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Monitoring Public Company Rankings for Investment Decisions: Are They Undervalued or Overvalued?

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Abstract

This study proposes a novel framework to monitor the rankings of public companies that are released periodically by worldwide business organizations. With different ranking rationales and diverse indicators, the released reports may not be comparable or suited to investment objectives. Therefore, this study introduces the DuPont model to derive well-recognized *common* investment indicators and then employs the data envelopment analysis (DEA) ranking method and the grey entropy (GE) ranking method to re-rank the listed companies. Both DEA and GE re-rankings are compared with the released rankings to generate a map of the DEA-gap versus the GE-gap to advise stock investors of undervalued or overvalued companies. As a demonstration, the proposed framework is applied to the case of *Taiwan Info Tech 100* released by Business Next. It is thought that continual monitoring of public company rankings may promote business opportunities in the long run; hence, application of the proposed framework to develop favorable business models is further addressed in this study.

Keywords: Data envelopment analysis, DuPont model, grey entropy, stock investment, public trading companies, ranking

JEL Classification codes: C10, G11, M21

http://dx.doi.org/10.7835/jcc-berj-2013-0091

Worldwide business organizations periodically release various reports ranking public companies. With different ranking rationales and diverse indicators, the resulting rankings may not be directly comparable or well suited to investment objectives. Some reports use quantitative indicators to measure the companies' financial performance, while others use qualitative indicators to measure their reputation. For example, Forbes released its *Global 2000* list based on four quantitative indicators: sales, profits, assets, and market value. *Business Next Magazine* employed five quantitative indicators to rank the *Asia Top 100 Info Tech Companies*: revenue, revenue growth rate, return on equity, profitability, and return on investment. *Fortune*, on the other hand, compiled the *World's Most Admired Companies* list through an annual survey of top executives, directors, and financial analysts to identify the companies that enjoy the strongest reputations within their industries and

across industries. In the *World's Most Admired Companies* list, the companies' reputation and performance are measured against nine qualitative indicators, including innovation, people management, use of corporate assets, social responsibility, quality of management, financial soundness, long-term investment, quality of products and services, and global competitiveness.

It is not necessarily a problem for the released reports to use different ranking rationales with diverse indicators because these reports have aimed at different goals and objectives. However, when applied to stock investment, it can be a problem because different rationales and indicators may not be directly comparable or well suited to investment objectives. General investors may not be familiar with the ranking rationales or indicators used in different reports, but they may learn about the resulting rankings through the media or the Internet. Should the investors simply base their investment on the rankings, they may easily be misled. Essentially, stock investors would rather invest in publicly traded companies that are profitable and financially healthy than put their money into relatively precarious investments.

Regardless of the ranking rationales or indicators used, the released ranking information can turn ordinary companies into celebrity companies (Fombrun, 2007; Rindova, Pollock, & Hayward, 2006). Once the publicly traded companies become celebrities, they would most likely gain enhanced corporate reputations and reap the consequent rewards from the marketplace. As Gabbioneta, Ravasi, and Mazzola (2007) pointed out, corporate reputation is regarded as a set of collectively held beliefs about a company's ability to satisfy the interests of its various stakeholders. A celebrity company has an enhanced ability to motivate general investors to purchase its products, to attract high quality employees, to garner the praise of local communities, and to retain essential transaction partners, including suppliers and distributors (Fombrun, 1996; Vidaver-Cohen, 2007).

Unfortunately, many investors may simply rely on the released ranking information to make their investment decisions, and they may be deceived on occasion. For instance, due to its accounting scandals, WorldCom, at the time ranked as the United States of America second largest long-distance phone company, filed for bankruptcy protection on July 21, 2002. It was the largest such filing in the United States of America history in comparison with other collapses like Lehman Brothers and Washington Mutual. The bankruptcy resulted in the cancellation of WorldCom stockholders' stock, making it worthless. Another notorious example, the Enron collapse, also taught investors a lesson about investing in a listed company simply trusting in its high ranking information. In fact, some of the companies in the released reports might be undervalued while others might be overvalued. Without an in-depth scrutiny, investors cannot discover the underestimated and overrated investment targets.

As mentioned, different ranking reports have essentially used different ranking rationales with diverse indicators. In most circumstances, the quantitative indicators are assumed to have equal weight (identical importance) when aggregated into an overall index for ranking. Such a *subjective* assumption is arguable. The qualitative indicators, on the other hand, are typically derived from some selected *experts* through questionnaire surveys. Again, their subjective judgments may be biased. Several immediate questions arise regarding the released ranking reports. Are these released reports reliable and suited to investment objectives? Are the companies undervalued or overvalued? How can we monitor the listed companies and further re-rank them to provide objective and comparable information to advise investors of the undervalued or overvalued companies? Who can act as another pair of eyes to monitor them continually?

So long as ranking reports are released to the general public, investors will need an objective system of monitoring public companies to expose information that may cause them to be undervalued or overvalued. Any ranking method will inevitably involve a set of criteria or indicators as well as weighting systems. The ranking outcomes are prone to change if based on the qualitative indicators evaluated by selected experts. Even with the quantitative indicators, any change in the weighting arrangements can also result in quite dissimilar rankings (Emrouznejad & De Witte, 2010). To enable various released ranking reports to become comparable for investment objectives, all ranking rationales must have the capability of generating objective ranking outcomes on the same platform using common indicators that are well acknowledged by investors worldwide.

Today, general investors may have become more cautious about the risk of business failure since the demise of such giant companies as WorldCom and Enron (Aziz & Dar, 2006); however, there is still a lack of objective tools that can effectively monitor the rankings of public companies released by different business organizations. To fill the gap, the aim of this study is to propose a novel framework that can monitor the released company rankings. First, the proposed framework will introduce the DuPont model to derive some common financial indicators for use. Then, the proposed framework will employ the super-efficiency data envelopment analysis (DEA) ranking method and the grey entropy (GE) ranking method, respectively, to

re-rank the listed companies to estimate the DEA-gap and GE-gap for each company. Finally, the proposed framework will develop a map of the DEA-gap versus the GE-gap to reveal the undervalued and overvalued companies. With this map, the hope is to assist prudent investors in their investment decisions by providing information to identify undervalued or overvalued companies. The proposed framework will be applied to the case of *Taiwan Info Tech 100* as a demonstration. Because continual monitoring of the ranking of worldwide public companies may lead to tremendous business opportunities in the long run, this study will also briefly address the issue of how to apply the proposed framework to develop favorable business models.

