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Approaching the Negative Super–SBM Model to Partner Selection of Vietnamese Securities Companies*

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Abstract

The purpose of the study is to determine the efficiency, position, and partner selection of securities companies via the negative super-SBM model used in data envelopment analysis (DEA). This model utilizes a variety of inputs, including current assets, non-current assets, fixed assets, liabilities, owner's equity and charter capital, and outputs including net revenue, gross profit, operating profit, and net profit after tax collected from the financial reports (Vietstock, 2020) of 32 securities companies, operating during the period from 2016 to 2019, negative data are collected as well. Empirical results determined both efficient and inefficient terms, and then further determined the position of each securities firm under consideration of every term. The overall score arrived at discovered a large performance change realizing a maximum score able to reach 20.791. In the next stage, alliancing inefficient companies was carried out based on the 2019 scores to seek out optimal partners for the inefficient companies. The tested result indicated that AAS was the best partner selection when its partners received a good result after alliancing, as with FTS (11.04469). The partner selection is deemed as a solution helpful to inefficient securities companies in order to improve their future efficiency scores.

Keywords: Securities Company, Negative Super-SBM Model, Data Envelopment Analysis (DEA), Partner Selection

JEL Classification Code: F50, F55, F59, F65

1. Introduction

The securities industry around the world is growing fast in both developed and developing countries. According to statistics (October, 2020), revenues in the security segment from 2017 to 2019 increased from US$5,726m to US$9,956.8m. In addition, the scale and scope of larger companies have moved from private firm development to that of cooperation, and they have contributed to enhancement of economic development. A good example of such positive business development is located in Southeast Asia. In Vietnam, over the past twenty years, the securities industry has formed, boosted and developed sharply in order to achieve a high rate of economic growth. In recent years, the securities market in Vietnam has achieved a development rate contributing 20% to the total investment digest in 2019. The development of a local securities industry equips a nation to restructure the economy and to maintain stable economic development (Pham, Sriratanaviriyakul, & Nkhoma 2013). Thus, the securities industry remains an important foundation for continued and future economic development considered as a central finance mechanism to ensure adequate financing for growing enterprises and to boost domestic investment and wealth creation (Steil, 2001). Securities activities are involved in managing and controlling investment banking, market creation, trading, portfolio management and corporate strategic growth (Bayyurt & Akin, 2014). To attract a variety of domestic and international

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investors, securities firms always promote better strategies, such as technical innovation involving the development of communication channels between investors and consumers (Iwamura & Jog, 1991). The operational efficiency of securities firms is measurable via the negative-SBM model in DEA.

In the financial statement of securities firms located in Vietnam, financial indices often present negative values, so the negative super-SBM model (Lin, Yang, & Huang, 2019) is useful to analyze operating processes because of its function of dealing with the negative data. Moreover, this model can compute super efficiency (Lin & Liu, 2019) with the separate performance and the maximum point approach that can help to rank-order the different positions of each securities firm according to every term. In this research, actual data possessing both positive and negative values gathered from Vietstock (2020). Therefore, the purpose of this study is to measure the performance of securities companies in Vietnam from 2016 to 2019 and then seek out the future partner selection for the inefficient securities firms based on 2019's empirical results. Firstly, the efficiency scores and positioning of each securities company were determined by means of the negative super-SBM model since this model can solve the presence of negative values. Secondly, an alliance was created between inefficient securities firms in 2019 along with other securities firms in order to select the best future partner bid. As a result, the inefficient securities firms had the potential to improve their future operational performance by choosing a right partner and strategic direction.

The paper is organized as follows: Section 1 introduces the purpose of this research. Section 2 reviews the literature about past studies of securities market, negative super-SBM model and partner selection. Section 3 provides the mathematical equations offered by the negative super-SBM model and describes the raw data resultant from such equations. Section 4 delivers the empirical results and discusses primary findings. Finally, Section 5 summarizes the main results and notes limitations and directions for future research.

2. Literature Review

Securities are always attractive to regular investors because securities indices change consistently and rapidly. Further, scientific research methodology has been utilized to study the securities industry through various methods and problem scenarios. For example, Gao, O'Sullivan, and Sherman (2017) tested the performance persistence of Chinese equity securities investment funds from May 2003 to May 2014 by means of persistence test methods. Gustafson (2018) gave evidence of the public securities market's accessibility creating a slight reduction in criminal bank hold-ups. Fisher, Gissler, and Verani, (2019) studied securities lending practices to show how they impacted over-the-counter market liquidity in U.S. insurance companies. Chanto and Fioriti (2019) investigated bidding on securities and discovered three fundamental characteristics, which included the losing bidder, payment of bidder and implementation decision in the winning bidder's decision. Faias and Guedes (2020) described the diffusion process of a financial innovation via the CAT bond market, and then, the analytic results indicated that investors could improve their estimates by observing the performance of successive vintages of the security. Silvers (2020) indicated that the securities market had expanded and grew around the world, in such a way that cross-border securities always required efforts to have suitable securities regulations in place in the capital markets of participating countries. Therefore, the securities industry has attracted a broad range of research including the present study of evaluative performance of securities companies located in Vietnam.

