denied medically necessary and appropriate care.

3. Why Does Insurance Work?

The Central Limit Theorem (CLT) (Hogg and Craig, 1978; Hogg and Klugman, 1984) explains that insurance works because large insurers issue many policies, and the year to year, or portfolio to portfolio, variation in average claim costs approaches population average costs as portfolio sizes increase. Large insurers costs are very predictable, while small insurers tend to earn excessive profits, or incur excessive losses, each year. This exposure to high and low losses is the hallmark of insurer inefficiency. Inefficient insurers, including risk assuming health care providers, are more likely to struggle financially and become insolvent, as has happened for the last forty years (Mayes, 2005).

Despite the greater efficiency of large insurers, most health care (finance) reform recommendations ignore the CLT. Capitation advocates and other health care reformers suggest the opposite effect, that increased competition, among many small insurers will increase health care (finance) system efficiency and consumer benefits. This is demonstrably false. Limited competition among very few, very large, and very efficient insurers would definitely be more efficient and would yield higher policyholder benefits than large numbers of very small, very inefficient insurers (See Section 10.3).

4. Basic Insurance Principles

Insurance was practiced long before modern risk theory. Insurers must collect sufficient premiums to pay all their Claims Costs and non-claim related Operating Expenses, reward policyholders or stockholders for using their capital (Profit Margin), and provide protection, the Risk Premium, for their exposure to higher than expected Claims Costs (Hogg and Klugman, 1984; Bowers, Gerber, Hickman, Jones, and Nesbitt, 1997). Before issuing policies, insurer's have expectations about their revenues and costs, their Prospective Insurer Premium Allocation By Cost Components:

$$\begin{aligned}\text{Premium Revenues} \quad = \quad & \text{Claims Costs} \\ & + \quad \text{Operating Expenses} \\ & + \quad \text{Profit Margin} \\ & + \quad \text{Risk Premium}\end{aligned} \tag{1}$$

Insurers' premium allocations are unknown until policies expire and accounting is complete. Claims Costs (Losses and Loss Adjustment Expenses) are usually insurers' highest and least certain costs. Insurers' Profits, Operating Losses, and Solvency are uncertain primarily because Claims Costs are uncertain. When all Claims Costs have been paid, when no uncertainty exists, there are no Profit Margins or Risk Premiums, just Profits or Operating Losses, the insurer's Retrospective Premium Allocation By Cost Components:

$$\begin{aligned}\text{Profit (Operating Loss)} \quad = \quad & \text{Premium Revenues} \\ & - \quad \text{Claims Costs} \\ & - \quad \text{Operating Expenses}\end{aligned} \tag{2}$$

5. Insurer Operating Results

I focus on a single year of insurance operations, considering insurers' revenues and costs, when all insurers and health care providers operate as efficiently as possible with current resources, and insurers randomly select policyholders from the same population. Efficient health care providers engage in continuous patient monitoring, early diagnosis and treatment, treating patients at minimal cost by using the latest technology, proven treatment protocols, the most appropriate drugs, and appropriate referrals to specialists and alternative resources. Efficient health care does not mean there are no variations in costs. Patients still ignore recommendations, fail to recognize the significance of symptoms, delay seeking care, have multiple co-morbid conditions, and most high cost care is due to unexpected illnesses and accidents.

One negative effect of efficient, protocol driven care is reduced innovation. Providers avoid deviating from protocols that may trigger negative utilization audits and delaying potentially cost beneficial protocol revisions while providers wait for others to initiate clinical risk taking leading to protocol modifications. In efficient health care (finance) systems there are unavoidable variations in the costs of treating patients, and these are precisely the costs that are managed through efficient insurance mechanisms.

5.1 Insurer Revenues

Insurers have many revenue streams, including: Premiums for insurance policies; Investment income from bonds and stocks; Interest income for mortgages, and Rent from leased properties. I focus on insurers' Earned Premiums for insurance services during the year.

5.2 Claims Costs

Insurers' Claims Costs include all costs to settle claims, including: Actual claim payments; Legal expenses related to claims; Claims department salaries, rent, and utilities; and Court fees and Penalties for wrongful claim denial. Claims Costs vary, year to year, or portfolio to portfolio, because policyholders' health care costs vary. This is why we buy insurance. Insurer's average claims costs rarely vary more than 5-20% of long term average Claims Costs, while individual policyholders' Claims Costs may vary between $0.00 and 10,000 times average Claims Costs.

5.3 Insurer Population Loss Ratio Estimates

Insurers' [Policyholders'] Population Loss Ratio Estimates (See Equation 3), ($PLRE_N$ [$PLRE_i$], are averages of their total Claims Costs to their total Earned Premiums:

$$\text{Population Loss Ratio Estimate} = \frac{\text{Claims Costs}}{\text{Earned Premiums}} \tag{3}$$

The standard deviation, σ, for an individual, randomly selected policyholder's Population Loss Ratio Estimate ($PLRE_i$) is much larger than the standard error, $\frac{\sigma}{\sqrt{N}}$, for a randomly selected insurer's Population Loss Ratio Estimate ($PLRE_N$). The expected values of sample standard deviations for a randomly selected policyholder's standard error, is identical in all portfolios. Insurers' PLRE standard errors decrease, and their accuracy increases, as portfolio sizes increase, and PLRE accuracy decreases as portfolio sizes decrease. Large insurers' PLREs more accurately estimate Population Loss Ratios than small insurers' PLREs, because their standard errors are smaller. I compare insurer performance using portfolio size adjusted standard errors (See Section 9 and Table 1).

