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The (Mis)alignment of Health Insurers' Efficiency Measures from Different Perspectives and Their (Un)linkage with Financial Ratios and Asset Allocation

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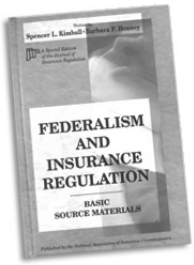

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The (Mis)alignment of Health Insurers' Efficiency Measures from Different Perspectives and Their (Un)linkage with Financial Ratios and Asset Allocation

Charles C. Yang*
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Abstract

This research uses Data Envelopment Analysis (DEA) models to examine the alignment of health insurers' efficiency measures from different perspectives. It also analyzes the linkage between efficiency measures and asset allocation, as well as traditional financial ratios including medical loss ratio (MLR). The DEA results indicate that the operating efficiency and the medical services efficiency are positively (but not highly) correlated with each other, and financial ratios are not effective indicators of the efficiency of health insurers. The composite efficiency is much higher than the operating or medical services efficiency. The correlation between the composite efficiency and the operating efficiency or the medical services efficiency is moderate. Neither the operating efficiency nor the medical services efficiency is an appropriate measure of the overall efficiency of health insurers. Therefore, innovative regulatory measures, such as a combination of efficiency measures and financial ratios, should be adopted to satisfy all the stakeholders. This research provides significant insights to policymakers, regulators, the health insurance industry and consumers.

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Introduction

Economic efficiency refers to maximizing the output value and minimizing the input cost. An optimal health care system should take into consideration all the three important components: 1) universal coverage; 2) cost containment; and 3) quality of services. Rising health care costs and affordability are among the biggest challenges in the U.S., so efficiency should be measured, monitored and improved without the sacrifice of availability or quality of health care services. Efficiency can be evaluated from different perspectives of stakeholders, such as customers, stockholders or policyholders, regulators, the company itself, or the society as a whole. An important provision of the federal Affordable Care Act (ACA) is the requirement of the minimum medical loss ratio (MLR) to encourage health insurers to provide quality services to enrollees. This research aims to discuss whether financial ratios are effective indicators of the overall efficiency of health insurers and what measures are appropriate for more effective regulation. To achieve this objective, this research examines the operating efficiency of both underwriting and investments from the perspective of the insurer and its alignment with the medical services efficiency of providing health care services from the perspective of the society. It also analyzes the composite efficiency to accommodate the interest of different parties and the linkage between efficiency measures and asset allocation, as well as traditional financial ratios including MLR. To our knowledge, this research is some of the first and should provide significant insights to policymakers, regulators and the health insurance industry regarding the operation of health insurers, cost and regulatory efficiency, and health care reform.

In the recent literature related to the composite efficiency analysis of this current research, Brockett et al. (2005) present a framework of the insurer as a financial intermediary that acknowledges that interests potentially conflict and the strategic decision makers must balance one concern versus another when managing the insurance company. Within this financial intermediary approach, solvency can be a primary concern for regulators of insurance companies, claims-paying ability can be a primary concern for policyholders, and return on investment can be a primary concern for investors. Accordingly, they investigate the efficiency of insurance companies using Data Envelopment Analysis (DEA) having the combination of solvency, claims-paying ability and return on investment as outputs. As to profitability, Greene and Segal (2004) explore the relationship between cost inefficiency and profitability in the U.S. life insurance industry. Their results suggest that cost inefficiency in the life insurance industry is substantial relative to earnings and that inefficiency is negatively associated with profitability measures such as the return on equity. Regarding financial ratios and asset allocation, Zou et al. (2012) examine the interrelation between underwriting and investment risks of property-liability insurers, where the underwriting risk is measured by the combined ratio while the investment risk is measured by the proportion of investment in common stocks, preferred stocks and

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long-term low-grade bonds. Their results suggest no significant relationship between the underwriting and investment risks.

On the efficiency of health insurance, related to efficiency perspectives of this current research, Brockett et al. (2004) apply the game-theoretic DEA model to evaluate the relative overall efficiency of two principle health maintenance organization (HMO) categories from two perspectives: 1) that of consumers; and 2) that of the society. Yang (2014) uses the DEA approach to examine the medical services efficiency of the U.S. health insurers in providing health care services. With regard to the MLR regulation, Harrington (2013) analyzes its potential unintended consequences and incentive effects and discusses modifications and alternatives to the MLR regulation to help achieve its stated goals with less potential for adverse effects; McCue, Hall and Liu (2013) gauge this rule's effect on insurers' financial performance; and Abraham, Karaca-Mandic and Simon (2014) investigate early responses of individual and small-group insurers' MLR-related outcomes to ACA provisions. However, none of these studies have analyzed the topics covered in this current research.

Specifically, this current research investigates the relationship between the operating efficiency and the medical services efficiency and examines the difference of this relationship by the organization type, the number of states the insurers serves and the size of the insurer. MLR is the percent of premium an insurer spends on claims and expenses that improve health care quality. Under the ACA, health insurers have to pay rebates to policyholders if they do not meet an MLR standard of at least 80% (for individuals and small groups) or 85% (for large groups). To show whether the different performance measures of health insurers are consistent, the relationship between financial ratios (MLR, loss ratio, combined ratio, operating ratio, investment income ratio and expense ratio) and the operating efficiency, as well as the medical services efficiency, is examined. In addition, the relationship between asset allocation (in bonds, mortgage-backed securities [MBS], stocks, real estate investments, and cash and cash equivalents) and the operating efficiency, as well as the medical services efficiency, is also explored. Furthermore, this current research analyzes the composite efficiency, which combines both the operating efficiency and the medical services efficiency, and its relationship with other efficiency measures, including the average efficiency (the average of the operating efficiency and the medical services efficiency).