The subsequent sections are organized as follows. The next section contains a discussion of the proposed framework, the DuPont model, and the DEA and GE ranking methods and an evaluation of the DEA-gap and GE-gap. The third section describes the implementation of the proposed framework in the case of *Taiwan Info Tech 100*. The following section further applies the proposed framework to develop favorable business models. In the final section, some implications and directions for future research are discussed.

The Proposed Framework

Conducting company rankings can be regarded as solving for a multiple criteria decision making (MCDM) problem, which involves a process of defining the decision goals, generating the possible alternatives, evaluating the alternatives for advantages and disadvantages, selecting the optimal alternative, and monitoring the results to ensure that the decision goals are achieved (Choo, Schoner, & Wedley, 1999; Opricovic & Tzeng, 2004; Seydel, 2006). This study, however, will not involve alternatives generation, evaluation, or selection; rather, its scope is limited to developing an evaluation framework that can objectively monitor the released company rankings and further re-rank them to disclose the undervalued or overvalued companies to help stock investors.

Various MCDM methods have been used for rankings, such as analytic hierarchy process (AHP), analytic network process (ANP), and technique for order preference by similarity to ideal solution (TOPSIS), among others (Opricovic & Tzeng, 2004); however, these methods require subjective weighting arrangements. To arrive at objective rankings, this study employs the DEA and GE ranking methods because both techniques can objectively solve for the criteria weights. Figure 1 presents the proposed framework, which includes four major steps, depicted as follows.

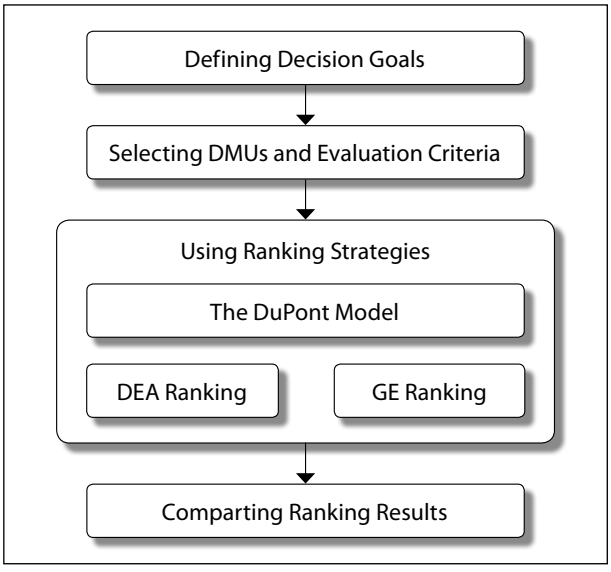


Figure 1. The proposed framework.

In the first step, we define the decision goals, which include monitoring the released company ranking reports, re-ranking them with objective investment indicators, identifying and displaying the undervalued or overvalued companies on a map so that general investors can easily visualize such information.

In the second step, we determine the decision-making units (DMUs) and the evaluation criteria or indicators. The DMUs to be investigated in this study come directly from the released ranking reports. As mentioned,

any released ranking information can enable outside investors to select the investment targets. The ranking information, however, can also form a treasure map embedded with poison, where risks may come from the diversified evaluation methods, measuring indicators, or weighting systems. A battery of indicators such as net income, total revenues, total assets, equity, return on equity (*ROE*), return on assets (*ROA*), profit margin, total asset turnover, equity ratio, earnings per share (*EPS*), and debt ratio have been used in different organizations to assess the companies' financial and economic situation (Castro & Chousa, 2006). Considerable disagreement may exist among different organizations about what constitutes the inputs and outputs while conducting the rankings. In this study, we do not attempt to elaborate on this issue; rather, the measuring indicators used in the following analysis will comprise only four common financial indicators derived from the DuPont model – a well-established model in investment literature (Bodie, Kane, & Marcus, 2009).

In the third step, the proposed framework introduces appropriate ranking strategies to re-rank the companies. We propose to use the DEA and GE ranking methods because these two techniques can create pure rankings with objective weighting systems.

In the last step, we compare the DEA and GE re-rankings with the released rankings to arrive at two gap values: the DEA-gap and the GE-gap. We then develop a map of the DEA-gap versus the GE-gap to display the undervalued and overvalued companies.

The following discussion contains further elaboration of the DuPont model and the DEA and GE ranking methods and evaluation of the DEA-gap and GE-gap.

The DuPont Model

The proposed framework is investment-oriented; it looks at such measures as return on equity and return on investment. When putting their money in the stock markets, investors should be concerned about the rate of return, which tells them if their investment is profitable or not. The DuPont model can easily calculate the ROE – a measure of the rate of return to stockholders (Bodie et al., 2009). Additionally, investors should be concerned about the risk of their investment, which relates to a company's financial and economic health. The DuPont model can easily calculate the company's ROA or return on investment (ROI) – a measure of the company's profitability as well as a view of its financial health in the areas of liquidity and operating efficiency (Bodie et al., 2009). The ROA of a publicly traded company relies heavily on the credibility of both income statement and balance sheet. Luckily, in many countries, this information is constantly audited by the regulatory authorities.

It is important to bear in mind that only by using the common financial indicators to monitor the released rankings can the resultant re-rankings become comparable for investment decisions. In its simple form, the DuPont model depicts the financial performance in ways that the ROE is influenced by ROA and equity ratio. The ROA is evaluated by profit margin (net income/sales) times total asset turnover (sales/total asset), whereas the equity ratio is evaluated as equity divided by total assets, depicted in Figure 2.