According to Alexander (2009), efficiency is a practical tool, an intellectual construct, a comparative mean, and a vision. In common terms, efficiency is a measurement tool for an organization when it utilizes its resources to produce goods and services, whereas, its resources are called "inputs"; and, its goods and service are called "outputs". DEA is a statistical tool that may determine the efficiency of an organization by calculating the ratio between outputs and inputs. The improvement of ineffective DMU's in the traditional DEA model is represented as a proportional reduction in the inputs/outputs. Tone (2001) proposed the SBM model with a non-radial aspect that addressed slack directly. However, this model only gives a limited score represented as "1" along with the efficient DMU's. Tone (2002) continued to recommend the super-SBM model with unlimited scores to be an efficient DNMU. In addition, Tone (2004) proposed an undesirable model with new non-parametric DEA scheme to compute measurable performance in the presence of undesirable outputs based on the demonstrated principles already found in the SBM model.

Consequently, there are many different models in DEA such as Slack-based measure, Super slack-based measure, and so on. These models have already been applied to the various aspects of enterprise. Feng, Zeng, and Ming, (2018) indicated the green innovation efficiency (GIE) of China's manufacturing industry from 2009 to 2015 through the use of a super-SBM model. An investigation of bank efficiency in China and Taiwan from 2008 to 2017 determined the overall technical efficiency of banks after China and Taiwan signed the ECFA cooperation agreement (Liao, 2020). Naushad, Faridi, and Faisal (2020) computed the managerial efficiency of 30 insurance companies in Saudi Arabia by means of the DEA approach. An application of the Malmquist productivity

index investigated empirical evidence of productivity in life insurance institutions in Malaysia by Masud, Rana, Mia, and Saifullah (2020). An evaluation of the land-use efficiency of 17 cities in Shangdong, China from 2006 to 2018 was conducted by means of a super-SBM model (Pang & Wang, 2020). Previous research approached the DEA method to measure the performance of a variety of areas. In this study, due to the presence of negative values, the negative super-SBM model has been selected for computing the performance of securities firms in Vietnam.

The negative super-SBM model is an analytical statistics model in DEA, which can conduct the efficiency score of a Decision-Making Unit (DMU) with the presence of negative input and/or output values (Khoveyni, Eslami, & Yang, 2017; Tone, Chang, & Wu, 2020). A return to scale is defined by variable return to scale technology (Allahyar & Malkhalifeh, 2015). Moreover, the negative super-SBM model owns the super efficiency. In a progressive comparison, there are many DMU's using similar terms, the super efficiency model conducts separate scores for both inefficient cases and efficient cases (Wang, Day, Nguyen, & Luu, 2018). Hence, it is a good tool to evaluate the performance and to distinguish the rank of each DMU. Thus, the efficiency scores overcome a limited efficiency score of "1". Many previous studies analyzed the presence characteristics of negative data in DEA, such as a semi-oriented radial measurement (Emrouznejad, Anouze, & Thanassoulis, 2010), a variant of radial measurement (Cheng, Zervopoulos, & Qian, 2013), congestion approaches (Mehdiloozad, Joe, & Sahoo, 2018), etc. Such a model was applied in measuring the performance of supply chains (Chiang, 2020), global airlines (Cui & Jin, 2020), the banking industry (Tavana, Izadikhah, Caprio, & Saen, 2018), and so on.

In this study, the negative super-SBM model in DEA was used for conducting the performance of Vietnamese securities companies from 2016 to 2019. In addition, from empirical results taken from the negative super-SBM model and the principle of partner selection, a good partner of inefficient DMU based on the efficiency score in 2019 was identified. Several previous studies utilized the partner selection strategy to determine the best partner who could cooperate and form a future alliance. Determination of a right partner is a crucial task in alliancing operations and development orientation (Nielsen, 2003). This is so much so that the right partner selection has been given an important position in the alliance process (Duisters, Duysters, & Man, 2001). Examples include the global aerospace and defense industry (Wang, Nguyen, Le, & Hsueh, 2018) and the Vietnamese construction industry (Nguyen, 2020), which revealed the importance of valuable performance indicators in any operational alliance. Inefficient firms located their partners who could assist them to extend their scores from inefficient to efficient.

3. Materials and Methodology

3.1. Data Collection

With the objective research of partner selection for securities companies in Vietnam, past operating progress of selected companies was evaluated and then given a decision related to partner selection. Therefore, the study chose to list Vietnamese securities companies found in Dunn & Bradstreet (2020) (see Table 1).