Data and Research Design

DEA, one prominent non-parametric frontier efficiency approach, has been used in a lot of studies for efficiency measures (Cummins and Weiss 2011). This

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current research adopts the Envelopment Model[1] to evaluate the efficiency of health insurers. The Envelopment Model pools together all the decision making units (DMUs, insurers in this current research), and the relative efficiency of a DMU is measured by comparing this DMU to "best practice" efficient frontiers formed by the most efficient DMUs. The efficiency score is obtained as the optimal ratio of the weighted sum of outputs over the weighted sum of inputs.[2]

Briefly, the Envelopment Model is presented as follows. Given n DMUs, each with m inputs and s outputs, the relative efficiency score of a test DMU_0 is determined by solving the following program (Brockett et al. 2004):

$$\begin{aligned} &\underset{u,v}{Max}\,\frac{y_0^T v}{x_0^T u} \\ &\text{s.t. } \frac{y_j^T v}{x_j^T u} \le 1,\ j = 1, 2, \ldots, n \\ &u, v \ge 0 \end{aligned} \tag{1}$$

where the subscript "0" denotes any one of the n DMUs whose efficiency is being evaluated. y^T and x^T denote the vector of the outputs and inputs of DMU j, respectively (T denotes the transpose of a vector); and u and v are the input and output weights.

Different parties to an efficiency analysis have different perspectives of what constitutes the best performance. To examine whether efficiency measures from different perspectives are consistent with each other, this current article examines three efficiency measures of health insurers: 1) the operating efficiency from the perspective of the insurer to generate profits; 2) the medical services efficiency from the perspective of the society to provide health care services; and 3) the composite efficiency to accommodate the two perspectives as above. The medical services efficiency model evaluates the insurer's performance in "providing policyholders with medical services which are received from health providers." Accordingly, the outputs are the measures of health coverage and medical services, and the inputs are the costs incurred by the insurer and health providers (Brockett et al. 2004 and Yang 2014). Specifically, for the medical services efficiency model, the outputs are enrollment (persons covered) and the utilization of medical services (ambulatory encounters and hospital patient days), whereas the

1. The dual Multiplier Model generates the same efficiency scores as the Envelopment Model (Zhu 2009).

2. Insurers operate in different states and different environments, and regulations and market conditions may significantly differ between states. However, the DEA efficiency score (the optimal ratio of weighted outputs over weighted inputs) should be comparable among different insurers. Differential regulations and market conditions are actually among the sources of the (in)efficiency of insurers.

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inputs are hospital and medical expenses (paid to health providers), and claim adjustment and general administrative expenses (paid to administrative and claim adjustment staff). The operating efficiency model evaluates the insurer's performance in generating profits relative to input costs. Obviously, the outputs are the operating profits/losses (the underwriting gain/loss and the investment gain/loss). The inputs are the human and capital costs of the insurance company: hospital and medical expenses, claim adjustment and administrative expenses (including investment expenses), and capital and surplus. The inputs (outputs) of the composite efficiency analysis are the combination of the inputs (outputs) of the above two models. The inputs and outputs for the three analyses are presented in Table 1.

Table 1:
Inputs and Outputs of the DEA Models

DEA efficiency models	Inputs	Outputs
Operating efficiency	Total hospital and medical expenses	Net underwriting gains/losses
	Claim adjustment expenses	Net investment gains/losses
	General administrative and investment expenses	
	Capital and surplus	
Medical services efficiency	Total hospital and medical expenses	Total member months
	Claim adjustment expenses	Ambulatory encounters
	General administrative expenses	Hospital patient days
Composite efficiency	Total hospital and medical expenses	Net underwriting gains/losses
	Claim adjustment expenses	Net investment gains/losses
	General administrative and investment expenses	Total member months
	Capital and surplus	Ambulatory encounters
		Hospital patient days

The operating efficiency model and the medical services efficiency model share some common inputs: 1) total hospital and medical expenses; 2) claim adjustment expenses; and 3) general administrative expenses. Reducing these costs should result in both higher operating efficiency and medical services efficiency, ceteris paribus. However, lower costs may lead to restricting the utilization of medical services (the output of the medical services efficiency model), lower premiums and profits (the output of the operating efficiency model), thus lower operating and medical services efficiency. Even though the two efficiency measures are related to completely different aspects of health insurers, they are not necessarily conflicting objectives. Therefore, it is expected that the operating efficiency and the medical services efficiency might be positively correlated, but it is uncertain whether they are closely aligned, as motivates the empirical analysis of this current research. The composite efficiency integrates the operating efficiency and the medical services efficiency and should be positively correlated with both of them.

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This current research uses the health insurers' data of 2013, obtained from their annual financial statements filed with the National Association of Insurance Commissioners (NAIC).[3] The insurers with missing and/or inappropriate values are excluded, as well as very small insurers with fewer than 10,000 total member months. The insurers with extreme values in every input and output variable are also excluded. The sample includes 417 insurers, and some descriptive statistics are presented in Table 2. Investment expenses are very small relative to general administrative expenses and make no significant difference on the efficiency measures. On average, total hospital and medical expenses account for 87% of all the expenses, and net underwriting and investment gains/losses are around 2% of all the expenses.