5.4 Insurer Operating Expense Ratios

Insurers' Operating Expenses are the costs for all non-claim activities, including: Commissions, rent, utilities, supplies, legal costs, and employee salaries. Expense Ratios are averages of Operating Expenses, to Earned Premiums (See Equation 4) and vary much less, year to year, or portfolio to portfolio, than PLREs. I assume Expense Ratios are 15% of Earned Premiums, to focus on the impact of PLRE variability on operating results.

$$\text{Expense Ratio} = \frac{\text{Operating Expenses}}{\text{Earned Premiums}} \tag{4}$$

6. Insurer Operating Results By Population Loss Ratio Estimate

Insurers' variable Claims Costs determine whether they succeed or fail: Are they profitable? Are they incurring operating losses? Are they solvent? What level of benefits can they provide? What are the highest level of Claims Costs they can pay and survive? Insurers earn profits if their PLREs and Operating Expense ratios sum to less than 100% (i.e. Claims Costs + Operating Expenses $<$ Earned Premiums) or they incur Operating Losses. If Claims Costs and Operating Expenses greatly exceed Earned Premiums insurers may be insolvent, unable to pay their obligations.

6.1 Insurer Operating Results By Population Loss Ratio Estimate - Profits

All insurers earn profits according to these relationships:

$$\text{Profit} \geq \text{(Profit Margin + Risk Premium) IF Claims Costs} \leq \text{Expected Claims Costs}$$

$$\text{Profit} \geq \text{Profit Margin IF Claims Costs} \leq \text{(Expected Claims Costs + Risk Premium)}$$

$$\text{Profit} \geq 0 \text{ IF Claims Costs} \leq \text{(Expected Claims Costs + Profit Margin + Risk Premium)}$$

6.2 Insurer Operating Results By Population Loss Ratio Estimate - Losses

Insurers incur Operating Losses (Claims Costs $>$ Expected Claims Costs + Profit Margins + Risk Premiums) and become insolvent when they have insufficient resources to pay all their obligations. Insolvent insurers should close their doors, but may continue for many years, as may insolvent health care providers. Insolvent insurers (health care providers) put policyholders (patients) at great risk for denied or delayed care due to insurer (provider) malfeasance or negligence.

Insurers can prevent some insolvencies by maintaining highly liquid assets ("Surplus") to cover excessive Claims Costs, but no insurer can prevent all risk of insolvency because the highly liquid assets devoted to Surplus are not available to produce goods or services. More Surplus decreases insurers' insolvency risks and profits. Most States have minimal statutory Surplus requirements, but this offers different levels of insolvency risk. I require all insurers to protect against insolvency with probability 0.9987, by maintaining Surplus assets sufficient to cover all Claims Cost from PLREs at, or below three standard errors above the Population Loss Ratio.

7. Efficient Insurer Portfolio Selections Are Random Samples

We know that insurer PLREs are uncertain because policyholders' health experiences vary. Very high PLREs occur when one, or more, policyholders incur high Claims Costs. Very low PLREs occur when very few policyholders incur high Claims Costs. But "perfect" years are years in which insurers' PLREs are exactly equal to the Population Loss Ratio. A perfectly efficient insurer does not have Claims Costs of $0.00. Perfectly efficient insurers issue infinitely many policies, and because σ_{e_∞} = 0.0000, their Claims Costs equal their Expected Claims Costs. Inefficient insurers have high, or low, Claims Costs but their "inefficiency" is due to their high Claims Costs variation (i.e. large standard errors).

Insurance premiums vary with policyholder risk characteristics and in efficient insurance markets, no insurer can systematically select lower risk policyholders. If this happens high risk policyholders may go uninsured, the most selective insurers get excessive premiums, and the least selective insurers, with too many high risk policyholders, get inadequate premiums. *In efficient insurance markets, insurers randomly select policyholders.*

Efficient insurance markets are stochastic processes subject to the Central Limit Theorem (CLT) (Hogg and Craig, 1978). PLREs are "averages" calculated from large, randomly selected groups of policyholders, and PLRE Cumulative Distribution Functions are normally distributed. I can analyze how portfolio size affects insurers' PLRE variability and operating results by specifying the Population Loss Ratio and either the standard error for a single, Paradigm Insurer (PI), or the standard deviation for an individual policyholder. Once these are specified, the CLT describes other insurer's standard errors and PLRE Distribution Functions, which I use to calculate probabilities of PLREs and operating results for insurers of any size.

Two insurers, ***M*** and ***N***, randomly selecting M and N ($M >> N$) policyholders from the same population, with individual policyholder PLRE standard deviation, σ, and Population Loss Ratio, μ, draw PLREs from very different, normally distributed Cumulative PLRE Distribution Functions: $\Phi_M(\mu, \frac{\sigma}{\sqrt{M}})$ and $\Phi_M(\mu, \frac{\sigma}{\sqrt{N}})$, where $\frac{\sigma}{\sqrt{M}} << \frac{\sigma}{\sqrt{N}}$ and each insurer's standard error determines all other insurers' standard errors since $\sigma_{e_M} = \sigma * \frac{\sqrt{N}}{\sqrt{M}}$.