Analyzing the effect of operating progress required having full and exact information of financial reports so that all of the actual values of input variables and output variables. Thirty-two securities companies, operating during the period from 2016 to 2019, were collected upon their posting on the financial report, Vietstock (2020). Based on the principle of the negative-SBM model in DEA, the quantity of input variables, as well as the quantity of output variables, showed that they cannot overcome the total DMU's. Hence, six input factors were chosen, including current assets (CA), non-current assets (NA), fixed assets (FA), liabilities (LS), owner's equity (OE), and charter capital (CP); and, four output factors, including net revenue (NR), gross profit (GP), operating profit (OP), and net profit after tax (NP), were also selected.

Input factors:

CA: All securities company assets that are sold, consumed, used, and exhausted in one year's time through standard business operations.
NA: All securities company assets that are invested on a long-term basis.
FA: All securities company assets that comprise land, machinery, equipment, buildings and other durables.
LS: All of the money a securities company owes to outside parties.
OE: All of the money a securities company must pay-off in the event of liquidation.
CP: All of the capital holdings of a securities company that are invested by the owner into the company within a specified period.

Output factors:

NR: All of the money that the securities company receives from its securities trading activities in which there has been no deduction of service charges, interest, and taxes.
GP: All of the profitability of a securities company after deducting service fees.
OP: All of the profitability of a securities company before deduction of interest and taxes.
NP: All of the profitability of a securities company after deduction of interest and taxes.

Table 1: Name of Securities Companies in Vietnam

Abbreviate	Name	Abbreviate	Name
APG	APG Securities	IVS	Vietnam Investment Securities
BSI	Bank for Investment & Development of Vietnam Securities	MBS	MB Securities
CTS	Viet Nam Bank For Industry & Trade Securities	PSI	Petrovietnam Securities Incorporated
FTS	FPT Securities	SHS	Saigon - Hanoi Securities
HCM	Ho Chi Minh City Securities	VIX	IB Securities
SSI	SSI Securities Corporation	WSS	Wall Street Securities
TVB	Tri Viet Securities	AAS	SmartInvest Securities
TVS	Thien Viet Securities	BMS	Bao Minh Securities
VCI	Viet Capital Securities	CSI	Vietnam Construction Securities
VDS	Viet Dragon Securities	DSC	Da Nang Securities
VND	VNDirect Securities	HAC	Hai Phong Securities
APS	Asia - Pacific Securities	ORS	Tien Phong Securities
ART	BOS Securities	PHS	Phu Hung Securities
BVS	Baoviet Securities	SBS	Sacombank Securities
EVS	Everest Securities	TCI	Thanh Cong Securities
HBS	Hoa Binh Securities	VFS	Viet First Securities

Source: Dum & Bradsheet (2020).

From the actual data posted to Vietstock (2020), there are three output variables including GP, OP and NP that appeared to contain negative values. Thus, the negative super-SBM model in DEA with the function of dealing with the presence of negative data was particularly equipped to calculate the efficiency score of securities companies

3.2. Super Slack-Based Measurement Model

DEA is a useful statistical tool used in operational research and economics for the estimation of a production frontier useful to evaluate the performance of DMU's. It utilizes the nonparametric method of benchmarking to measure the efficiency of operations research. According to the common principle of DEA, the efficiency of a DMU is to be determined by the given ratio between outputs and inputs. Let the inputs as x, output as y and the production possibility as p:

$$p = (x, y) \tag{1}$$

s^- and s^+ are considered as input excess and output shortfall, respectively, the expression for a certain $DMU = (x_0, y_0)$ is determined by:

$$x_0 = x\lambda + s^- \tag{2}$$
$$y_0 = y\lambda + s^+ \tag{3}$$

The index p is calculated by:

$$p = \frac{1 - \frac{1}{m}\sum_h^m s_h^- / x_{h0}}{1 + \frac{1}{s}\sum_k^s s_k^+ / y_{k0}} \tag{4}$$

The efficiency score of $DMU = (x_0, y_0)$ is formulated by the following fractional program SBM in λ, s^-, s^+ as follows:

$$\text{Min}_p = \frac{1 - \frac{1}{m}\sum_h^m s_h^- / x_{h0}}{1 + \frac{1}{s}\sum_k^s s_k^+ / y_{k0}} \tag{5}$$

The score of each DMU is computed between $[0 \sim \infty]$, it will occur two cases as follows:

If $p^* < 1$, the DMU does not have efficiency.

If $p^* \geq 1$, the DMU has efficiency.

4. Results and Discussions

4.1. Data Analysis

In order to compute the efficiency score and then to determine the alliance partner selection for securities firms in Vietnam, input and output variables have been selected

and then summarized (see Table A1). The maximum value of CA, NA, FA, LS, OE, CC, NR, GP, OP and NP during the period of 2016–2019 attained as 22,290,867; 4,753,248; 179,210; 17,643,055; 9,401,060; 5,100,637; 3,672,838; 2,063,970; 1,567,030 and 1,302,937, respectively. The minimum value of CA, NA, FA, LS, OE, CC, NR, GP, OP and NP during the period of 2016–2019 was 134,806; 2,336; 21; 984; 102,019; 96,000; 1,780; 1,602; 72; 10, respectively. These values revealed that all input and output values were suitable for inclusion into the super-SBM model in DEA.