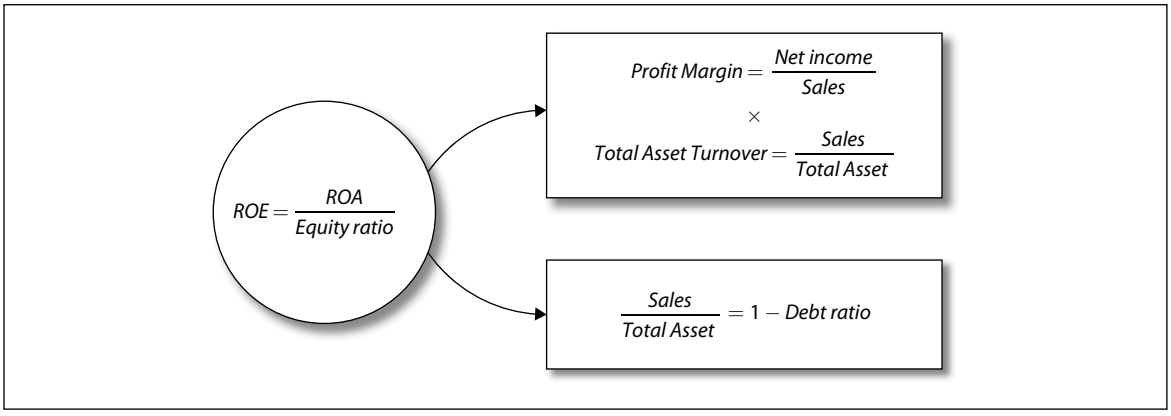


Figure 2. The DuPont model.

$$ROE = \frac{Net\ income}{Equity} = \frac{Net\ income}{Pretax\ income} \times \frac{Pretax\ income}{EBIT} \times \frac{EBIT}{Sales} \times \frac{Sales}{Assets} \times \frac{Assest}{Equity}, \quad (1)$$

where:

Net income - net income after taxes,
Equity - shareholders' equity,
EBIT - earnings before interest and taxes,

$$ROA = \frac{Net\ income}{Sales} \times \frac{Sales}{Total\ assets} = \frac{Net\ income}{Total\ assets}. \quad (2)$$

In other words, the four common indicators – total assets, equity, net income, and total revenues (i.e., sales) are affecting the performance of ROE. In the following re-ranking, total assets and equity are regarded as the inputs, while net income and total revenues are regarded as the outputs.

The DEA Ranking Method

The technique of data envelopment analysis (DEA) has been widely used for benchmarking and ranking purposes in various settings (e.g., Bendoly, Rosenzweig, & Stratman, 2009; Bouyssou, 1999; Charles, Kumar, Zegarra, & Avolio, 2011; Chiou, Lan, & Yen, 2012; Donthu, Hershberger, & Osmonbekov, 2005; Emrouznejad, Parker, & Tavares, 2008; Wöber, 2007; Zhu, 2011). DEA modeling has some merits; for instance, it does not require assumptions on the functional forms to represent the production systems; it does not require designating any subjective weights associated with the inputs and outputs (Cook, Seiford, & Zhu, 2004; Cook & Zhu, 2005). DEA is a powerful nonparametric approach for measuring the relative efficiency of a set of DMUs with multiple outputs and inputs. A variety of DEA models can be found, including the conventional CCR model (Charnes, Cooper, & Rhodes, 1978) and BCC model (Banker, Charnes, & Cooper, 1984), the super-efficiency model (Adler, Friedman, & Sinuany-Stern, 2002; Andersen & Petersen, 1993; Tone, 2002), and more (e.g., Chiou, Lan, & Yen, 2010; Tone & Tsutsui, 2010).

Generally, the relative efficiency can be defined as the ratio of total weighted outputs to total weighted inputs. The efficiency of DMU k can be expressed as follows:

$$h_k = Max \frac{\sum_{r=1}^{s} u_r y_{rk}}{\sum_{i=1}^{m} v_i x_{ik}}, \quad (3)$$

$$\text{Subject to: } \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \le 1;\ j = 1,2,...,n;$$

$$u_r, v_i \ge \varepsilon;\ r = 1,...,s;\ \text{and}\ i = 1,...,m.$$

The weights u_r and v_i are nonnegative, and ε is a nonarchimedean value as a device to enforce strict positivity on the variables.

Specifically, the CCR model assumes a constant returns to scale relationship between inputs and outputs. It does not place any restrictions on the weights in the model, and it is possible for units to be rated as efficient through a very uneven distribution of weights. One mathematical form of the CCR modeling can be expressed as:

$$h_k = Max \sum_{r=1}^{s} u_r y_{rk}, \quad (4)$$

$$\text{Subject to: } \sum_{i=1}^{m} v_i x_{ij} - \sum_{r=1}^{s} u_r y_{rj} \ge 0; \quad j = 1,...,n;$$

$$\sum_{i=1}^{m} v_i x_{ik} = 1;$$

$$u_r, v_i \ge \varepsilon;\ r = 1,...,s;\ \text{and}\ i = 1,...,m.$$

The BCC model adds an additional constant variable c_k to the above CCR model in order to allow a variable returns to scale relationship between inputs and outputs. It suggests that the BCC model permits an

increase in a unit's inputs without generating a proportional change in its outputs. One mathematical form of the BCC modeling can be expressed as:

$$h_k = Max \sum_{r=1}^{s} u_r y_{rk} - c_k, \tag{5}$$

Subject to: $\sum_{i=1}^{m} v_i x_{ij} - \sum_{r=1}^{s} u_r y_{rj} + c_k \geq 0; \quad j = 1,...,n;$

$$\sum_{i=1}^{m} v_i x_{ik} = 1;$$

$u_r, v_i \geq \varepsilon$; $r = 1,...,s;$ and $i = 1,...,m.$

The super-efficiency DEA model enables an extremely efficient unit to achieve an efficiency score greater than 1 or 100%. One mathematical form of the super-efficiency modeling can be expressed as:

$$h_k = Max \sum_{r=1}^{s} u_r y_{rk}, \tag{6}$$

Subject to: $\sum_{i=1}^{m} v_i x_{ij} - \sum_{r=1}^{s} u_r y_{rj} \geq 0; \; j = 1,...,n; \; j \neq k;$

$$\sum_{i=1}^{m} v_i x_{ik} = 1;$$

$u_r, v_i \geq \varepsilon; \; r = 1,...,s;$ and $i = 1,...,m.$

Since all efficient DMUs receive the efficiency score of 1 or 100%, it is not possible for the conventional DEA models, like CCR and BCC, to distinguish further among efficient DMUs. The super-efficiency DEA model can amend this deficiency because it allows a DMU to be located above the efficient frontier; hence, the efficiency scores for the efficient DMUs can receive any value greater than or equal to 1 or 100% – the higher the value, the higher the rank (Banker & Chang, 2006; Nahra, Mendez, & Alexander, 2009). Viewed in this light, this study uses the super-efficiency DEA method to re-rank the released companies.