I will specify the Population Loss Ratio (PLR) and a reasonable, market appropriate, assumption about Population Loss Ratio Estimate (PLRE) variation for a single, "reasonably efficient" Paradigm Insurer (PI), then analyze, and compare, the impact of portfolio size on operating results for four other insurers. The "Market Premium" for this reasonably efficient insurer is an adequate, but not excessive, expense, risk, and profit loaded premium such that if all policyholders pay the "Market Premium," the expected value of the total industry PLRE equals the PLR, and the market will continue to operate. Reasonable efficiency means that when the Paradigm Insurer receives the market premium, it can continue to operate with minimal risk of insolvency and acceptable levels of profits.

8. Paradigm insurer

The Paradigm Insurer's future operating results depend on the variation in PI's Population Loss Ratio Estimates ($PLRE_{PI}$s), PI's standard error, $\sigma_{e_{1,000,000}} = \sigma_{e_{PI}} = \frac{\sigma}{\sqrt{1,000,000}}$ which I assume to be 0.0500. PI's Cumulative PLRE Distribution Function is normally distributed, Φ_{PI}(0.7500, 0.0500). Insurance risk assuming health care providers are similar to insurers smaller than PI. PI's operating characteristics include:

- Issues 1,000,000 policies and charges each policyholder the $4,000 "market premium" collecting Earned Premiums totaling $4,000,000,000 (1,000,000 * $4,000)
- Bears "risk" because $PLRE_{PI}$ is unknown until policies expire and accounting is complete
- Operating results are functions of the PLRE ($PLRE_{PI}$)

- Expected[Population Loss Ratio Estimate] = Population Loss Ratio (0.7500)
- Incurs "Underwriting Expenses" of $0.15 per premium dollar ($600,000,000)
- Charges policyholders a market based "Profit Margin" of 5% ($200,000,000)
- Charges policyholders a market based "Risk Premium" of 5% ($200,000,000)
- Pays Claims Costs of $3,000,000,000 or less ($PLRE_{PI} \leq$ 0.7500) from current revenues, earning profits of at least 10%, with probability 0.5000
- Pays Claims Costs of $3,200,000,000 or less ($PLRE_{PI} \leq$ 0.8000) from current revenues, earning profits of at least 5%, with probability 0.8413
- Pays Claims Costs of $3,400,000,000 or less ($PLRE_{PI} \leq$ 0.8500) from current revenues, and avoids net operating losses, with probability 0.9772
- Starts the year with Surplus of $200,000,000 protecting itself from Claims Costs up to $3,600,000,000 ($PLRE_{PI} \leq 0.9000$)
- Becomes insolvent (Probability = 0.00135) when Claims Costs $>$ $3,600,000,000

Table 1 Column 4, highlights PI's future operating results. Before proceeding, I stress that all insurers, and all health care providers, operate as efficiently as possible. I will show that small insurers and small, clinically efficient, capitated health care providers must cut services below the level PI provides. Capitation cannot create more efficient health care (finance) systems because it cannot work in efficient health care (finance) systems.

9. Quantitative Analysis of Insurer Operations

Insurers NHI, B, PI, D and E randomly select 308,000,000; 10,000,000; 1,000,000; 100,000; and 10,000 policyholders from the same population (See Table 1 Row 1). Each insurer produces a Population Loss Ratio Estimate (PLRE) of the Population Loss Ratio. How accurate these PLREs are is measured by each insurer's portfolio size adjusted standard error. Insurers select large samples, so their PLRE distribution functions are all normally distributed, even if policyholder PLREs are not. I will show that transferring insurance risks to health care providers (Capitation) is flawed, by comparing the impact of portfolio size on PLRE variability, PLRE probabilities, and these five insurers' probabilities of earning Profits, incurring Operating Losses, or becoming Insolvent. I will also compare insurers' Surplus requirements and Maximum Sustainable Benefits for policyholders.

9.1 Insurer Standard Errors by Portfolio Size

Table 1 Row 1, shows insurer portfolio sizes in thousands (1,000s) of policyholders. Table 1 Row 2, shows portfolio size adjusted standard errors, $\sigma_{e_N} = \sigma_{e_{PI}} * \frac{\sqrt{1{,}000{,}000}}{\sqrt{N}}$. NHI's standard error, $\sigma_{e_{NHI}}$, is 0.00285 while σ_{e_E} = 0.50000, ten times larger than $\sigma_{e_{PI}}$ (0.05000), and 175 times larger than $\sigma_{e_{NHI}}$.

These insurers' normally distributed Population Loss Ratio Estimate Distribution Functions, are: Φ(0.7500, 0.002849); Φ(0.7500, 0.015811); Φ(0.7500, 0.050000); Φ(0.7500, 0.158114); and Φ(0.7500, 0.500000), for NHI, B, PI, D and E.

Capitation advocates must have failed to note these profound differences in PLRE Distribution Functions because *all insurers larger than PI have more probability below PLR +* ϵ ($\epsilon > 0$) than PI, and *all smaller insurers have more probability above PLR +* ϵ than PI.