However, these values must be tested with Pearson's correlation coefficient to ensure the appropriate relationship between input and inputs; output and output; and, input and output exist before their application into DEA. The relationship between two variables is always isotonic (Wang, Nguyen, Le, & Hsueh, 2018). The correlation coefficients are ranged from −1 to +1, it has a perfect linear relationship as near to ±1, a strong correlation as near to ±0.5 and ±0.8, a medium correlation as near to ±0.3 and ±0.49, and a low correlation when lower than ±0.29. All variables demonstrating unqualified Pearson's correlation must be removed. The data of thirty-two securities companies were checked with the Pearson's correlation coefficient before they were used for conducting the efficiency score by means of the negative super-SBM model. In this research, the Pearson correlations between variables ranged from 0.46146 to 1, thus, they were determined to have a good linear relationship. All raw data were suitable to approach for the super-SBM model in DEA.

4.2. Efficiency and Position before Alliance

The use of super efficiency provides the separate scores of each DMU in every year observed. In this research, a determination of the efficiency scores of securities companies in Vietnam during the time-period of 2016–2019 was conducted (see Table 2).

As seen in Table 2, the performance of most of securities companies fluctuated sharply with the exception of SSI, which obtained efficiency and owned a stable score for the entire term of "1". The scores of APG, FTS, HCM, VCI, APS, SHS, CSI and DSC in every term achieved the efficiency level, but they had a large amount of variation, ranging from 1.0871 to 14.3305. Whereas, the score of FTS increased sharply and received the highest score as 14.3305 in 2019, it became the best securities firm in 2019. In contrast, CTS, VDS, IVS, AAS and PHS were the worst companies since they did not attain the efficiency level standard during the whole time because their scores were always under "1". The score of these companies always had a variation slightly and at the lowest value, with IVS determined to be the worst company having the lowest scores ranging from 0.2096 to 0.4461 during 2016–2019. The remaining securities companies were determined to exist with both efficient and inefficient scores, whereas, EVS and HBS had a large fluctuation from 0.4756 to 20.793 and from 0.5164 to 17.0089, respectively. The empirical results indicated that the efficiency scores of these securities firms were divided into three groups: an efficient group; an inefficient group; and a mixed efficient and inefficient group.

Based on the available efficiency scores, the study defined the position of securities companies in every term (see Table 3).

Correspondingly, the principle of super efficiency and the conducted score presented in Table 3 for each securities company in every year describes a separate position from the first to the thirtieth ranking. The position of a given securities companies always changed in each year. For instance, HBS ranged in the first, second, nineteenth and twelfth positions, and EVS ranked in the twelfth, first,

Table 2: Efficiency of Securities Companies before Alliance

DMU	2016	2017	2018	2019	DMU	2016	2017	2018	2019
APG	1.1329	4.9723	10.7290	6.2432	ART	0.8437	5.1090	2.9060	2.2443
BSI	1.4393	0.6459	1.5192	1.0595	BVS	3.2752	1.9303	0.4326	1.2445
CTS	0.5414	0.3593	0.4573	0.5238	HBS	17.9143	17.0321	75.7977	2.3698
FTS	2.8321	11.9418	9.2305	14.3305	MBS	0.4282	0.5549	1.0431	1.1188
HCM	1.8621	1.0871	2.0616	2.6217	PSI	3.0083	0.4094	2.2071	0.6310
SSI	1.0000	1.0000	1.0000	1.0000	SHS	2.4169	2.4080	2.0487	1.8092
TVB	1.7364	0.5496	1.1120	0.7406	VIX	0.4440	1.1883	1.2488	1.8075
TVS	0.4572	0.7635	1.4648	1.6942	AAS	0.3502	0.4262	4.1708	1.9155
VCI	3.4050	3.2407	3.0670	10.0720	BMS	0.4828	1.1986	1.5938	2.4622
VDS	0.4377	0.4835	0.4851	0.4285	VFS	4.4745	1.2549	0.5331	0.7225
VND	0.4186	1.4103	0.4553	1.8563	Average	2.3286	2.7603	5.884	2.7093