The GE Ranking Method

The technique of GE, which incorporates the grey system theory with the entropy weighting algorithm, can also be a favorable ranking method (Wen, 2004; Wen, Chang, & You, 1998; Wu, 2012; You & Wen, 2005). In grey entropy, no matter how large the rank is, the operational processing can be modified by the users, making the analytic results more convincing and practical (You & Wen, 2005). The grey system theory, coined by Deng (1982), is designed to deal with systems having well-defined external boundaries but with internal uncertainty or vagueness.

Conventional statistical methods require a large sample size, with prior knowledge of the distribution of samples, and only allowing a few variable factors. In contrast, the grey system theory enables us to analyze data characterized by uncertainty with multiple inputs, discreteness, and small sample size, and without knowing the distribution of samples (Liu & Lin, 1998; Wen et al., 1998). The entropy weighting algorithm, on the other hand, can calculate the relative importance of all attributes or criteria by comparing the entropy values of the attributes or criteria; therefore, it is an objective weighting technique (Krogh & Mitchison, 1995; Wang, Lin, & Hu, 2007). In this light, this study also employs the GE method to re-rank the listed companies with the same input variables (total assets, equity) and output variables (net income, total revenues).

Referring to Wen et al. (1998) and Wang et al. (2007), a procedure utilizing the GE weighting algorithm includes the following seven steps:

Step 1: Let X be a factor set of grey relation, one sequence belonging to X is denoted as:

$$x_i = (x_i(1), x_i(2), x_i(3), \ldots, x_i(k)) \in X; \; i = 0,1,...,m; \; k = 1,...,n. \tag{7}$$

Step 2: Compute the summation of each attribute's value for all sequences D_k:

$$D_k = \sum_{i=1}^{m} x_i(k). \tag{8}$$

Step 3: Compute the normalization coefficient K:

$$K = \frac{1}{(e^{0.5} - 1)n}, \tag{9}$$

where n represents the number of attributes.

Step 4: Find the entropy for the specific attribute e_k:

$$e_k = K \sum_{i=1}^{m} W_e(z_i), \tag{10}$$

where: $W_e(z_i) = z_i e^{(1-z_i)} + (1-z_i)e^{z_i} - 1$,

$z_i = \frac{x_i(k)}{D_k}$.

Step 5: Compute the total entropy value E:

$$E = \sum_{k=1}^{n} e_k. \tag{11}$$

Step 6: Determine the relative weighting factor λ_k:

$$\lambda_k = \frac{1}{n - E}(1 - e_k). \tag{12}$$

Step 7: Calculate the normalized weight of each attribute β_k:

$$\beta_k = \frac{\lambda_k}{\sum_{i=1}^{n} \lambda_i}. \tag{13}$$

In this study, the GE ranking method is based on the above GE weighting algorithm. By comparing n DMUs with s outputs y_{rk} and m inputs x_{ik}, Equation 14 will be used to calculate the GE efficiency score g_k for DMU k. The higher the GE efficiency score, the higher the rank.

$$g_k = \frac{\sum_{r=1}^{s} u_r y_{rk}}{\sum_{i=1}^{m} v_i x_{ik}}. \tag{14}$$

In Equation 14, u_r and v_i are nonnegative objective weights of outputs and inputs. Both weights can be computed by the Matlab Toolbox for Grey System Theory (Wen, Chang-Chien, Yeh, Wang, & Lin, 2006).

Evaluation of DEA-Gap and GE-Gap

To identify the undervalued or overvalued companies, this study defines the DEA-gap for a specific company as its DEA score (%) divided by the original score (%). Similarly, the GE-gap for a specific company is defined as its GE score (%) divided by the original score (%). As such, if the value of the DEA-gap or the GE-gap is greater than 1, then the specific company can be regarded as undervalued. If the gap value is less than 1, then the specific company can be regarded as overvalued.

Let $(n - m + 1)$ be the original score (%) for a specific company, where n is the number of total ranked companies and m is the specific company's ranking order. In our case study of *Taiwan Info Tech 100*, for instance, the top 100 companies are to be re-ranked, so $n = 100$. If one is interested in a specific company, which is originally ranked as, say, the 8th, then $m = 8$. In this circumstance, the specific company will obtain an original score of 93%. Hence, if the re-ranked DEA score or GE score is greater than 93%, then the corresponding gap value is greater than 1, and this specific company should be regarded as undervalued. In contrast, if the re-ranked DEA score or GE score is less than 93%, then the corresponding gap value is less than 1, and this company should be regarded as overvalued. The highest-ranked company in the above settings will obtain an original score of 100%, while the lowest-ranked company will obtain an original score of 1%.