When correctly analyzed, these subtle Distribution Functions result in dramatically different insurer operating results when insurance markets and health care (finance) systems are as efficient as possible, and policyholders are randomly selected.

9.2 Insurer Probabilities of Profits by Portfolio Size

Insurers use the 85% of their premiums not allocated to operating expenses in Formula 1 to pay policyholders' health expenses, converting all unused portions to profits. Table 1 Row 3, shows all insurers have probability, $\Phi_N(0.7500)$ = 0.5000, of profits of at least 10%, at PLREs at, or below, PLR (0.7500), because E[PLRE] = PLR for all insurers. Capitation advocates may not have gone any further than this because this is obviously the only PLRE value for which insurers' profit probabilities are identical. Small insurers have more probability in the tails of their distributions which is why they tend to have volatile operating results. Large insurers tend to have most of their probability close to the PLR, so their operating results tend to vary very little.

Table 1 Row 4, shows insurers' probabilities ($\Phi_N(0.8000)$) of profits of at least 5%, at PLREs below 0.8000. NHI earns such profits with probability 1.0000, B with probability 0.9992, and PI with probability 0.8413. D and E have much lower probabilities of earning such profits, 0.6241 and 0.5398, respectively. However, $\Phi_{NHI}(0.8000)$) = 1.0000 is very misleading. NHI's probability, Φ_{NHI}(PLR + 3 * $\sigma_{e_{NHI}}$) = $\Phi_{NHI}(0.758547)$ = 0.9987. NHI *almost always* earns profits greater than 9.15%, and since $\Phi_B(0.79743)$ = 0.9987, B *almost always* earns profits greater than 5.25%!

Table 1 Row 5, shows insurers' probabilities of profits greater than 0% (Break Even), $\Phi_N(0.8500)$, at PLREs below 0.8500. NHI and B have probability 1.0000, PI's probability is 0.9772, but D and E have much lower "break-even" probabilities, 0.7365 and 0.5793, respectively.

9.3 Insurer Probabilities of Operating Losses by Portfolio Size

NHI and B have probability 0.0000 of incurring operating losses, PI has probability 0.0228, but D and E have much higher operating loss probabilities, 0.2635 (1.0000 - 0.7365) and 0.4207 (1.0000 - 0.5793), respectively.

Table 1 Row 6, shows insurers' probabilities of incurring operating losses greater than 5% ($1.0000 - \Phi_N(0.9000)$), at PLREs above 0.9000. NHI and B incur such operating losses with probability 0.0000, PI's probability is 0.00135, but D and E have probabilities, 0.1714 and 0.3821, respectively. Insurer D is 127 times more likely, and Insurer E is 283 times more likely, to incur such operating losses, than PI. Table 1 Row 7, shows insurers' probabilities of operating losses greater than 10%, at PLREs above 0.9500. Φ_{NHI}(0.9500) = Φ_B(0.9500) = $\Phi_{PI}(0.9500)$ = 0.0000, while $\Phi_D(0.9500)$ = 0.1030 and $\Phi_E(0.9500)$ = 0.3446. D can expect such high operating losses more than one year in ten, and E more than one year in three.

10. Insurer Risk and Surplus Requirements

I have shown that small insurers have higher probabilities, of high operating losses, than large insurers, a result capitation advocates must have failed to consider because this alone shows that capitation would never work in efficient health care (finance) systems.

All insurers must anticipate years in which their PLREs exceed 0.8500. If they incur PLREs higher than 0.8500 and have no additional assets (Surplus), beyond current premiums, they become insolvent (bankrupt). Insolvency means failed commitments to suppliers, employees, stockholders, claimants, and policyholders. Regulators set many

Table 1: Insurer Standard Errors, Financial Outcome Probabilities, Surplus Requirements, Maximum Sustainable Benefits, and Risk Adjusted Premiums by Portfolio Size

(1) Row	(2) Operating Characteristic	(3) NHI	(4) B	**(5) PI**	(6) D	(7) E
(1)	Size (N) (1,000s)	308,000	10,000	**1,000**	100	10
(2)	Standard Error (σ_{e_N})	0.00285	0.01581	**0.0500**	0.1581	0.5000
(3)	**P[Profit≥10%]**	**0.5000**	**0.5000**	**0.5000**	**0.5000**	**0.5000**
(4)	P[Profit≥5%]	1.0000	0.9992	**0.8413**	0.6241	0.5398
(5)	P[No loss]	1.0000	1.0000	**0.9772**	0.7365	0.5793
(6)	P[Losses≥5%]	0.0000	0.0000	**0.0013**	0.1714	0.3821
(7)	P[Losses≥10%]	0.0000	0.0000	**0.0000**	0.1030	0.3446
(8)	SPLR	0.7586	0.7974	**0.9000**	1.2243	2.2500
(9)	Surplus Needs $1M	$0	$0	**$200**	$150	$56
(10)	Agg Surplus $1 Trillions	$0	$0	**$0.616**	$4.612	$172
(11)	MSB 5% Profits	0.7972	0.7842	**0.7500**	0.6419	0.3000
(12)	MSB 5% Profits $	3,189	3,137	**3,000**	2,568	1,200
(13)	MSB Avoid Losses	0.8443	0.8184	**0.7500**	0.5338	0.0000
(14)	MSB Avoid Losses $	3,377	3,274	**3,000**	2,135	0.00
(15)	Prof Adj'd Risk Prm % EP	80.38	81.5	**85.0**	95.8	130.0
(16)	Loss Adj'd Risk Prm % EP	75.67	78.0	**85.0**	106.6	175.0

solvency requirements, including: minimum capitalization, statutory surplus and reserve requirements; rate regulation; restrictions on risky investments; and also conduct periodic financial inspections to reduce the numbers of insurer insolvencies (Barth, 2000; Cummins, Harrington and Niehaus, 1994).