Table 3: Position of Securities Companies before Alliance

DMU	2016	2017	2018	2019	DMU	2016	2017	2018	2019
APG	17	12	3	3	IVS	29	31	32	29
BSI	14	21	13	21	MBS	27	22	17	19
CTS	21	26	24	27	PSI	13	24	18	32
FTS	4	3	1	1	SHS	6	7	8	13
HCM	11	18	7	6	VIX	24	17	15	15
SSI	18	19	16	22	WSS	10	30	12	17
TVB	15	28	30	31	AAS	32	32	27	25
TVS	25	20	11	14	BMS	23	15	14	16
VCI	2	5	4	2	CSI	5	9	6	7
VDS	26	23	21	30	DSC	7	11	2	4
VND	28	13	23	11	HAC	20	29	31	20
APS	16	14	9	8	ORS	31	25	10	10
ART	19	6	5	9	PHS	22	27	28	26
BVS	3	10	25	18	SBS	30	4	29	5
EVS	12	1	20	23	TCI	8	8	26	24
HBS	1	2	19	12	VFS	9	16	22	28

twentieth and twenty-third position over 2016–2019, respectively. FTS was the only company having made a big effort to improve their efficiency score and rank up from the fourth and third positions in 2016 and 2017, respectively, to reach the first position during the period of 2018–2019. IVS was considered as the worst performing company after this company ranked twenty-ninth in 2016 and 2019, thirty-first in 2017 and thirty-second in 2018.

In consideration of the above analysis, the securities companies altered sharply not only their efficiency scores but also their position according to each term. Respective the normal way to realize super efficiency, inefficiency could actually improve the overall score by reducing input excess and increasing output shortfall. From these analysis results of past data, future operational performance can be further extended. Hence, the reduction of input factors and the extension of output factors could promote performance operations. Besides, another method such as the alliance selection method is applicable to improve the efficiency score. The scores in 2019 determined the relative market standing of inefficient securities companies in need of future score improvement. The particular results of this study are offered in Section 4.3.

4.3. Efficiency and Position after Alliance

To provide suggestions for improvement to inefficient securities in the future, the research used the alliance method to explore potential partnerships based on historical financial reports and efficiency scores from 2019. All inefficient securities companies were utilized to make an alliance and then to calculate novel performance as shown in Tables A2 and A3. Based on the rule of negative super-SBM models, each company post-alliancing determined their new scores. The allied securities companies also reached a desired efficiency levels when their scores were higher than "1" and considered as non-performing when they obtained performance scores lower than "1". Examination results indicated that the total partners of AAS, TCI, CTS, EVS, IVS, PHS, PSI, TVB, VDS and VFS reached efficiency levels as 13, 13, 6, 6, 8, 4, 6, 4, 5 and 3, respectively. All inefficient companies determined their partners were able to help them to improve operational processes and achieve an upgrade to reach an efficient score. In contrast, the alliance partners and inefficient securities companies should not make an alliance when their scores were lower than "1".

The findings revealed that AAS and TCI had the same numbers and their total efficient partners were more than the other securities companies. The efficiency score of TCI ranged from 1 to 2.11842; and, the efficiency score of AAS was from 1 to 11.04469. Therefore, AAS possessed a higher score than TCI, so it was seen to be the best partner selection available.

As seen in Table 4, the optimal alliance partners have an efficiency score including FTS, VCI, HMC, VND, APG, ORS, VIX, ART, MBS, BVS, BMS, BSI and SSI. The variance of their scores was 10.51017; 2.01812; 1.25584;

Table 4: Good Alliance Partner of ASS

DMU	Score (a)	Rank (b)	Target ASS		Difference change	
			Score©	Rank (d)	(a–c)	(b–d)
FTS + AAS	11.04469	1	0.53452	42	10.51017	41
VCI + AAS	2.55264	6	0.53452	42	2.01812	36
HCM + AAS	1.79036	13	0.53452	42	1.25584	29
VND + AAS	1.37431	18	0.53452	42	0.83979	24
APG + AAS	1.30631	19	0.53452	42	0.77179	23
ORS + AAS	1.13717	22	0.53452	42	0.60265	20
VIX + AAS	1.10366	23	0.53452	42	0.56914	19
ART + AAS	1.10349	24	0.53452	42	0.56897	18
MBS + AAS	1.08337	26	0.53452	42	0.54885	16
BVS + AAS	1.08081	27	0.53452	42	0.54629	15
BMS + AAS	1.05152	31	0.53452	42	0.51700	11
BSI + AAS	1.04789	32	0.53452	42	0.51337	10
SSI + AAS	1.00000	34	0.53452	42	0.46548	8

Table 5: Bad Alliance Partner of ASS

DMU	Score (a)	Rank (b)	Target ASS		Difference change	
			Score©	Rank (d)	(a–c)	(b–d)
EVS + AAS	0.47587	46	0.53452	42	–0.05865	–4
VDS + AAS	0.46342	47	0.53452	42	–0.0711	–5
HAC + AAS	0.44094	49	0.53452	42	–0.09358	–7
DSC + AAS	0.43581	50	0.53452	42	–0.09871	–8
PHS + AAS	0.41067	52	0.53452	42	–0.12385	–10
CSI + AAS	0.40548	53	0.53452	42	–0.12904	–11
PSI + AAS	0.4036	54	0.53452	42	–0.13092	–12
SBS + AAS	0.34591	56	0.53452	42	–0.18861	–14
APS + AAS	0.32243	58	0.53452	42	–0.21209	–16
HBS + AAS	0.28889	59	0.53452	42	–0.24563	–17
TVB + AAS	0.28468	60	0.53452	42	–0.24984	–18
VFS + AAS	0.2834	61	0.53452	42	–0.25112	–19
WSS + AAS	0.2684	62	0.53452	42	–0.26612	–20
IVS + AAS	0.22995	63	0.53452	42	–0.30457	–21