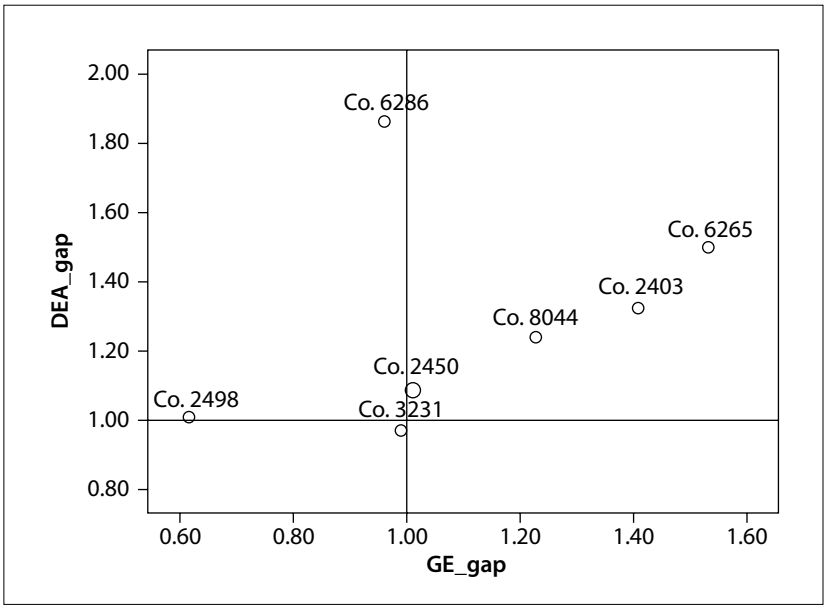
Implementation

To implement the proposed framework, a case of *Taiwan Info Tech 100* released by Business Next Magazine is demonstrated to provide the stock investors with objective and value-added information for making better investment decisions. *Taiwan Info Tech 100* has ranked the top 100 listed companies in Taiwan with annual revenues exceeding US$30 million. The Matlab Toolbox for Grey System Theory (Wen et al., 2006) is used to compute the objective weights of inputs and outputs. The results show that, for the two inputs, total assets has a little higher weight (50.49%) than equity (49.51%); for the two outputs, net income has a little higher weight (50.04%) than total revenues (49.96%). The following analyses will be based on the computed weights.

The software Efficiency Measurement System (EMS) is used to calculate the super-efficiency DEA score, while the Matlab Toolbox is used to calculate the GE score. Table 1 presents the detailed results, which show more information than the original rankings in *Taiwan Info Tech 100*. For instance, Company 2498 (originally ranked as No. 2) is re-ranked as No. 1 by the DEA method, but as No. 40 by the GE method. Company 6286 (originally ranked as No. 50) is evaluated as efficient and re-ranked as No. 6 by the DEA method, but it is rated as inefficient and re-ranked as No. 52 by the GE method. It shows that different ranking methods would generate quite distinct results; thus, we should not dispense with either method because both methods have in effect produced equally relevant results for disclosing the undervalued or overvalued rating.

According to the above definitions of the DEA-gap and GE-gap, Company 8299 (originally ranked as No. 99) is the most undervalued company as it has the largest DEA-gap value (32.5) and the largest GE-gap value (40.5). In contrast, Company 2313 (originally ranked as No. 65) is the most overvalued company if based on the DEA-gap value (0.03), while Company 2474 (originally ranked as No. 52) is the most overvalued company if based on the GE-gap value (0.02). By referring to both DEA-gap and GE-gap information, one can gain more insight into the ranking gaps for each company.

Both the DEA and GE re-ranking methods have concurrently arrived at seven efficient DMUs: Companies 3231, 2498, 2450, 8044, 2403, 6265, and 6286. If stock investors are particularly interested in these seven efficient DMUs as potential investment targets and if they wish to know more about whether these companies are undervalued or overvalued, they simply produce a map of the DEA-gap versus the GE-gap by locating these companies' DEA-gap values on the vertical axis and the GE-gap values on the horizontal axis. Both the DEA-gap values and the GE-gap values are found in Table 1, and the map is shown in Figure 3. This map reveals that Company 6265 (originally ranked as No. 37) is the most undervalued company among the seven efficient companies, and thus Company 6265 can be viewed as a latent promising investment target. In contrast, Company 2498 (originally ranked as No. 2) is the most overvalued company among the seven efficient companies; thus the investors must treat this company with caution when selecting investment targets.



Note. Company (Co.).

Figure 3. A map of the DEA-gap versus the GE-gap.

Table 1a
Monitoring and Re-Ranking Taiwan Info Tech 100

Original Rank	Company Code	*ROE* (%)	Equity (NT$ million)	Total Assets (NT$ million)	Total Revenues (NT$ million)	Net Income (NT$ million)	DEA Score (%)	DEA Rank	GE Score (%)	GE Rank	DEA Gap	GE Gap
1	3 231	19.76	368 712 250	1 078 928 930	4 222 813 680	68 779 290	108.09	4	294.81	2	0.97	0.99
2	2 498	49.06	606 614 860	1 152 263 620	1 525 587 660	286 353 490	134.97	1	102.65	40	1.01	0.62
3	2 382	23.31	860 753 490	2 239 854 110	7 630 641 910	202 194 500	96.04	8	251.34	5	0.95	0.98
4	2 356	14.21	385 846 050	1 059 853 010	3 506 529 910	53 354 330	83.10	19	244.93	6	0.85	0.98
5	2 353	14.76	823 189 590	1 780 468 650	4 189 390 150	117 421 350	63.39	39	164.70	16	0.65	0.89
6	3 045	37.15	509 025 980	898 755 010	543 116 050	153 713 860	68.65	30	49.34	81	0.75	0.21
7	6 121	25.56	99 656 180	171 359 160	307 992 060	23 535 970	70.13	29	121.93	27	0.77	0.79
8	5 478	24.04	42 621 780	65 489 770	62 672 380	9 979 220	63.06	40	67.02	63	0.66	0.41
9	2 330	20.74	4 763 771 110	5 405 592 470	3 217 670 830	999 331 680	73.26	27	41.42	90	0.80	0.12
10	2 450	27.48	41 683 290	65 493 900	220 642 430	10 893 820	111.28	2	215.41	9	1.09	1.01
11	6 163	33.94	11 656 460	30 492 230	52 884 420	3 136 640	73.68	25	132.24	24	0.84	0.86
12	3 561	19.91	20 552 090	63 417 120	48 358 260	3 772 970	46.28	72	61.73	66	0.33	0.39
13	4 906	15.13	73 771 420	121 353 170	181 342 920	11 365 520	51.14	58	98.46	43	0.49	0.66
14	6 188	14.83	76 026 120	117 591 690	214 990 380	11 261 360	56.07	48	116.53	31	0.61	0.80
15	6 282	13.74	68 591 510	113 787 680	169 681 980	9 052 960	47.11	70	97.69	45	0.36	0.65
16	3 211	35.14	38 535 940	74 195 190	175 439 260	12 210 420	91.68	12	165.83	15	1.05	1.01
17	3 059	20.56	95 677 690	181 832 460	229 649 700	18 369 620	52.82	55	89.04	49	0.55	0.62
18	6 239	33.32	215 117 340	436 619 350	311 889 820	65 446 880	64.45	37	57.67	70	0.77	0.37
19	2 376	5.92	189 797 250	259 798 240	457 970 100	11 402 310	43.77	77	104.16	39	0.29	0.76
20	2 454	22.91	816 109 010	965 874 260	680 155 430	191 899 970	78.73	21	48.88	83	0.99	0.22
21	2 385	36.33	82 939 970	154 160 190	158 033 540	29 007 890	76.00	23	78.61	55	0.98	0.58
22	8 044	19.67	5 944 710	21 656 890	74 382 910	1 063 610	109.25	3	271.61	4	1.24	1.23
23	2 324	16.19	778 365 070	1 478 969 390	4 049 929 100	126 390 370	73.58	26	184.31	14	0.96	1.12
24	3 380	13.24	79 936 770	127 508 970	228 329 710	10 525 630	52.03	56	114.80	33	0.58	0.88
25	2 317	15.49	3 611 668 470	6 486 639 880	14 730 262 800	551 331 750	63.50	38	150.80	21	0.83	1.05