Table 2:
Descriptive Statistics of Input and Output Variables of DEA Models

Input and output variables	Mean	StDev
Total member months	2721863	6281237
Total hospital and medical expenses ($)	4697	3434
Claim adjustment expenses ($)	182	142
General administrative expenses ($)	499	428
Investment expenses ($)	2.9	9.6
Capital and surplus ($)	1178	2049
Net underwriting gain/loss ($)	41	492
Net investment gains/losses ($)	37	67
Ambulatory encounters	12.4	9.3
Hospital patient days	0.7	0.9

Note: All the variables are on a per member per year basis except "total member months."

In the medical services efficiency analysis, for efficiency measures to be comparable among different insurers, the input variables are adjusted for regional cost differences. In other words, we divide the inputs by state average weekly

3. The 2013 data was the most recent at the start of this research. Similar results are obtained using other years of data so they are not included in this article. For example, for the comparison purpose and robustness checks, the data of 2006 and 2008 (two years before ACA, one with an economic downturn and the other with an economic upturn) are analyzed. Overall, the correlation coefficients between operating efficiency and medical services efficiency are 0.32 and 0.30 for 2006 and 2008, respectively (0.27 for 2013). Additionally, the 2014 data are also examined (after the completion of this research), and the correlation is 0.31. Another reason of using one-year data is to reduce the potential noise from, for example, regulatory changes, especially during a time period of high regulation volatility.

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wages, which are obtained from the Bureau of Labor Statistics (BLS) (*www.bls.gov*) (Yang 2014). Unlike the medical services efficiency, there is no need to adjust the inputs or outputs for the operating efficiency, which is a comparable measure among insurers. Now that the inputs of the medical services efficiency model should be adjusted for regional cost differences but not necessarily for the operating efficiency model, the variables of these two models may not simply be pooled together for the composite efficiency model. Interestingly, the medical services efficiency scores are highly correlated by using adjusted and unadjusted inputs, respectively (with a correlation coefficient of 0.98). Therefore, in the composite efficiency model, inputs do not have to be and are not adjusted for regional cost differences.

In the operating and composite efficiency model, some insurers have non-positive outputs (net underwriting gains/losses and net investment gains/losses). However, DEA models only apply to positive inputs and outputs. To make outputs all positive, a sufficient positive number is added to the two output variables of all the insurers, respectively. For DEA models, the model orientation refers to whether a DEA model is input-oriented or output-oriented, and the frontier type refers to the returns to scale type of the DEA efficient frontier. The input-oriented BCC model (Banker, Charnes, and Cooper 1984) with variable returns to scale (VRS) is translation invariant to outputs, the output-oriented VRS BCC model is translation invariant to inputs, but the CCR models (Charnes, Cooper, and Rhodes 1978) with constant returns to scale (CRS) are not translation invariant (Lovell and Pastor 1995).[4] Therefore, the input-oriented VRS BCC models are adopted for the operating efficiency analysis so that the results are translation invariant. To be consistent, the input-oriented VRS BCC models are also adopted for the medical services and composite efficiency analysis. The DEA optimization problems are solved using the DEA software developed by Joe Zhu (*www.deafrontier.net/software.html*).

As indicated, this article aims to discuss whether financial ratios are effective measures of the overall efficiency of health insurers and what measures are appropriate for more effective regulation. To achieve this goal, this research examines whether financial ratios (such as MLR) are consistent with efficiency measures of health insurers. After efficiency scores of the insurers are obtained, this research conducts a series of correlation analyses that work very effectively for the regulatory purpose by presenting clearly the (mis)alignment of different efficiency measures and their (un)linkage with financial ratios and asset allocation. For example, a low correlation between MLR and medical services efficiency indicates high MLR does not necessarily lead to high medical services efficiency. Thus, the MLR regulation might not be effective from the efficiency perspective.[5]

4. In the literature, Hu, Yu and Wang (2012) apply the translation invariant BCC model to handle negative output values in measuring the operational environment-adjusted efficiency of 60 mutual funds in Taiwan from 2006 to 2010.

5. This research discusses the (mis)alignment of different efficiency measures and their (un)linkage with financial ratios for the regulatory purpose. It does not examine specifically the determinants of financial ratios or efficiency measures. Second-stage regression models, with the

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The Relationship Between Operating Efficiency and Medical Services Efficiency

As discussed, efficiency can be measured from different perspectives. It should be very interesting and important for all the stakeholders to understand if different efficiency measures are aligned with each other. This section explores the correlation between operating efficiency and medical services efficiency. (See Table 3.) The correlation is interpreted according to Table 4 (Hinkle, Wiersma and Jurs 2003).

Table 3:
Pearson Correlation Between Medical Services Efficiency (ME) and Operating Efficiency (OE)

Insurers	Correlation between OE and ME
All 417 insurers	0.27
Top 50% OE	0.38
Bottom 50% OE	-0.09
Top 50% ME	0.27
Bottom 50% ME	-0.05
Single-state	0.25
Multistate	0.35
Single-state (stock only)	0.23
Multistate (stock only)	0.29
Stock insurers	0.24
Non-stock insurers	0.37
Stock insurers (single-state)	0.23
Non-stock insurers (single-state)	0.32
Small insurers	0.46
Medium insurers	0.09
Big insurers	0.20
Small insurers (stock and single-state)	0.51
Medium insurers (stock and single-state)	0.02
Big insurers (stock and single-state)	0.08

"efficiency measure" or the "ratio of the efficiency measures" as the dependent variable, are not suitable for this research in delineating the relationship between financial ratios and efficiency measures and among efficiency measures themselves—for example, the correlation between the operating efficiency and the medical services efficiency.