10.1 Solvency Preserving Loss Ratio

There are no magic formulas for solvency protection. I require all insurers to meet a uniform solvency protection standard, the "Solvency Preserving Loss Ratio" ($SPLR_N$). $SPLR_N$ is the highest level PLRE insurers must be able to cover, before issuing policies, and it protects each insurer from PLREs up to PLR + 3 * σ_{e_I}, or all the Claims Costs it incurs with probability 0.9987. Insurers with adequate Surplus face insolvency less than 14 out of 10,000 years.

Table 1 Row 8, shows insurers' Solvency Preserving Loss Ratios. $SPLR_{PI}$ = 0.9000, but larger insurers, with lower standard errors, have lower SPLRs: $SPLR_{NHI} = 0.7586$ and $SPLR_B = 0.7974$, while smaller insurers, with higher standard errors, have much higher SPLRs: $SPLR_D = 1.2243$ and $SPLR_E = 2.2500$. To be as well prepared as PI, to cover unusually high Claims Costs, D and E will need to idle huge amounts of Surplus, before issuing any policies. My risk adjusted Surplus requirement inhibits market entry by small, inefficient insurers, that are likely to fail, and encourages market entry by large, efficient insurers that are likely to succeed.

Regulators encourage other insurers to cover failed insurer's policies to maintain consumer confidence. NHI and B, with profits over 9%, and 5%, can cover many failed insurers' policies and earn good will. But small, inefficient insurers decrease the efficiency of insurance markets, taking excessive profits, or shifting their losses, to other insurers.

10.2 Surplus Requirements by Portfolio Size

Insurer's Surplus requirements, S_N, are dollar amounts of highly liquid assets, set aside before issuing policies, to cover the layer of operating losses between PLREs of 0.8500 and $SPLR_N$ [i.e. S_N = Max(0,($SPLR_N$ - 0.8500) * Earned Premiums * Size)]. Table 1 Row 9 shows that S_{NHI} = S_B = $0.00 because Φ_{NHI}(0.8500) = Φ_B(0.8500) = 1.0000. S_{PI} = $200,000,000 at $SPLR_{PI}$ = 0.9000, S_D = $149,736,660 and S_E = $56,000,000 because $SPLR_D$ = 1.22434 and $SPLR_D$ = 2.2500.

10.3 Aggregate Surplus by Portfolio Size

We want to insure all Americans so Table 1 Row 10 shows, the total Surplus needs, in Billions of dollars, by portfolio size. NHI and B can insure everyone with $0.00 aggregate Surplus, while 308 PI's need $61.6 Billion. But, 3,080 D's need $4.6 Trillion, and 30,800 E's need $172 Trillion. By ignoring small insurers', and risk assuming health care providers' Surplus needs, capitation advocates missed the greatest flaw in capitation, small insurers (risk assuming health care providers) need Trillions of dollars in Surplus. Inadequately capitalized, risk assuming health care providers have been failing, clinically and financially for decades (Mayes, 2005). In the aftermath of Hurricane Katrina, patients died because health care facilities were inadequately staffed and provisioned and could not continue to deliver care, despite having been paid, in advance, through capitation.

Before becoming health insurers, risk assuming health care providers should have diverted most of their assets to capitalizing their inefficient insurance operations, becoming inefficient clinicians because Surplus assets are not available to produce clinical services. Capitated providers continue their inefficient and under-capitalized insurance operations because capitation advocates refuse to admit that capitation cannot work in efficient health care (finance) systems.

While daunting, these aggregate Surplus levels are understated because S_N protects single insurers. Bonferroni corrected aggregate surplus requirements for small insurers and risk assuming health care providers are much higher.

Insurer Risk and Maximum Sustainable Benefits

I can compare insurers' Maximum Sustainable Benefits (MSB_N) when matching PI's probabilities of: Profits of at least 5%; or Avoiding operating losses. Each constraint produces different MSB_Ns. Until now, insurers paid identical benefits, to efficient providers, for identical symptoms. But Table 1 Rows 4 and 5, revealed that larger and smaller insurers have different probabilities of earning profits, or avoiding operating losses, than PI, so they cannot offer identical benefits *and* match PI's profitability or loss avoidance performance.

11. Maximum Sustainable Benefits for Profits of 5 Percent

Insurers' Maximum Sustainable Benefit For Profits of 5% ($MSBP5_N$) are the highest portion of a premium dollar insurers can pay, throughout the year, and match PI's probability (0.8413) of profits of at least 5%. To adjust for differences in PLRE variability, $MSBP5_N$ = 0.8000 - 1 * σ_{e_N} because PLREs above 0.8000 do not yield these profits. Table 1 Row 11, shows $MSBP5_{NHI}$ = 0.79715 and $MSBP5_B$ = 0.78419. NHI and B can pay higher benefits than PI (0.7500), but $MSBP5_D$ = 0.6419 and $MSBP5_E$ = 0.3000. E must cut PI's benefits by 60% because it is so inefficient.

