Is There a Better Semiconductor Firm in Taiwan?

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ABSTRACT
The authors investigate the firm value of semiconductor industry in Taiwan in order to differentiate between outstanding semiconductor company and weak semiconductor company. The authors use GAP which is analytical tool to perform four steps: the original maps, sorting maps with clustering trees, summary sufficient maps, and sediment maps. The findings offer a good instruction for policymakers to make related policies in semiconductor firms. Additionally, the paper helps to find firms needed to be reformed through classification by GAP.

KEYWORDS: *firm value, generalization association plot, semiconductor industry, Taiwan.*

JEL CLASSIFICATION: *G32, G34, M10, M14, M40, L25.*

1. INTRODUCTION

The economy of Taiwan is based on farming in the past. With the rise of the computers, communications, and consumer electronics (3C), the trade and industry of Taiwan have grown fast and amazingly. The development of semiconductor industry drives the economy to grow fast (Hsieh, Huang & Ho, 2013).

The semiconductor industry has been rapidly growing since the government started to promote this industry in Taiwan in the 1970s (Hsu & Hsu, 2009). Taiwan's semiconductor industry plays a significant role in the world. Only output value of integrated circuit (IC) design industry is inferior to the USA (Torng, Tseng, Lee & Chang, 2009). The performance of IC packaging industry is quite good in Taiwan, and its market share is the first in the world (Fang, Chen & Su, 2014).

With the advance of the electronic parts and semiconductors, economic growth and harsh competition have been detected. Kuo and Yang (2012) indicated that under an extremely competitive market and a dynamic industrial environment, it is important to evaluate and enhance the performance of a firm. High-tech industries, especially semiconductor, are facing aggressive competition and challenges. Thus keeping up the competitive advantages in the market has been necessitated increasingly.

By reviewing the existing literature, this paper discusses firm value in Taiwan depending on different indicators. By classifying method, this paper differentiates between good firms and bad firms. At last, our purpose is to find a METHOD to classify the semiconductor firms in Taiwan that has a certain firm value.

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2. LITERATURE REVIEW

Science and technology in the twenty-first century have greatly influenced the development of high-technology industry, as semiconductor. The semiconductor industry is a key driver for economic growth in its role as technology enabler. The semiconductor industry needs high degrees of flexibility and innovation in order to constantly adjust to the rapid pace of change in the market.

Additionally, the firm management environment is rapidly changing (Kita, 2001). Kosten (2016) pointed out that a single indicator cannot serve for purposes. Hence the purpose is served by a combination of the indicators. The authors employ nine different indicators which can be used in combination. This paper focuses on financial or non-financial factors of interacted conditions in the firms. This paper follows the above factors of classification by Kuo and Yang (2012). Nine indicators are Pretax income per share, Operating cash flow ratio, Operating expense ratio, Sales growth, Inventory turnover, Gross margin growth, Employee fee %, Research and Development (R&D) %, and Fixed asset turnover.

2.1 Pretax income per share

Tax affects operating results. The authors pick pretax profit to estimate EPS. Earnings per share (EPS) is a very good indicator of the profitability for some organization. EPS is a useful measure when comparing profitability between similar companies by EPS. Liu (2010) declared that Pretax income per share affects market value variations in merged company.

2.2 Operating cash flow ratio

The Operating cash flow ratio can be used to measure how liquidity a firm is in the short run since it is related to current liabilities and cash flows from operations. If the ratio for a firm is less than one, the firm is not generating enough cash to pay off its short-term liabilities. It is a signal which needs more capital, or the firm may not be able to continue operating. Lean & Ting (2016) suggested that a higher Operating cash flow ratio supports the fact that the firm has better performance when assessing company characteristics.

2.3 Operating expense ratio

The Operating expense ratio can help us to realize how a firm can produce goods efficiently. A measurement of management efficiency is considered. Be more specific, a lower Operating expense ratio points out a greater profit. The benchmark comparisons should be more competitive in different industries. With evidence which supports the agency theory, Wang (2010) pointed out that Agency Costs (AC) contains total asset turnover and Operating expense ratio. In other words, AC has a significantly negative impact on firm performance, stock return and Free Cash Flows (FCF). The firm value can be viewed based on improving free cash flow.

2.4 Sales growth

The Sales growth of YOY is frequently used in evaluating a firm's sales performance. YOY comparisons mitigate seasonality sales. In addition, Iqbal and Zhuquan (2015) considered that efficient working capital management is a critical part of the business strategy to boost shareholder value. They also discovered a positive relationship between the measure of

profitability and the Sales growth. That is to say, the firm's sales increase the profitability and demonstrate a positive side.