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Overall, for all the 417 insurers, the correlation is very low (0.27), so is that for the top 50% in operating efficiency or medical services efficiency (0.38 and 0.27), but higher than the bottom 50%, which have little correlation (-0.09 and -0.05). The correlation between medical services efficiency and operating efficiency is presented for single-state and multistate insurers, respectively, for the whole sample of 417 insurers and the sub-sample of 314 stock insurers. The correlation is very low for both single-state and multistate insurers, consistent with the overall correlation for all the 417 insurers (0.27), and there is not much difference between single-state and multistate insurers (0.25 vs. 0.35, and 0.23 vs. 0.29).

Table 4:
Strength of Correlation

Size of the correlation coefficient	Interpretation
0.90 to 1.00	Very high correlation
0.70 to 0.89	High correlation
0.50 to 0.69	Moderate correlation
0.30 to 0.49	Low correlation
0.00 to 0.29	Little if any correlation

Stock insurers and non-stock insurers are compared for the whole sample of the 417 insurers and the sub-sample of the 328 single-state insurers. The results show that both stock and non-stock insurers have a low correlation between operating efficiency and medical services efficiency (0.24 vs. 0.37, and 0.23 vs. 0.32). The correlation between operating efficiency and medical services efficiency is also compared by the size of the insurers based on total invested assets. In this research, the big, medium and small insurers are the top 30%, the middle 30% and the bottom 30% by enrollment, respectively. It shows that there is a low correlation between operating efficiency and medical services efficiency for small insurers (0.46 and 0.51), while there is very little correlation for big and medium insurers.

Overall, the correlation is very low for all the 417 insurers, stock, single-state, big or medium insurers (below 0.30), higher but still low for non-stock, multistate or small insurers (around 0.30-0.50). Therefore, operating efficiency and medical services efficiency are not consistent with each other. The insurer that is operating efficient may not be medical services efficient, and vice versa.

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Operating and Medical Services Efficiency: Relationship with Financial Ratios

Financial ratios are important traditional tools for regulators, investors, customers and the management to evaluate insurers. This research analyzes the relationship between efficiency measures and financial ratios, which include MLR, loss ratio, combined ratio, operating ratio, investment income ratio and expense ratio.[6] MLR is the ratio of (hospital & medical expenses + changes in contract reserves) to earned premium, while the loss ratio is the ratio of (hospital & medical expenses + changes in contract reserves + claim adjustment expenses) to earned premium. The investment income ratio is very low compared to other ratios: the average is only 0.8% and the median is only 0.5%. Interestingly, the correlation of the operating ratio and the combined ratio is very high (0.99), and so is that between the MLR and the loss ratio (0.94). The correlation is around 0.90 (0.78) between the loss ratio (MLR) and the combined (operating) ratio. The correlation of the investment income ratio with other financial ratios is very low. (The absolute values of the correlation coefficients are no bigger than 0.16.)

The relationship of the operating efficiency with all the financial ratios is presented in Table 5. To reduce the potential effect of extreme values of the variables, 5% of the insurers are truncated at both ends of the financial ratios.[7] The results show that, overall, there is a moderate negative correlation between the operating efficiency and the operating/combined ratio (around -0.60), a low correlation with the MLR and the loss ratio, and very little correlation with the investment income ratio and the expense ratio.

The relationship of the operating efficiency with financial ratios is also examined by the efficiency score, the number of states the insurer serves, the organization type and the size of the insurer based on total invested assets. Generally, the correlation between the operating efficiency and the operating ratio is low for the insurers of the top 50% or bottom 50% in operating efficiency, but the bottom 50% insurers score a higher correlation. Interestingly, there is a relatively high correlation between the operating efficiency and the operating ratio (around -0.77) for multistate insurers, and a moderate correlation for single-state

6. This research focuses on MLR and other related insurance-specific financial ratios, including loss ratio, combined ratio, operating ratio, investment income ratio and expense ratio. Financial ratios such as return on assets (ROA) and return on equity (ROE) are also important measures of firm performance. The correlation coefficients between ROA (ROE) and the three efficiency measures (operating efficiency, medical services efficiency and composite efficiency) are 0.51, -0.09 and 0.26 (0.51, -0.07 and 0.29), respectively—consistent with those for combined ratio and operating ratio but in opposite signs. Detailed analyses of ROA and ROE are not included in this research because they provide no more regulatory information than the insurance-specific ratios.

7. For the comparison purpose, the correlation of efficiency measures with financial ratios and asset allocation is also presented for all the 417 insurers without truncation throughout the article.

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insurers and stock insurers (around -0.60), but low or little correlation for non-stock insurers.

As to the relationship of the operating efficiency with financial ratios by the size of insurers based on total invested assets, there is a relatively high correlation with the operating ratio for big insurers (around -0.80), a moderate correlation for medium insurers (around -0.65) and a low correlation for small insurers (around -0.45).