0.83979; 0.77179; 0.60265; 0.56914; 0.56897; 0.54885; 0.54629; 0.517; 0.51337; and 0.46548, respectively. The variance of their position was 41; 36; 29; 24; 23; 20; 19; 18; 16; 15; 11; 10; and 8, respectively. All of them had a positive variance. The alliance with others securities companies was comprised of SHS, TVS, TCI and CTS which could potentially improve the score; however, the score was still lower than "1". Thus, these companies improved their score and position, and it was recommended that they should not form an alliance.

Moreover, Table 5 indicated those securities firms constituting so-called "bad partner" selections. The securities

companies possessed a score lower than the target score of 0.53452 (see Table 5). These partners had scores from 0.22995 to 0.47587, and their position ranged according to the final positions. The variance of scores for these companies with ASS target was from −0.30457 to −0.05865. The variance position of EVS, VDS, HAC, DSC, PHS, CSI, PSI, SBS, APS, HBS, TVB, VFS, WSS and IVS was −4; −5; −7; −8; −10; −11; −12; −14; −16; −17; −18; −19; −20; and −21, respectively. Consequently, it did not encourage alliance.

5. Conclusion

In general, the securities market in Vietnam has exhibited marked variation of its operational performance during 2016–2019, as computed by the negative super-SBM model. The empirical results of this modeling presented a separate efficiency score and ranking for each of the securities companies examined in the study, both before and after alliancing.

The study applied technical alliance selection into the process of seeking out valued partners and improvement of the efficiency score. This was especially true for the possibility of inefficient securities companies in the future when based on the efficiency score in 2019. Optimal partner selection is fundamental to the support of an enterprise to foresee a chance for extending improved operational performance in the future. The main findings contribute to maintaining and developing sustainable securities industry in Vietnam and towards giving an effective operational orientation in the future.

The overall performance and ranking of securities companies in Vietnam is presented to a greater extent, but the study still has limitations. Future research is necessary to compare the Vietnamese securities industry with other Southeast Asian nations such as Indonesia, Thailand, and others in order to have a larger overview of securities industry and a comparison for the growing region.

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Appendix

Table A1: Descriptive Statistics of Actual Data from 2016 to 2019 (Vietnam Dong)

Indication	Year	CA	NA	FA	LA	OE	CC	NR	GP	OP	NP
Max	2016	11884989	1342980	131417	6075402	7152567	4900637	2216769	1369128	1054324	874997
Min		134806	2366	326	984	102019	96000	1780	1602	72	10
Average		2020596	156811	22016	1009645	1167761	875411	381546	222489	140754	117467
SD		2580294	289051	33348	1443993	1473261	986935	497858	312030	235259	193630
Max	2017	17227983	1536392	179210	10148125	8616250	5000637	2898078	1760681	1392315	1161105
Min		143918	2336	69	2431	138549	135000	9299	4459	618	2451
Average		2853088	193762	31939	1593573	1453276	925362	590136	356247	249898	208630
SD		3879612	358814	49477	2455508	1805547	999318	705507	446300	343456	283010
Max	2018	22270357	1555270	174929	14669962	9155665	5100637	3672838	2021808	1567030	1302937
Min		146140	3161	21	1104	145484	135289	10084	4097	2575	2573
Average		3373666	179004	33190	1879933	1672776	1054657	786941	420434	294426	248686
SD		4880630	322716	44950	3331904	1928731	1033691	902190	512514	393698	325000
Max	2019	22290867	4753248	166591	17643055	9401060	5100637	3234978	2063970	1098617	907097
Min		146776	6979	2213	1500	343215	310000	13774	7775	7015	6345
Average		3783856	348840	33628	2235676	1897019	1258026	669958	387556	226849	188325
SD		5006226	988680	44450	3943658	2031296	1098525	751371	501799	284675	232742

Note: Max: Maximum; Min: Minimum; SD: Standard deviation.
Source: Vietstock (2020).