Note. New Taiwan dollar (NT$).

Table 1b
Monitoring and Re-Ranking Taiwan Info Tech 100

Original Rank	Company Code	*ROE* (%)	Equity (NT$ million)	Total Assets (NT$ million)	Total Revenues (NT$ million)	Net Income (NT$ million)	DEA Score (%)	DEA Rank	GE Score (%)	GE Rank	DEA Gap	GE Gap
26	3 443	30.24	26 388 950	40 207 730	92 820 630	7 470 490	92.16	11	150.19	22	1.20	1.05
27	3 504	29.38	22 892 250	33 046 780	60 100 600	6 137 770	85.50	17	118.12	28	1.14	0.99
28	3 060	21.60	25 775 170	50 585 950	62 555 940	5 356 590	54.61	53	88.59	50	0.66	0.70
29	3 209	15.98	9 356 210	20 062 430	61 925 180	1 423 970	79.10	20	214.41	10	1.13	1.26
30	2 403	11.76	70 476 580	147 475 850	637 885 840	8 008 750	100.24	7	295.09	1	1.32	1.41
31	3 514	24.86	86 240 830	229 023 380	158 276 490	19 086 280	50.41	60	55.97	72	0.59	0.41
32	2 412	11.67	3 765 564 210	4 592 686 710	1 867 806 500	450 103 420	38.84	84	27.69	99	0.25	0.03
33	3 519	36.63	52 556 590	129 784 670	87 889 930	14 680 510	60.16	44	55.99	71	0.84	0.44
34	2 374	18.83	70 692 830	100 308 040	332 178 720	13 555 280	92.68	10	201.69	12	1.36	1.33
35	2 308	17.36	583 434 640	817 443 590	379 064 130	102 509 150	49.88	61	34.30	95	0.61	0.09
36	4 904	13.49	712 962 020	853 603 490	513 414 790	101 607 470	47.17	69	39.20	91	0.49	0.15
37	6 265	11.72	14 093 160	26 892 370	119 705 220	1 551 360	103.23	5	294.72	3	1.50	1.53
38	6 115	20.25	32 900 210	49 376 510	57 598 790	6 330 110	57.87	46	77.50	56	0.87	0.71
39	3 452	23.31	68 028 510	196 592 300	135 881 130	12 134 340	43.41	79	55.63	73	0.35	0.45
40	3 008	29.41	119 307 700	137 519 570	55 196 010	32 423 030	93.43	9	34.09	96	1.51	0.08
41	2 354	14.35	371 124 310	704 250 750	1 190 964 120	62 029 290	55.91	49	116.08	32	0.87	1.15
42	2 377	9.13	257 001 840	515 644 440	977 730 510	22 696 340	47.92	67	128.96	25	0.58	1.29
43	6 244	16.89	138 474 630	206 963 270	228 593 050	23 023 550	51.45	57	72.65	59	0.76	0.72
44	2 395	19.99	115 424 110	141 184 580	122 756 660	25 566 380	71.76	28	57.71	69	1.28	0.56
45	2 337	12.37	369 390 680	428 102 650	232 577 380	45 146 040	41.91	80	34.78	94	0.38	0.13
46	6 192	23.87	21 431 200	36 058 680	41 564 960	4 911 440	60.44	42	80.59	53	1.07	0.87
47	8 081	19.28	34 114 250	40 848 580	33 235 240	5 419 660	54.48	54	51.49	78	0.87	0.43
48	2 451	16.19	144 196 890	177 448 870	333 160 150	22 470 370	66.86	33	110.38	37	1.28	1.21
49	5 483	25.52	73 740 850	182 410 580	94 106 260	17 225 790	49.66	62	43.26	88	0.75	0.25
50	6 286	33.37	41 235 240	53 232 280	68 087 670	13 433 420	101.55	6	86.14	52	1.86	0.96

Note. New Taiwan dollar (NT$).