Table 5:
Pearson Correlation of Operating Efficiency (OE) with Financial Ratios

Insurers	Correlation of OE and					
	MLR	Loss ratio	Combined ratio	Operating ratio	Investment income ratio	Expense ratio
All 417 insurers	-0.30	-0.31	-0.31	-0.35	0.32	-0.11
All insurers with 5% truncated at both ends of the financial ratio	-0.33	-0.38	-0.54	-0.62	0.15	-0.13
Top 50% OE	-0.05	-0.11	-0.26	-0.34	-0.09	-0.07
Bottom 50% OE	-0.35	-0.29	-0.39	-0.48	0.51	-0.01
Single-state	-0.30	-0.36	-0.50	-0.58	0.16	-0.10
Multistate	-0.42	-0.42	-0.69	-0.76	0.12	-0.29
Single-state (stock only)	-0.34	-0.43	-0.61	-0.65	0.26	-0.16
Multistate (stock only)	-0.43	-0.45	-0.71	-0.78	0.27	-0.34
Stock insurers	-0.36	-0.44	-0.64	-0.68	0.26	-0.19
Non-stock insurers	-0.22	-0.22	-0.23	-0.43	-0.02	0.04
Stock insurers (single-state)	-0.34	-0.43	-0.61	-0.65	0.26	-0.16
Non-stock insurers (single-state)	-0.21	-0.21	-0.17	-0.40	-0.02	0.08
Small insurers	-0.32	-0.30	-0.42	-0.44	0.19	-0.10
Medium insurers	-0.34	-0.45	-0.61	-0.69	0.15	-0.05
Big insurers	-0.37	-0.41	-0.61	-0.78	0.14	-0.26
Small insurers (stock and single-state)	-0.25	-0.35	-0.49	-0.45	0.23	-0.10
Medium insurers (stock and single-state)	-0.29	-0.40	-0.54	-0.64	0.06	-0.21
Big insurers (stock and single-state)	-0.47	-0.56	-0.83	-0.87	0.41	-0.23

Next, same analyses are conducted on the relationship of the medical services efficiency and financial ratios, based on the sample with 5% of the insurers truncated at both ends of the financial ratios. The relationship of the medical services efficiency with financial ratios is also compared by the efficiency score, the number of states the insurer serves, the organization type and the size of the insurer (based on total invested assets). Surprisingly, there is generally no or very little correlation between the medical services efficiency and the MLR, the loss ratio or any other financial ratio. (See Table 6.)

Overall, the financial ratios are not effective indicators of the operating or medical services efficiency of health insurers.

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Table 6:
Pearson Correlation of Medical Services Efficiency (ME) with Financial Ratios

Insurers	Correlation of ME with					
	MLR	Loss ratio	Combined ratio	Operating ratio	Investment income ratio	Expense ratio
All 417 insurers	0.03	0.01	-0.04	-0.05	0.02	-0.13
All insurers with 5% truncated at both ends of the financial ratio	0.18	0.17	0.07	0.05	-0.07	-0.16
Top 50% ME	0.05	0.04	0.07	0.09	-0.08	0.08
Bottom 50% ME	-0.04	-0.07	-0.12	-0.11	-0.07	-0.04
Single-state	0.23	0.21	0.11	0.11	-0.10	-0.12
Multistate	-0.03	-0.05	-0.12	-0.17	0.06	-0.26
Single-state (stock only)	0.23	0.24	0.07	0.07	-0.13	-0.15
Multistate (stock only)	-0.05	-0.11	-0.06	-0.15	0.20	-0.18
Stock insurers	0.17	0.17	0.04	0.03	-0.06	-0.15
Non-stock insurers	0.12	0.03	0.02	0.07	-0.22	-0.12
Stock insurers (single-state)	0.23	0.24	0.07	0.07	-0.13	-0.15
Non-stock insurers (single-state)	0.14	0.03	0.10	0.14	-0.18	-0.04
Small insurers	0.16	0.12	0.07	0.08	-0.08	-0.10
Medium insurers	0.19	0.18	0.08	0.08	-0.16	-0.17
Big insurers	0.18	0.20	0.02	-0.04	0.04	-0.24
Small insurers (stock and single-state)	0.21	0.17	0.01	0.01	-0.08	-0.18
Medium insurers (stock and single-state)	0.16	0.29	0.08	0.09	-0.15	-0.17
Big insurers (stock and single-state)	0.36	0.23	0.03	0.00	-0.12	-0.20

Operating and Medical Services Efficiency: Relationship with Asset Allocation

Underwriting and investments are two major business activities of insurers. Zou et al. (2012) examine the interrelation between underwriting and investment risks of property-liability insurers. This section examines the relationship between efficiency and asset allocation (the holding in each asset). The total invested assets are distributed among bonds (including MBS), stocks, mortgage loans, real estate investments, cash, cash equivalents and short-term investments (cash), contract loans, and derivatives. Each asset allocation is measured as the proportion (in percentage) of the asset in total invested assets—that is, the asset divided by total invested assets. The distribution of the insurers with regard to asset allocation is presented in Table 7.

There are very little investments in mortgage loans, contract loans or derivatives, so they are deleted. The analysis focuses on bonds, stocks, real estate investments, cash (including cash equivalents and short-term investments) and MBS. The investment in real estate is small—1% of total invested assets on average. The share of stocks is around 10% of total invested assets, similar to that of MBS. Bonds account for about 50%, while cash, cash equivalents and

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short-term investments around 30%. There is a relatively high negative correlation between the holdings of bonds and cash, cash equivalents and short-term investments (-0.69), and a low negative correlation between stocks and cash (-0.52).