Table A2: Efficiency Score of AAS, TCI, CTS, EVS and IVS in 2019

DMU	Score	DMU	Score	DMU	Score	DMU	Score	DMU	Score
FTS + AAS	11.0447	VCI + TCI	2.1184	VCI + CTS	2.3406	VCI + EVS	2.2978	APG + IVS	4.1824
VCI + AAS	2.5526	FTS + TCI	1.8411	HCM + CTS	1.8662	HCM + EVS	2.0786	FTS + IVS	2.4221
HCM + AAS	1.7904	HCM + TCI	1.6726	VND + CTS	1.3746	SHS + EVS	1.4752	ART + IVS	1.9656
VND + AAS	1.3743	APG + TCI	1.4805	MBS + CTS	1.0589	VND + EVS	1.2889	HCM + IVS	1.7716
APG + AAS	1.3063	ART + TCI	1.2762	BSI + CTS	1.0223	MBS + EVS	1.0109	VIX + IVS	1.4524
ORS + AAS	1.1372	VND + TCI	1.2412	SSI + CTS	1	SSI + EVS	1	VCI + IVS	1.3928
VIX + AAS	1.1037	VIX + TCI	1.1451	SHS + CTS	0.6931	VIX + EVS	0.8335	BVS + IVS	1.1907
ART + AAS	1.1035	ORS + TCI	1.1423	ORS + CTS	0.6513	BMS + EVS	0.7674	SSI + IVS	1
MBS + AAS	1.0834	BVS + TCI	1.0769	BVS + CTS	0.6209	BVS + EVS	0.6971	VND + IVS	0.7931
BVS + AAS	1.0808	BMS + TCI	1.0743	BMS + CTS	0.6093	ORS + EVS	0.6901	ORS + IVS	0.649
BMS + AAS	1.0515	BSI + TCI	1.0482	VIX + CTS	0.6054	BSI + EVS	0.6847	SHS + IVS	0.6236
BSI + AAS	1.0479	MBS + TCI	1.0433	APG + CTS	0.5619	TVS + EVS	0.6814	MBS + IVS	0.6038
SSI + AAS	1	SSI + TCI	1	TVS + CTS	0.5616	APG + EVS	0.5968	BSI + IVS	0.5976
SHS + AAS	0.6617	SHS + TCI	0.6629	AAS + CTS	0.5477	ART + EVS	0.5306	BMS + IVS	0.5341
TVS + AAS	0.5850	TVS + TCI	0.5934	TCI + CTS	0.5391	APS + EVS	0.5192	TVS + IVS	0.4328
TCI + AAS	0.5687	AAS + TCI	0.5687	ART + CTS	0.5272	CTS + EVS	0.5079	CTS + IVS	0.4129
CTS + AAS	0.5477	CSI + TCI	0.5538	HAC + CTS	0.5093	CSI + EVS	0.4993	HAC + IVS	0.3795
EVS + AAS	0.4759	CTS + TCI	0.5391	EVS + CTS	0.5079	TCI + EVS	0.4946	CSI + IVS	0.3408
VDS + AAS	0.4634	DSC + TCI	0.5087	DSC + CTS	0.5072	HAC + EVS	0.4808	APS + IVS	0.3404
HAC + AAS	0.4409	EVS + TCI	0.4946	CSI + CTS	0.5008	AAS + EVS	0.4759	VDS + IVS	0.3178
DSC + AAS	0.4358	VDS + TCI	0.4600	FTS + CTS	0.4939	FTS + EVS	0.4733	EVS + IVS	0.3149
PHS + AAS	0.4107	HAC + TCI	0.4550	VDS + CTS	0.4938	WSS + EVS	0.4673	HBS + IVS	0.2911
CSI + AAS	0.4055	PHS + TCI	0.4462	PSI + CTS	0.4791	VDS + EVS	0.4671	TCI + IVS	0.2788
PSI + AAS	0.4036	SBS + TCI	0.4364	PHS + CTS	0.4684	PHS + EVS	0.4665	WSS + IVS	0.2745
SBS + AAS	0.3459	PSI + TCI	0.3974	SBS + CTS	0.4672	SBS + EVS	0.4292	PHS + IVS	0.2498
APS + AAS	0.3224	HBS + TCI	0.395	APS + CTS	0.4667	DSC + EVS	0.4051	DSC + IVS	0.248
HBS + AAS	0.2889	APS + TCI	0.3855	VFS + CTS	0.4550	PSI + EVS	0.3948	VFS + IVS	0.2305
TVB + AAS	0.2847	VFS + TCI	0.3759	HBS + CTS	0.4491	VFS + EVS	0.3817	AAS + IVS	0.2300
VFS + AAS	0.2834	TVB + TCI	0.3559	TVB + CTS	0.4432	TVB + EVS	0.3682	SBS + IVS	0.2051
WSS + AAS	0.2684	WSS + TCI	0.3071	WSS + CTS	0.4385	HBS + EVS	0.3657	TVB + IVS	0.1994
IVS + AAS	0.2300	IVS + TCI	0.2788	IVS + CTS	0.4129	IVS + EVS	0.3149	PSI + IVS	0.1819