Table 1c
Monitoring and Re-Ranking Taiwan Info Tech 100

Original Rank	Company Code	*ROE* (%)	Equity (NT$ million)	Total Assets (NT$ million)	Total Revenues (NT$ million)	Net Income (NT$ million)	DEA Score (%)	DEA Rank	GE Score (%)	GE Rank	DEA Gap	GE Gap
51	3 227	27.22	50 252 980	62 820 200	48 048 710	13 596 970	85.77	16	54.43	75	1.70	0.52
52	2 474	15.72	294 537 370	357 880 680	37 514 490	43 463 840	48.13	65	12.40	100	0.73	0.02
53	2 362	12.71	69 318 180	109 695 210	157 846 500	8 762 060	45.63	73	92.80	47	0.58	1.13
54	8 099	18.91	9 679 760	16 429 920	35 585 470	1 755 000	66.51	35	142.55	23	1.40	1.66
55	2 325	9.85	593 141 210	723 105 780	604 744 680	63 135 300	39.91	83	50.66	79	0.39	0.48
56	3 376	23.23	56 812 460	84 588 630	35 866 160	11 856 130	55.89	50	33.67	97	1.13	0.09
57	3 015	13.61	47 443 280	93 801 410	145 051 390	6 319 720	47.80	68	106.75	38	0.75	1.43
58	2 312	0.51	190 574 940	288 287 270	226 000 580	1 056 920	17.61	99	47.28	86	0.05	0.35
59	2 392	10.89	180 096 500	300 793 620	431 350 490	18 953 020	41.50	81	93.34	46	0.48	1.31
60	8 046	17.96	355 146 110	398 949 460	372 988 130	66 472 100	67.25	32	58.21	68	1.68	0.80
61	5 471	24.83	30 175 360	34 547 280	38 527 820	7 383 480	85.12	18	70.85	61	2.08	1.00
62	5 371	12.69	186 321 020	296 128 170	400 672 010	23 184 490	43.96	76	87.60	51	0.64	1.28
63	6 170	14.34	12 293 640	25 145 360	42 590 830	1 674 310	50.74	59	117.75	30	1.11	1.87
64	6 125	17.87	43 599 780	91 226 350	52 834 580	7 348 800	37.39	85	44.46	87	0.43	0.38
65	2 313	0.92	163 516 610	277 536 960	187 008 890	1 473 530	15.14	100	42.59	89	0.03	0.33
66	2 485	26.35	62 911 760	82 690 510	96 496 380	15 543 540	77.38	22	76.80	57	2.26	1.26
67	3 042	17.72	56 253 140	80 912 460	65 473 400	9 518 170	49.56	63	54.54	74	1.12	0.79
68	2 345	6.46	65 497 570	92 122 730	150 897 840	4 087 870	41.39	82	98.09	44	0.58	1.73
69	3 034	19.73	183 595 630	256 953 640	261 762 100	35 325 180	58.87	45	67.28	62	1.75	1.22
70	3 389	12.01	7 118 260	17 200 390	53 446 650	783 800	75.27	24	221.92	8	2.48	3.00
71	6 285	12.21	59 680 370	104 907 730	176 283 770	7 216 450	48.13	64	111.11	36	1.20	2.17
72	2 301	7.40	577 904 090	1 047 124 770	1 244 616 480	44 194 330	32.77	91	79.03	54	0.34	1.62
73	6 152	10.00	21 846 870	30 214 060	45 141 610	2 113 380	43.59	78	90.56	48	0.82	1.89
74	3 323	19.78	20 740 430	56 284 090	87 550 050	3 866 210	57.01	47	118.06	29	2.00	2.67
75	2 393	13.56	97 750 550	163 144 590	110 427 010	13 584 080	36.57	87	47.39	85	0.54	0.62

Note. New Taiwan dollar (NT$).

Table 1d
Monitoring and Re-Ranking Taiwan Info Tech 100

Original Rank	Company Code	*ROE* (%)	Equity (NT$ million)	Total Assets (NT$ million)	Total Revenues (NT$ million)	Net Income (NT$ million)	DEA Score (%)	DEA Rank	GE Score (%)	GE Rank	DEA Gap	GE Gap
76	3 367	16.44	133 919 240	191 497 320	625 662 180	21 940 990	87.72	14	198.51	13	3.48	3.52
77	2 331	1.45	221 373 590	338 710 950	699 714 990	3 236 930	46.41	71	125.15	26	1.25	3.13
78	2 347	12.11	278 034 000	487 363 330	474 328 030	32 927 690	36.23	88	66.05	64	0.57	1.61
79	2 441	16.66	96 807 830	106 330 190	83 338 770	16 088 280	60.19	43	48.90	82	2.64	0.86
80	8 016	16.64	25 987 120	35 606 690	64 019 130	4 720 760	67.73	31	111.35	35	3.33	3.14
81	8 131	12.10	78 902 710	151 806 770	101 772 300	10 142 440	32.33	92	48.33	84	0.45	0.85
82	6 281	18.86	24 776 810	43 636 770	139 544 120	4 701 000	86.11	15	210.12	11	4.53	4.74
83	1 785	11.68	67 039 010	109 184 840	189 312 000	7 635 770	48.36	64	111.42	34	2.06	3.72
84	6 176	9.60	133 360 070	150 260 250	95 876 020	12 555 930	36.01	89	38.19	92	0.71	0.53
85	2 314	6.72	50 884 540	78 396 580	76 210 260	3 542 230	28.30	94	61.52	67	0.44	2.13
86	2 365	19.24	41 141 610	60 817 350	94 915 480	8 486 470	66.86	33	101.16	42	4.53	3.93
87	2 430	9.06	62 763 890	137 432 590	308 839 240	5 530 890	55.00	51	156.34	19	3.57	5.86
88	3 481	5.06	964 243 300	1 517 032 790	1 592 770 110	48 509 500	27.23	95	65.95	65	0.46	2.77
89	2 409	7.31	2 900 589 710	5 301 018 840	4 219 574 400	212 673 860	25.50	97	53.85	76	0.33	2.08
90	6 118	3.64	9 866 800	36 281 560	110 317 010	355 860	89.36	13	238.29	7	8.00	8.55
91	8 008	6.81	193 709 090	264 609 550	315 557 350	13 319 180	33.70	90	71.60	60	1.10	4.10
92	3 189	12.38	178 442 670	200 006 060	122 149 830	21 983 800	44.28	75	38.04	93	2.89	0.89
93	2 489	9.35	103 685 360	280 736 680	613 144 700	9 647 410	54.67	52	161.15	18	6.13	10.38
94	2 414	8.44	28 517 830	46 830 030	120 769 170	2 434 550	61.62	41	163.00	17	8.57	12.00
95	2 379	5.55	152 279 620	180 937 570	167 444 020	8 810 330	28.45	93	52.81	77	1.33	4.00
96	3 037	8.58	282 244 630	503 116 210	371 259 460	24 264 580	26.75	96	50.19	80	1.00	4.20
97	3 010	11.52	62 747 300	114 106 590	174 247 900	7 284 770	44.78	74	102.28	41	6.75	15.00
98	3 026	9.09	73 061 270	107 272 240	127 774 540	6 744 970	36.69	86	74.40	58	5.00	14.33
99	8 299	10.80	52 638 620	73 640 790	188 563 140	5 539 840	65.86	36	153.34	20	32.50	40.50
100	2 311	8.51	696 719 940	1 239 312 460	484 510 170	61 600 520	21.68	98	28.11	98	3.00	3.00

Note. New Taiwan dollar (NT$).