Table 7:
The Distribution of the Insurers by Assets (% of Total Invested Assets)

% of total invested assets	# of insurers							
	Bonds	Stocks	Mortgage loans	Real estate investments	Cash, cash equivalents and short-term investments	Contract loans	Derivatives	Mortgage-backed securities
>=90%	57	1	0	0	55	0	0	0
(80%, 90%)	55	2	0	0	11	0	0	1
(70%, 80%)	46	3	0	1	15	0	0	0
(60%, 70%)	40	4	0	0	22	0	0	0
(50%, 60%)	36	8	0	0	15	0	0	4
(40%, 50%)	38	17	0	0	23	0	0	9
(30%, 40%)	28	20	0	0	35	0	0	15
(20%, 30%)	22	36	0	2	45	0	0	35
(10%, 20%)	16	31	0	4	55	0	0	89
(5%, 10%)	6	21	0	21	60	0	0	68
(0%, 5%)	27	33	2	46	48	0	1	43
0%	46	241	415	343	1	417	416	153
<0%	0	0	0	0	29	0	0	0
Total	417	417	417	417	417	417	417	417

Similar analyses are conducted on the relationship of asset allocation and the operating efficiency, as well as the medical services efficiency for the whole sample, by the efficiency score, the number of states the insurer serves, the organization type and the size of the insurer. (See Table 8 and Table 9.) In all the analyses, 5% of the insurers are truncated at both ends of each asset, respectively, to reduce the impact of extreme values. The results show that there is generally little correlation between the efficiency and any of the assets. Furthermore, the correlation is examined for the insurers with positive investments in stocks and MBS. Still, little correlation is documented between the efficiency and the holding in stocks/MBS. This is as expected because the investment income ratio is very low. (The average is 0.8%, and the median is 0.5%.)

Composite Efficiency vs. Operating and Medical Services Efficiency

It is shown that the operating efficiency and the medical services efficiency are not highly correlated. Therefore, neither of them is a good measure of the overall efficiency of health insurers. This section analyzes the composite efficiency, which is computed with all the input and output variables from both the

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medical services and operating efficiency models. As stated, the medical services efficiency scores are highly correlated by using adjusted inputs based on regional cost differences as indicated in Section 2 and unadjusted inputs, respectively. Therefore, in the composite efficiency model, inputs do not have to be and are not adjusted for regional cost differences.

Table 8:
Pearson Correlation of Operating Efficiency (OE) with Assets
(% of Total Invested Assets)

Insurers	Correlation of OE with				
	Bonds	Stocks	Real estate investments	Cash	MBS
All 417 insurers	0.09	-0.01	0.06	-0.08	0.01
All insurers with 5% truncated at both ends of the asset	0.08	-0.01	0.03	-0.05	0.03
Top 50% OE	-0.06	-0.07	0.01	-0.07	0.02
Bottom 50% OE	0.13	0.21	0.18	0.00	-0.01
Single-state	0.09	0.00	0.04	-0.11	0.07
Multistate	0.02	-0.01	0.01	0.22	-0.14
Single-state (stock only)	0.09	0.02	0.14	-0.12	0.11
Multistate (stock only)	0.06	0.07	0.10	0.18	-0.09
Stock insurers	0.09	0.02	0.13	-0.06	0.07
Non-stock insurers	0.07	0.02	-0.06	-0.02	-0.09
Stock insurers (single-state)	0.09	0.02	0.14	-0.12	0.11
Non-stock insurers (single-state)	0.12	0.00	-0.09	-0.07	-0.04
Small insurers	-0.02	-0.16	0.00	0.05	-0.10
Medium insurers	0.13	0.04	0.05	-0.20	-0.04
Big insurers	0.28	0.08	-0.02	-0.07	0.25
Small insurers (stock and single-state)	-0.06	-0.15	0.04	0.03	-0.11
Medium insurers (stock and single-state)	0.15	-0.01	0.18	-0.14	0.03
Big insurers (stock and single-state)	0.22	0.15	0.15	-0.31	0.34

The distribution of the insurers by the efficiency score is presented in Table 10. DEA models with more inputs and outputs specified usually lead to higher efficiency scores. More insurers are efficient based on the composite efficiency. On average, the composite efficiency score is much higher than the operating or medical services efficiency score (0.61 vs. 0.38/0.36). In addition, there are more insurers that are composite efficient (16%) than those that are operating efficient (8%) or medical services efficient (6%), respectively. Also, 61% of the insurers have an efficiency score of 0.50 or higher based on the composite efficiency, but only 27% and 17% based on the operating and medical services efficiency.

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Table 9:
Pearson Correlation of Medical Services Efficiency (ME) with Assets (% of Total Invested Assets)

Insurers	Correlation of ME with				
	Bonds	Stocks	Real estate investments	Cash	MBSs
All 417 insurers	-0.24	-0.01	0.03	0.21	-0.18
All insurers with 5% truncated at both ends of the asset	-0.24	0.01	-0.06	0.22	-0.18
Top 50% ME	-0.26	-0.01	-0.11	0.24	-0.21
Bottom 50% ME	-0.18	0.06	0.01	0.15	-0.20
Single-state	-0.29	0.03	-0.06	0.24	-0.19
Multistate	-0.02	-0.03	-0.06	0.13	-0.12
Single-state (stock only)	-0.28	-0.09	-0.06	0.26	-0.15
Multistate (stock only)	0.00	0.10	0.09	0.10	0.07
Stock insurers	-0.22	-0.05	-0.03	0.23	-0.13
Non-stock insurers	-0.28	-0.07	-0.23	0.35	-0.35
Stock insurers (single-state)	-0.28	-0.09	-0.06	0.26	-0.15
Non-stock insurers (single-state)	-0.28	-0.00	-0.20	0.32	-0.32
Small insurers	-0.17	-0.06	-0.09	0.22	-0.22
Medium insurers	-0.25	0.09	-0.08	0.25	-0.11
Big insurers	-0.06	0.07	0.01	0.06	-0.14
Small insurers (stock and single-state)	-0.34	-0.23	-0.07	0.30	-0.22
Medium insurers (stock and single-state)	-0.18	-0.03	-0.09	0.18	-0.10
Big insurers (stock and single-state)	-0.14	0.06	0.05	0.16	0.07