Table 1 Row 12 shows dollar values ($MSBP5_N$ * $4,000) of average policyholder benefits by insurer. NHI, B, PI, D and E can provide average benefits of: $3,189; $3,137; $3,000; $2,568; and $1,200. Contrary to capitation advocates' claims, these are reduced benefits, cuts in medically necessary and appropriate care due to providers' inefficient insurance operations, not capitation induced savings from increased clinical efficiency.

11.1 Maximum Sustainable Benefits to Avoid Operating Losses

Insurers' Maximum Sustainable Benefit For Avoiding Losses, $MSBAL_N$, are the highest portions of premium dollars they can provide, as benefits, throughout the year, while matching PI's probability (0.9772) of avoiding operating losses. To adjust for their differences in PLRE variability, $MSBAL_{NHI}$ = 0.8500 - 2 * σ_{e_N} because PLREs above 0.8500 produce operating losses. Table 1 Row 13, shows that $MSBAL_{NHI}$ = 0.8443; $MSBAL_B$ = 0.8184; and $MSBAL_{PI}$ = 0.7500. $MSBAL_D$ = 0.5338 and because σ_{e_E} is ten times larger than $\sigma_{e_{PI}}$, $MSBAL_E$ is less than 0.0000 (0.8500 - 2 * 0.5000), because E's probability of losses (0.4207) is much higher than PI's (0.0228).

Insurers' Maximum Average Benefits Per Policyholder To Avoid Operating Losses $MABPPL_N$ are the highest benefits, in dollars, ($MABPPL_N$ = $MSBAL_N$ * \$4,000) insurers can pay, while matching PI's probability (0.9772) of avoiding operating losses. Table 1 Row 14, lists these benefits. $MABPPL_{NHI}$ = \$3,377, $MABPPL_B$ = \$3,274 and $MABPPL_{PI}$ = \$3,000. $MABPPL_D$ = \$2,135 and $MABPPL_E <$ \$0.00.

Matching PI's ability to earn profits is easier than matching PI's ability to avoid losses, because the more loss smaller insurers are, the more they need to cut benefits, to match PI's probability of avoiding losses. PI', D's and E's probabilities of earning profits, or incurring losses, are similar near the PLR, but rapidly diverge above the PLR, making it increasingly more difficult to match PI's performance.

12. Risk Adjusted Premiums

The real flaw in capitation is that smaller insurers need higher Risk Premiums than PI's market based Risk Premium of 5%, while larger insurers can accept lower Risk Premiums. Portfolio Risk Adjusted Premiums (PRAPs) reflect insurers' different probabilities of adverse operating results. The "Market Premium" of \$4,000 per policyholder, per year is adequate, and not excessive for the Population, and it works well for PI, because PI has the only portfolio size that results in the operating characteristics described in Section 8. In an efficient insurance market, with large and small insurers, there exists only one portfolio size for which the market premium is adequate, but not excessive. PI has the operating characteristics it has because 1,000,000 policyholders is the perfect size for a reasonably efficient insurer. The market premium (\$4,000) is inadequate for smaller insurers, and excessive for larger insurers. Recall that PI's Market Premium has a Risk Premium of 5%:

$$\begin{aligned}\text{Market Premium} &= \text{Expected Claims Costs} \\ &+ \text{5\% Market Average Profit Margin} \\ &+ \text{5\% Market Average Risk Premium}\end{aligned} \tag{5}$$

while insurers smaller (larger) than PI need higher (lower) Portfolio Risk Adjusted Premiums to compensate for their higher probabilities of excessive Claims Costs:

$$\begin{aligned}\text{Portfolio Risk Adjusted Premium} &= \text{Expected Claims Costs} \\ &+ \text{5\% Market Average Profit Margin} \\ &+ \text{Portfolio Size Adjusted Risk Premium}\end{aligned} \tag{6}$$

This analysis will show that when PI transfers its Claims Costs to other insurers, smaller insurers need payments that exceed 85% of PI's Earned Premiums, guaranteeing Operating Losses for PI. Larger insurers can accept less than 85% of PI's Earned Premiums, guaranteeing PI certain profits. This happens because larger insurers are more efficient than PI and all smaller insurers.

Insurer's Portfolio Risk Adjusted Premiums ($PRAP_N$) adjust for the fact that small insurers have higher probabilities of PLRE's above 1, 2, 3, 4 standard errors above the PLR than PI and larger insurers. To earn profits of 5%, or simply to avoid losses, with the same probability as PI, they need additional payments, or additional Surplus, to cushion them from these Claims Costs. If PI transfer its Claims Costs portfolio to larger insurers the transaction can benefit both parties (See Section 13, but if PI transfers its portfolio to D and E, at least one party is harmed. Risk assuming health care providers like D and E, are, *almost always*, going to need higher Portfolio Size Adjusted Risk Premiums than PI can provide without incurring Operating Losses or becoming insolvent.