2.5 Inventory turnover

A low rate of Inventory turnover means that a firm purchases too much goods or the expected sales does not occur. If Inventory turnover is high, the goods would be sold quickly. However, according to Ahmadi, Arasi and Garajafary (2012), managers can generate a positive value for stockholders by shortening of the Inventory turnover period. Since the greater Inventory turnover is the greater profitability of the company.

2.6 Gross margin growth

This paper estimates the firm value with its Gross margin growth rate. Hsu and Peng's (2006) study thinks that the Gross margin growth has a positive relationship with the firm value. Their empirical results support the assumption. It means that the firm value will be higher if its Gross margin growth is higher.

2.7 Employee fee %

Wang and Kang (2010) used Employee fee % as proxy variable. If the ratio is higher, the agency cost gets higher. Employee fee % denotes the value come from the equation: staff costs divided by sales revenue. When the staff cost is relatively low, each staff's ability for creating revenue is higher. Otherwise, it is regarded as a kind of waste of resource. Han & Chuang (2015) found that diminishing staff turnover to enhance firm performance is beneficial.

2.8 R&D %

Mahlich (2007) pointed out that higher research orientation results in higher market value. Moreover, they suggested that R&D investment is associated with international market expansion. It can be said that R&D would be their core competencies. Furthermore, Chen, Shih and Chang (2012) investigated that related technological diversification (RTD) and unrelated technological diversification (UTD) affect innovation performance and cooperate the growth of semiconductor industry in Taiwan. Their results indicate that RTD and UTD can directly or indirectly affect corporate growth by innovation performance. Zhou, van Witteloostuijn and Zhang (2014) even argued that higher technology intensity has the higher value, and attracts overseas acquisition.

2.9 Fixed asset turnover

The Fixed asset turnover is also known as capacity utilization. Hsu and Peng (2006) clearly indicated that it can assess the efficiency of the fixed asset such as factories, machine, equipment, and land. Fixed asset turnover focuses on the management of production line. Yield is habitually used as a quality index. Hence, the authors can cut the production cost and gain profit when the authors improve the yield. Namely, fixed asset turnover has a positive relationship on the firm value. Their empirical results support the hypothesis.

3. RESEARCH METHOD

Wu, Tien and Chen (2010) stated that generalization association plot (GAP) is a tool which illustrates a graphical environment over matrix visualization (MV) and cluster analysis.
This study has already been reported in the past but has never used a GAP to observe the firm value in previous studies. Therefore, this paper employs GAP to examine the semiconductor firm value in Taiwan.

This paper selects a GAP tool written in Java. GAP can do exploratory data analysis (EDA). GAP is used in matrix visualization (MV) and clustering the high-dimensional data sets. This paper employs GAP-Software Version 0.2.7d and all rights reserve from copyright lab for information visualization. Daraio and Glänzel (2016) discussed about big challenges of data integration and focused on the data quality which is a single dataset. The single data is context-dependent and appropriate.

The data is collected from Taiwan Economic Journal (TEJ) database. Taiwan Economic Journal Co. Ltd. provides historical financial statements and corporate information in Asia. TEJ database is TEJ Plus software which accesses data of companies throughout Asia.
The data in 2015 is chosen. Subjects are as follows: R306 (Pretax income per share), R205 (Operating cash flow ratio), R201 (Operating expense ratio), R401 (Sales growth), R610 (Inventory turnover), R402 (Gross margin growth), R202 (Employee fee %), R203 (R&D %), and R612 (Fixed asset turnover). This paper intends to pick the indicators provided by the Taiwan Economic Journal.

This paper only selects sample semiconductor companies which are listed in 2015, because merge between semiconductor companies had been occurred most frequently in 2015. Nine indicators drawn from a total of 61 semiconductor companies run GAP. The GAP is conducted as four following steps: the original maps, sorting maps with clustering trees, summary sufficient maps, and sediment maps (Tsai & Huang, 2012).

Column denotes the indicator, and row denotes each firm in the original map of GAP. GAP has three matrix maps with suitable color projections. Three matrixes are raw data matrix, column proximity matrix, and row proximity matrix. The relationships between each firm and indicator can be shown in raw data matrix.