Table A3: Efficiency Score of PHS, PSI, TVB, VDS and VFS in 2019

DMU	Score	DMU	Score	DMU	Score	DMU	Score	DMU	Score
VCI + PHS	2.8362	HCM + PSI	1.9649	HCM + TVB	1.6649	VCI + VDS	2.3874	HCM + VFS	1.4837
HCM + PHS	2.1349	VCI + PSI	1.8702	VCI + TVB	1.5855	HCM + VDS	2.2473	VCI + VFS	1.3539
VND + PHS	1.3289	VND + PSI	1.2498	VND + TVB	1.1404	VND + VDS	1.3595	SSI + VFS	1
SSI + PHS	1	VIX + PSI	1.1185	SSI + TVB	1	MBS + VDS	1.028	VND + VFS	0.9476
MBS + PHS	0.7891	BVS + PSI	1.0747	FTS + TVB	0.7422	SSI + VDS	1	FTS + VFS	0.8069
SHS + PHS	0.6524	SSI + PSI	1	MBS + TVB	0.7123	SHS + VDS	0.6219	BVS + VFS	0.7843
BSI + PHS	0.6154	MBS + PSI	0.7663	BVS + TVB	0.6498	BSI + VDS	0.6218	MBS + VFS	0.7440
VIX + PHS	0.6109	BSI + PSI	0.6511	VIX + TVB	0.6426	VIX + VDS	0.5986	ART + VFS	0.7068
BMS + PHS	0.5863	FTS + PSI	0.6303	SHS + TVB	0.6382	BMS + VDS	0.5828	VIX + VFS	0.6800
TVS + PHS	0.5849	SHS + PSI	0.6093	BSI + TVB	0.6073	BVS + VDS	0.5828	BSI + VFS	0.6794
BVS + PHS	0.5765	BMS + PSI	0.5993	ART + TVB	0.585	ORS + VDS	0.5578	SHS + VFS	0.6564
ORS + PHS	0.5554	ORS + PSI	0.5744	BMS + TVB	0.5437	TVS + VDS	0.5420	BMS + VFS	0.5985
CSI + PHS	0.4742	ART + PSI	0.5052	ORS + TVB	0.4952	CTS + VDS	0.4938	ORS + VFS	0.5646
CTS + PHS	0.4684	TVS + PSI	0.4963	TVS + TVB	0.4844	APG + VDS	0.4807	TVS + VFS	0.4968
EVS + PHS	0.4665	CTS + PSI	0.4791	CTS + TVB	0.4432	EVS + VDS	0.4671	CTS + VFS	0.4550
TCI + PHS	0.4462	APG + PSI	0.4590	APG + TVB	0.3740	ART + VDS	0.4645	APG + VFS	0.4285
FTS + PHS	0.4406	AAS + PSI	0.4036	EVS + TVB	0.3682	AAS + VDS	0.4634	EVS + VFS	0.3817
ART + PHS	0.4363	VDS + PSI	0.4023	TCI + TVB	0.3559	TCI + VDS	0.4600	TCI + VFS	0.3759
APG + PHS	0.4333	TCI + PSI	0.3974	VDS + TVB	0.3550	FTS + VDS	0.4335	CSI + VFS	0.3666
DSC + PHS	0.4265	EVS + PSI	0.3948	PHS + TVB	0.3523	HAC + VDS	0.4245	VDS + VFS	0.3610
VDS + PHS	0.4219	PHS + PSI	0.3572	CSI + TVB	0.3253	PHS + VDS	0.4219	PHS + VFS	0.3535
HAC + PHS	0.4212	HAC + PSI	0.3008	SBS + TVB	0.3042	CSI + VDS	0.4086	APS + VFS	0.3338
SBS + PHS	0.4193	CSI + PSI	0.2905	HAC + TVB	0.2901	PSI + VDS	0.4023	HAC + VFS	0.3184
AAS + PHS	0.4107	DSC + PSI	0.2800	AAS + TVB	0.2847	DSC + VDS	0.4013	DSC + VFS	0.3154
APS + PHS	0.3607	SBS + PSI	0.2754	VFS + TVB	0.2845	SBS + VDS	0.3902	HBS + VFS	0.3103
PSI + PHS	0.3572	APS + PSI	0.2580	DSC + TVB	0.2833	APS + VDS	0.3809	SBS + VFS	0.3096
VFS + PHS	0.3535	TVB + PSI	0.2332	APS + TVB	0.2831	VFS + VDS	0.3610	WSS + VFS	0.2861
TVB + PHS	0.3523	WSS + PSI	0.2239	HBS + TVB	0.2720	TVB + VDS	0.3550	TVB + VFS	0.2845
HBS + PHS	0.3372	VFS + PSI	0.2205	WSS + TVB	0.2518	WSS + VDS	0.3515	AAS + VFS	0.2834
WSS + PHS	0.2830	HBS + PSI	0.2122	PSI + TVB	0.2332	HBS + VDS	0.3481	IVS + VFS	0.2305
IVS + PHS	0.2498	IVS + PSI	0.1819	IVS + TVB	0.1994	IVS + VDS	0.3178	PSI + VFS	0.2205