Application

The map of the DEA-gap versus the GE-gap provides worldwide investors with pragmatically useful information on top of the released ranking reports. It is thought that continually monitoring worldwide public companies with the proposed framework can lead to important business opportunities, and it may eventually turn into a promising business model. Here we explore in more detail how to develop favorable business models with the proposed framework. Referring to previous literature (e.g., Shafer, Smith, & Linder, 2005; Shin & Park, 2009; Teece, 2010; Timmers, 1998), four procedures are suggested to develop favorable business models: (a) identifying the value propositions, (b) creating the value chain, (c) estimating the potential benefits, and (d) devising the competitive strategies.

In identifying the value propositions, the proposed framework can serve as an additional pair of eyes to continually monitor the released ranking reports. Based on the DEA and GE ranking methods, the proposed framework can objectively re-rank the companies, which can also identify the undervalued and overvalued companies. Accordingly, it can decrease the investment risks with special caution against the overvalued companies, increase the investment benefits based on the adjusted re-ranking information, and have facilitation value by simultaneously enhancing the quality and trust in selecting the investment targets.

In creating the value chain, the supervisory stock authority, the accredited securities companies, financial data companies, and even investment-oriented virtual communities may implement the proposed framework to monitor the rankings of publicly traded companies on a regular basis. We suggest the social network sites (SNSs) such as Google, Facebook, and Yahoo (Boyd & Ellison, 2007) serve as the second pair of eyes to implement or even to refine the proposed framework by incessantly monitoring the company rankings released worldwide.

In estimating the potential benefits, we suggest the SNSs disseminate the re-ranked outcomes (as in Table 1) and information about the overvalued or undervalued companies (as in Figure 3) to accumulate their reputation capital in the beginning. The participating SNSs are likely to generate countless business opportunities in the future because the reputation capital can be extended to form different brands, from which considerable products, services, information, and solutions may be derived.

Finally, in devising the competitive strategies, we must simultaneously focus on investors' perceived benefits and perceived risks (Evans & Krueger, 2011). In theory, any competitive strategy for a favorable business model must boost the customers' expected value of *trust* by increasing their perceived benefits and decreasing their perceived risks. In practice, decreasing the stock investors' perceived risks can be more imperative than increasing their perceived benefits. In this sense, any strategies that can decrease the investors' perceived risks should be used as market differentiators for developing favorable business models.

Discussion

Implications

There is no doubt that the public company rankings released by different business organizations may profoundly influence the companies' reputations and investors' decisions. In general, highly-ranked companies are more likely to elicit greater public attention with positive emotional responses, and thus possess more economic opportunities than companies with a lower ranking. Highly ranked companies may draw more market resources which, in turn, strengthen their financial performance and thus enhance their reputation and competitiveness. On the other hand, low-ranked companies may draw fewer market resources, thus entering a vicious circle in which their reputation and competitiveness decline. Notwithstanding, we must not forget the lessons from WorldCom and Enron that an investment should not rely only on the released ranking information as the resultant rankings are based on different ranking rationales with diverse indicators, which may not be directly comparable or well suited to investment objectives. Simply relying on the released ranking information may easily mislead stock investors, and this is why it is essential to use appropriate approaches for the continual monitoring of the released public company rankings.

Our proposed framework can satisfactorily monitor public company rankings with the four common financial indicators derived from the DuPont model. The re-ranked outcomes are sensible, comparable, and useful for investment guidance. In particular, the map of the DEA-gap versus the GE-gap is pragmatically useful for advising stock investors of undervalued or overvalued companies. The prudent investor should treat

companies with a DEA-gap and GE-gap essentially less than 1 with caution. However, investors may give more creditability to companies with a DEA-gap and GE-gap significantly greater than 1.

Conclusions

This study is the first of its kind to propose a novel framework to monitor the rankings of public companies released by different business organizations. The proposed framework can satisfactorily re-rank the public companies and further expose the undervalued or overvalued companies to help investors make better investment decisions. In sum, this study has contributed to investment theory and practice in several ways. It has cast new light on the undervaluation or overvaluation of companies in the released company ranking reports. The proposed framework employed the super-efficiency DEA ranking method and the GE ranking method to re-rank the listed companies based on four common financial indicators derived from the DuPont model. In so doing, company rankings released by different organizations would become comparable for investment objectives. Most importantly, this study has developed a map of the DEA-gap versus the GE-gap, which can reveal undervalued and overvalued companies to aid stock investors in making investment decisions.

Limitations

It should be emphasized that this study does not attempt to replace the released ranking reports. Instead, it aims to add value to the current reports to help stock investors make investment decisions. Although the demonstration of the proposed framework is only for *Taiwan Info Tech 100*, it is believed that by applying the proposed framework to other listed companies, investors would gain more insight into the companies' performance, financial health, and operating efficiency so that they could become more informed when selecting investment targets.

However, this study inevitably has some limitations which call for future studies. First, the present study only implements the proposed framework to a case of *Taiwan Info Tech 100* released by Business Next. The proposed framework should be readily applicable to monitor any other released public company rankings to uncover undervalued or overvalued companies for investment objectives. It requires further exploration to help worldwide stock investors make investment decisions. Next, this study uses the super-efficiency DEA and GE ranking methods to re-rank the companies and to estimate the DEA-gap and GE-gap for each company. It is worth developing other ranking methods and comparing the re-ranked outcomes to test the robustness of the proposed framework. Finally, the proposed framework is intended only for investment objectives. It would be interesting yet challenging to develop appropriate tools to monitor different types of released ranking reports other than for investment objectives, for instance, the World Economic Forum's global *Travel and Tourism Competitiveness Report* (Wu, Lan, & Lee, 2012a), its *Global Information Technology Report* that ranks information and communications technology competitiveness (Wu, Lan, & Lee, 2012b), and its *Global Competitiveness Report* which assesses the competitiveness of national economies. Of course, a completely different set of indicators must be identified prior to introducing the appropriate tools. Our proposed framework has shed new light on this interesting yet challenging issue. It deserves further exploration.

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This study was sponsored in part by the National Science Council, Taiwan (NSC 101-2221-E-233-010). The authors wish to thank the Editor-in-Chief, Vincent Charles, and the reviewers for their insightful comments and constructive suggestions, which helped ameliorate the quality of this paper.

Editors of the Special Issue