Table 10:
The Distribution of Insurers by Composite Efficiency (CE), Operating Efficiency (OE) and Medical Services Efficiency (ME-Unadj)

Efficiency score	CE		ME-unadj		OE	
	# of insurers	%	# of insurers	%	# of insurers	%
(0, 0.20)	3	1%	71	17%	122	29%
(0.20, 0.40)	95	23%	237	57%	140	34%
(0.40, 0.60)	132	32%	48	12%	72	17%
(0.60, 0.80)	88	21%	19	5%	31	7%
(0.80, 1)	33	8%	9	2%	18	4%
1	66	16%	23	6%	34	8%
Total	417	100%	417	100%	417	100%

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Table 11 presents the relationship between the composite efficiency and financial ratios for the sample with 5% of the insurers truncated at both ends of the ratio. It shows that, overall, there is a low correlation between the composite efficiency and the combined or operating ratio (-0.35 and -0.37, respectively), but little correlation with the MLR and the loss ratio. In addition, the results indicate that there is little correlation between the composite efficiency and the MLR, the loss ratio, the combined ratio or the operating ratio for the insurers of the top 50% or the bottom 50% in efficiency.

Table 11:
Pearson Correlation Between Composite Efficiency (CE) and Financial Ratios

Insurers	Correlation of CE with					
	MLR	Loss ratio	Combined ratio	Operating ratio	Investment income ratio	Expense ratio
All 417 insurers	-0.20	-0.22	-0.25	-0.26	0.14	-0.15
All insurers with 5% trurcated at both ends of the financial ratio	-0.14	-0.21	-0.35	-0.37	-0.09	-0.17
Top 50% CE	0.07	0.00	-0.07	-0.12	-0.06	-0.12
Bottom 50% CE	-0.05	-0.09	-0.15	-0.23	0.14	-0.17
Single-state	-0.07	-0.15	-0.29	-0.30	-0.09	-0.15
Multistate	-0.41	-0.44	-0.58	-0.62	-0.06	-0.23
Single-state (stock only)	-0.11	-0.20	-0.38	-0.36	-0.04	-0.22
Multistate (stock only)	-0.41	-0.45	-0.57	-0.62	0.08	-0.31
Stock insurers	-0.18	-0.25	-0.42	-0.42	-0.01	-0.24
Non-stock insurers	-0.01	-0.07	-0.10	-0.20	-0.20	0.00
Stock insurers (single-state)	-0.11	-0.20	-0.38	-0.36	-0.04	-0.22
Non-stock insurers (single-state)	0.02	-0.05	-0.03	-0.16	-0.19	0.03
Small insurers	-0.10	-0.13	-0.24	-0.24	0.03	-0.20
Medium insurers	-0.10	-0.22	-0.34	-0.35	-0.21	-0.08
Big insurers	-0.27	-0.31	-0.49	-0.57	-0.08	-0.25
Small insurers (stock and single-state)	-0.07	-0.14	-0.24	-0.21	0.08	-0.20
Medium insurers (stock and single-state)	0.01	-0.11	-0.29	-0.31	-0.31	-0.13
Big insurers (stock and single-state)	-0.24	-0.37	-0.58	-0.56	0.05	-0.34

Furthermore, there is a moderate correlation between the composite efficiency and the combined or the operating ratio for multistate insurers (around -0.60), a low correlation for single-state insurers (around -0.30), a low correlation with the MLR and the loss ratio for multistate insurers (around -0.40), and little correlation for single-state insurers. There is a low correlation with the combined or operating ratio (around -0.40), little correlation with the MLR and the loss ratio for stock insurers, and little correlation with the MLR, the loss ratio, combined ratio or the operating ratio for non-stock insurers. For big insurers, the correlation is moderate with the combined or the operating ratio (around -0.55), but low or little correlation with the MLR, the loss ratio, the combined ratio and the operating ratio

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for small and medium insurers. These results indicate that financial ratios are not effective indicators of health insurers' overall efficiency either.

Table 12 presents the relationship between the composite efficiency and asset allocation. Generally, there is little correlation between the composite efficiency and the holding in each asset. (The absolute value of the correlation coefficient is generally below 0.30.)

Table 12:
Pearson Correlation Between Composite Efficiency (CE) and Asset Allocation

Insurers	Correlation of CE with				
	Bonds	Stocks	Real estate investments	Cash	MBS
All 417 insurers	-0.14	-0.06	-0.01	0.18	-0.14
All insurers with 5% truncated at both ends of the financial ratio	-0.15	-0.07	-0.05	0.25	-0.13
Top 50% CE	-0.15	-0.01	0.08	0.19	-0.16
Bottom 50% CE	-0.04	0.18	-0.04	0.06	-0.04
Single-state	-0.17	-0.05	-0.04	0.21	-0.11
Multistate	-0.02	-0.13	-0.08	0.37	-0.17
Single-state (stock only)	-0.16	-0.08	0.09	0.16	-0.04
Multistate (stock only)	0.00	-0.03	0.05	0.31	-0.08
Stock insurers	-0.12	-0.07	0.08	0.19	-0.05
Non-stock insurers	-0.26	0.00	-0.20	0.41	-0.36
Stock insurers (single-state)	-0.16	-0.08	0.09	0.16	-0.04
Non-stock insurers (single-state)	-0.22	0.01	-0.22	0.37	-0.31
Small insurers	-0.24	-0.08	0.09	0.24	-0.15
Medium insurers	-0.27	0.02	-0.02	0.27	-0.22
Big insurers	0.21	-0.21	-0.13	0.31	0.00
Small insurers (stock and single-state)	-0.26	-0.23	0.19	0.24	-0.11
Medium insurers (stock and single-state)	-0.22	-0.09	0.06	0.22	-0.20
Big insurers (stock and single-state)	-0.07	-0.02	0.04	0.20	0.10