12.1 Portfolio Risk Adjusted Premiums - Matching PI's Profit Probabilities

Assume that brand new D and E (actually Claims Costs Managers) want PI's probability (0.8413) of earning profits of at least 5% on portfolios of 100,000 (10,000) policyholders. Their standard errors are higher than PI's, so $PRAP5_D$ = 0.9581 (0.7500 + 0.0500 + 1 * 0.1581) and $PRAP5_E$ = 1.3000 (0.7500 + 0.0500 + 1 * 0.5000) are the portions of each dollar of PI's Earned Premiums D and E need to match PI's probability of earning profits of at least 5% on their portfolios.and PLR + 1 * σ_{e_E}, 0.9081 and 1.2500 respectively. D and E need Size Adjusted Risk Premiums of 15.81% and 50.00% of PI's 5%, market competitive Risk Premium. To adequately compensate inefficient D [E] and they each have PI's pre-transfer probability of earning 5% profits, If PI pays 10 Ds [100 Es] less than 95.81% (0.7500 + 0.05 + 15.81) [130.00% (0.7500 + 0.05 + 0.5000)] of its Earned Premiums for transferring its Claims Costs, they do not match PI's profit probability. If PI adequately compensates D and E, it incurs catastrophic operating losses of 10.81% and 45% on each transfer, becoming insolvent, and about 62.41% of D's will have PLREs below 0.8000, as will 53.98% of E's, so they will be grossly overpaid by 15.81% and 50% of PI's Earned Premiums.

12.2 Portfolio Risk Adjusted Premiums - Matching PI's Loss Avoidance Probabilities

When matching PI's probability of avoiding losses, $PRAPL0_D$ = 1.0662 (0.7500 + 2 * 0.1581)) and $PRAPL0_E$ = 1.7500 (0.7500 + 2 * 0.5000) are the Portfolio Risk Adjusted portions of policyholder's premiums PI needs to pay each new insurer D and E if they are going to match PI's probability of avoiding losses. PI's payment must cover their risk of Claims Costs up to (PLR + 2 * σ_{e_N}) and include a 5% Profit Margin.profits, If PI pays D [E] less than 106.62% [175.00% of its Earned Premiums to assume the Claims Costs for transferred policies, their probabilities of avoiding losses fall below PI's. If PI pays these amounts it becomes insolvent, incurring certain operating losses of 31.62% and 90.00% on the transfers. PI still needs to do this for every D and E it needs to transfer all its Claims Costs. About 62.41% of D's will have PLREs at, or below 0.8000, as will 53.98% of E's, so they would receive much more than they need. But overpaying all these insurers is the only way PI can adequately compensate all risk assuming insurers, for the risks they are assuming. But we know (See Section 9.2 that D and E have "break-even" probabilities of 0.7365 and 0.5793. If PI adequately compensates all its risk assuming partners, 73.65% of Ds and 57.93% of Es will be overcompensated.

Overpaying most smaller risk assuming insurers, and most risk assuming health care providers, is the price PI pays to adequately compensate smaller, less efficient insurers, for assuming its Claims Costs. Yet another fatal, and uncorrectable, flaw in the theory of capitation financed health care. their risk assumption because the providers become inefficient insurers just like D and E.

13. Reinsurance - How PI Can Eliminate Risk and Lock In Profits

PI cannot adequately compensate smaller, less efficient insurers (risk assuming health care providers), but PI can lock in profits and eliminate risk by passing its Claims Costs to more efficient insurers, NHI and B. If B assumes all PI's policyholders' Claims Costs, σ_{e_B} drops from $\sigma_{e_{10,000,000}}$ = 0.015811, to $\sigma_{e_{11,000,000}}$ = 0.015076. NHI's $\sigma_{e_{308,000,000}}$ = 0.002849 drops to $\sigma_{e_{309,000,000}}$ = 0.002844. NHI and B become larger, more efficient insurers by accepting PI's risks, and can accept less than 85% of PI's Earned Premiums, eliminate PI's risk, and match, even exceed, PI's pre-transfer probabilities of earning profits of at least 5%; or avoiding operating losses, on their entire portfolios.

13.1 Profit Adjusted Premiums - PI Transfers Risks to Insurer B or NHI

B's new probability, Φ_B(0.765076), of a PLRE less than 0.765076 (PLR + 1 * 0.015076) is 0.8413, PI's probability of profits of at least 5%. B can exceed PI's probability of earning 5% profits on its portfolio, if PI pays B 81.51% (100% * (0.765076 + 0.05000)) of its Earned Premiums. PI's profits are guaranteed at 3.49%. Phi_{NHI}(0.752844), NHI's probability of a PLRE less than 0.752844 (PLR + 1 * $\sigma_{e_{309,000,000}}$), is 0.8413, so NHI can exceed PI's probability of earning 5% profits on its portfolio, if PI pays NHI 80.28% (0.752844 + 0.05000) of its Earned Premiums. PI's profits are guaranteed at 4.72%.

13.2 Loss and Risk Adjusted Premiums - PI Transfers Risks to Insurer B and NHI

PI's situation improves if NHI and B have more modest goals: Avoiding losses with PI's pre-transfer probability. B's probability, Φ_{NHI}(0.780152), of a PLRE less than 0.780152 (PLR + 2 * $\sigma_{e_{11,000,000}}$), is 0.9772, PI's probability of avoiding operating losses. If PI pays B 78.02% of its Earned Premiums, B exceeds PI's probability of avoiding operating Losses on its entire portfolio, and PI's guaranteed profits are 6.98%. NHI's probability, Φ_{NHI}(0.755688), of a PLRE less than PLR + 2 * $\sigma_{e_{309,000,000}}$, is 0.9772. PI can pay NHI 75.57% of its Earned Premiums and lock in profits of 9.43%, while NHI's probability of avoiding losses on its entire portfolio exceeds PI's pre-transfer probability.

B and NHI would want more of PI's profits, but no insurer (risk assuming health care provider) smaller, post-transfer, than PI, can assume PI's Claims Costs for less than NHI or B. Previously clinically efficient providers, accepting capitation from PI, become inefficient insurers and must cut patient care (See Section 10.3), or face financial ruin. Even generous reinsurance companies will not accept risks at affordable fees for capitated providers. Reinsurers do not want the risks of high Claims Costs that PI rejected, because PI's benefits come from forcing providers to cut medically necessary and appropriate care. Low cost, low risk provider reinsurance would reduce, or eliminate, capitation induced cuts in needed care, the only benefit (curse) of capitation.

14. The Impact of Case Mix Adjusted Capitation Rates on Risk Bearing Providers

Flaws in capitation created a "Case Mix Adjustment" cottage industry. Capitation systems start with payments deemed adequate, but not excessive, for a population. The population is a mix of epidemiologically significant characteristics that influence costs. Even if capitation rates are correct, on average, some providers are overpaid, and others underpaid, despite receiving identical per patient capitation payments. Payment-cost disparities arise for two reasons: Main factor effects when providers' portfolios differ from the population on epidemiologically relevant characteristics; and Increased PLRE variability, due to small portfolios.

Correcting capitation rates for main factor effects, through case mix adjustments, is simple but inadequate, because small providers are less efficient insurers than PI. Case mix adjusted capitation rates cannot compensate providers because the providers need higher Portfolio Risk Adjusted Premiums to compensate for their inefficient insurance operations. Case mix adjustments, while necessary, are insufficient corrections for the providers' risks.

Only providers who believe their costs are higher than appropriate, will request case mix adjustments, the "Lake Wobegon" effect: "All Lake Wobegon providers believe their costs are above average." No Lake Wobegon providers ever requests reduced case mix payments. Provider initiated case mix adjustments result in inefficient increases in aggregate capitation payments, even if the original capitation payments were correct. Some successful case mix adjustments correct for inefficient insurance operations, not epidemiological differences in expected Claims Costs, so these increased capitation payments are inefficient. Even when capitation payments are perfect, providers are either underpaid, or underpaid, for their future costs, because provider's costs, including profit margins, are *almost never* equal to capitation payments, because the most significant sources of providers' Claims Cost variations are not corrected by case mix adjustments.

Worse still, provider's portfolios are *almost never* random selections from the population for which capitation rates were calculated. Patient-provider matching is *almost always* non-random due to geography, transportation routes, age, gender, current and prior health status, and socioeconomic factors. "Park Avenue" providers avoid poor patients and rich patients avoid providers in poor areas. Real insurers are statutorily forbidden from "Red Lining" neighborhoods, in marketing and underwriting activities, while risk assuming health care providers freely "Red Line" neighborhoods as they select service locations and set operating hours, and discouraging undesirable patients in pre-appointment screening. Provider portfolios are *almost never* random, increasing barriers to care for some patients.

15. Conclusions and Recommendations

I have shown that small insurers are less efficient than large insurers due to higher variation in their Population Loss Ratio Estimates. Capitation forces clinically efficient health care providers to become inefficient insurers and inefficient clinicians because risk assuming health care providers must cut PI's benefits, even when their capitation payments are adequate for the population. Capitation increases the financial risks of operating health care facilities, disproportionately benefits risk transferors, harms providers and patients, and forces our health care (finance) systems to become less, not more, efficient.

Capitation only works in very inefficient health care (finance) systems when providers can avoid cutting medically necessary and appropriate care, because most providers are overpaid (See Section 12. D and E cannot maintain service quality and quantity unless PI pays all of them more than 90% of its Earned Premiums.

The conclusion is stark: Capitation cannot steer inefficient health care (finance) systems toward efficiency because as providers adjust to capitation, the quality and quantity of health care services they provide must fall far below the level of medically necessary and appropriate care. Capitation steers health care (finance) systems from inefficient states in which patients receive medically necessary and appropriate care to inefficient states in which some, if not all patients, do not.

To improve health care (finance) system effectiveness and efficiency we must identify and eliminate inefficient insurance operations, beginning with risk assuming health care providers, then working on hundreds of our smallest, least efficient health insurers. NHI is the most efficient insurer possible, but 30 - 40 large, efficient Bs, can offer higher benefits than PI, need less Surplus, would better protect health providers from financial ruin, will earn reasonable and sustainable profits, avoid operating losses, and avoid insolvency with probabilities close to NHIs. Increased insurer efficiency, not capitation, is the path toward more efficient health care (finance) systems.

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