Table 13 presents the correlation between the composite efficiency, the medical services efficiency (unadjusted), the operating efficiency and the average efficiency (which is the average of the operating efficiency and the medical services efficiency). Interestingly, there is a relatively high correlation between the composite efficiency and the average efficiency (around 0.80). Therefore, the average efficiency should be a decent (even though not perfect) alternative to the composite efficiency measure. The correlation between the composite efficiency and the operating efficiency or the medical services efficiency is generally moderate (0.70 and 0.62, respectively, for all the 417 insurers). Now that the correlation between the operating efficiency and the medical services efficiency is

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very low, both of them should be included or the composite efficiency be incorporated for the efficiency evaluation of health insurers.

Table 13:
Pearson Correlation Between Composite Efficiency (CE), Average Efficiency (AE), Medical Services Efficiency (ME) and Operating Efficiency (OE)

Insurers	CE & AE	CE & ME-unadj	CE & OE	AE & ME-unadj	AE & OE	ME-unadj & OE
All 417 insurers	0.83	0.62	0.70	0.74	0.85	0.27
Top 50% ME-unadj	0.79	0.61	0.65	0.72	0.86	0.27
Bottom 50% ME-unadj	0.83	0.13	0.81	0.14	0.98	-0.07
Top 50% OE	0.82	0.55	0.82	0.83	0.83	0.38
Bottom 50% OE	0.72	0.78	-0.07	0.92	0.30	-0.10
Top 50% CE	0.70	0.49	0.52	0.66	0.77	0.02
Bottom 50% CE	0.67	0.47	0.46	0.58	0.78	-0.05
Single-state	0.82	0.62	0.68	0.73	0.84	0.25
Multistate	0.86	0.60	0.79	0.77	0.87	0.35
Single-state (stock only)	0.82	0.57	0.70	0.71	0.85	0.23
Multistate (stock only)	0.86	0.60	0.76	0.72	0.87	0.29
Stock insurers	0.82	0.58	0.71	0.71	0.85	0.24
Non-stock insurers	0.86	0.78	0.66	0.80	0.89	0.38
Stock insurers (single-state)	0.82	0.57	0.70	0.71	0.85	0.23
Non-stock insurers (single-state)	0.86	0.78	0.63	0.78	0.85	0.33
Small insurers	0.86	0.73	0.73	0.82	0.87	0.43
Medium insurers	0.79	0.59	0.59	0.66	0.80	0.09
Big insurers	0.85	0.53	0.79	0.70	0.87	0.26
Small insurers (stock and single-state)	0.86	0.71	0.77	0.84	0.88	0.47
Medium insurers (stock and single-state)	0.79	0.57	0.58	0.62	0.81	0.03
Big insurers (stock and single-state)	0.81	0.44	0.74	0.59	0.89	0.15

Conclusions

Rising health care costs and affordability are among the biggest challenges in the U.S. Therefore, an effective regulation should be able to improve cost efficiency of health insurers besides other objectives. An important provision of the ACA is the requirement of the minimum MLR to encourage health insurers to provide quality services to enrollees. This research aims to provide evidences on whether financial ratios are effective measures of the overall efficiency of health insurers and what measures are appropriate for more effective regulation.

To accomplish this purpose, this research analyzes the alignment of different efficiency measures and their linkage with traditional financial ratios. The result shows that generally the financial ratios including the MLR are not effective

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indicators of the operating efficiency, the medical services efficiency or the composite efficiency of health insurers. The result also indicates that neither the operating efficiency nor the medical services efficiency is an appropriate measure of the overall efficiency of health insurers. Therefore, innovative regulatory measures, such as a combination of efficiency measures and financial ratios, should be adopted to satisfy all the stakeholders.

Specifically, there is a moderate negative correlation between the operating efficiency and the operating/combined ratio, and a low correlation with the MLR or the loss ratio, for the whole sample. A relatively high correlation is documented between the operating efficiency and the combined or operating ratio for multistate insurers or big insurers. Surprisingly, there is generally very little correlation between the medical services efficiency and any of the financial ratios including MLR. The composite efficiency combines both the operating efficiency and the medical services efficiency. It shows that for the whole sample, there is a low correlation between the composite efficiency and the combined or operating ratio, but little correlation with the MLR or the loss ratio. However, there is a moderate correlation between the composite efficiency and the combined or the operating ratio for multistate insurers or big insurers.

The correlation between the medical services efficiency and the operating efficiency is generally very low. Therefore, the operating efficiency and the medical services efficiency are not consistent with each other. Therefore, an insurer that is operating efficient may not be medical services efficient, and vice versa. Comparing the different efficient measures, the composite efficiency is much higher than the operating or medical services efficiency, and there are more insurers that are composite efficient than those that are operating or medical services efficient, respectively. The correlation between the composite efficiency and the operating efficiency or the medical services efficiency is generally moderate.

This research also examines the impact of asset allocation on the efficiency of health insurers. Generally, there is little correlation between the holding in any asset and the composite efficiency, the medical services efficiency or the operating efficiency. This is as expected because the investment income ratio is very low. (The average is only 0.8%, and the median is only 0.5%.)

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