GAP can make sorting maps with clustering trees. The sorting data rows represent semiconductor firms in Taiwan. Since the column data is not same unit, each column needs to be normalized to acquire better value with the same unit. K-means clustering in GAP can group each indicator into unit. K-means clustering is used as the clustering algorithm. K-means method of optimization has been used and regarded as the grouping method (Bluszcz, 2016).

The summary sufficient maps of GAP are validated by different features and criteria. The related columns are grouped to obtain the relationships between semiconductor firms. Then, the column of semiconductor firms is shown in the same color on GAP graph. On the bottom of the left side in GAP graph showed the relationship between the semiconductor firms and firm value.

The sediment maps of GAP shows the extreme values in this paper, and it explains the position of semiconductor firm value in Taiwan. Thus, the authors can choose the factors to

find a better firm. This paper also explores what advantages the firms have and how outstanding the firms are. The authors employ GAP as a tool because GAP can group each firm into unit through data mining technique.

4. RESULT ANALYSIS

Step 1: the original maps

GAP data type has continuity. The authors select the corresponding proximity measures to analyze. Proximity measures take Euclidean distance (L2) for row processing and take Pearson's correlation coefficient for column processing. There are 61 semiconductor firms (rows) with 9 marker variables (columns) in the original maps, which is the unsorted raw data map.

Step 2: the sorting maps with clustering trees

The indicators of firm value use dendrogram branching structure. GAP splits the firm value indicators into four clusters (red, green, blue, and yellow) as shown in Figure 1.

The red color group includes R610 (Inventory turnover), R202 (Employee fee %), R203 (R&D), R201 (Operating expense ratio), and R306 (Pretax income per share). The green color group includes R402 (Gross margin growth) and R401 (Sales growth). The blue color group only has R205 (Operating cash flow ratio). The yellow color group only has R612 (Fixed asset turnover).

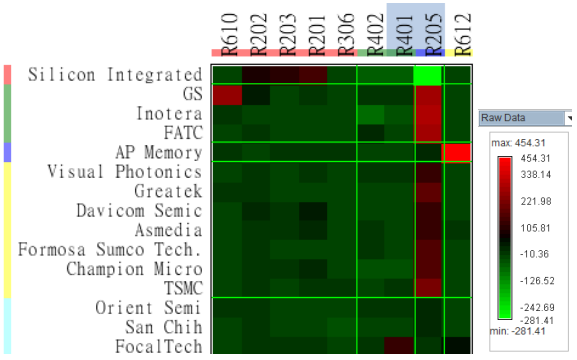

Figure 1. Extreme firm indicator values

Source: data come from analysis conducted by the authors.

This paper investigates the extreme firm indicator values within each indicator group. The relationships between each firm and indicators are observed in the GAP proximity matrix. The extreme values in the proximity matrix are shown and put in different colors. The highest value with default is red. The lowest value with default is green. The color spectrum offers visualizing ways to view the data. Results of Figure 1 are as below.

Firstly, the authors review R201, R202 and R203 in firms of pink group. The result shows that the Silicon Integrated Systems Corp has much top values in R201, R202 and R203. The three items are R202 (Employee fee %), R203 (R&D %), and R201 (Operating expense ratio). A positive correlation exists between the R&D intensity and the firm value; the other two items are reversed.

Secondly, the authors gain R610 in firms of pink group. This paper finds that the Giga Solution Tech. Co., Ltd has a top value in R610 (Inventory turnover). . It points out that the firm profitability is greater if its Inventory turnover is greater.

Thirdly, the authors obtain R401 in firms of pink group. Focal Tech Systems Co., Ltd. has a top value in R401 (Sales growth). The findings indicate that it increases the profitability and has a positive effect on firm sales.

Finally, the authors gain R612 in firms of pink group. AP Memory Technology Corp. has a top value in R612 (Fixed asset turnover). The result has a positive relationship between the Fixed asset turnover and firm value

It is worth noting that the most special index is R205 (Operating cash flow ratio). Since a higher Operating cash flow ratio helps to find better firms. The firms of green group are greater than firms of yellow group; the firms of yellow group are greater than others. The firms of green group are Giga Solution Tech. Co., Inotera Memories, Inc., and Formosa Advanced Technologies Co., Ltd. The firms of yellow group are Visual Photonics Epitaxy Co., Ltd., Greatek Electronics Inc., Davicom Semiconductor, Inc., Asmedia Technology Inc., Formosa Sumco Technology Corp., Champion Microelectronic Corp., and Taiwan Semiconductor Mfg. Co., Ltd. Silicon Integrated Systems Corp has the lowest value in R205.

Step 3: the summary sufficient maps

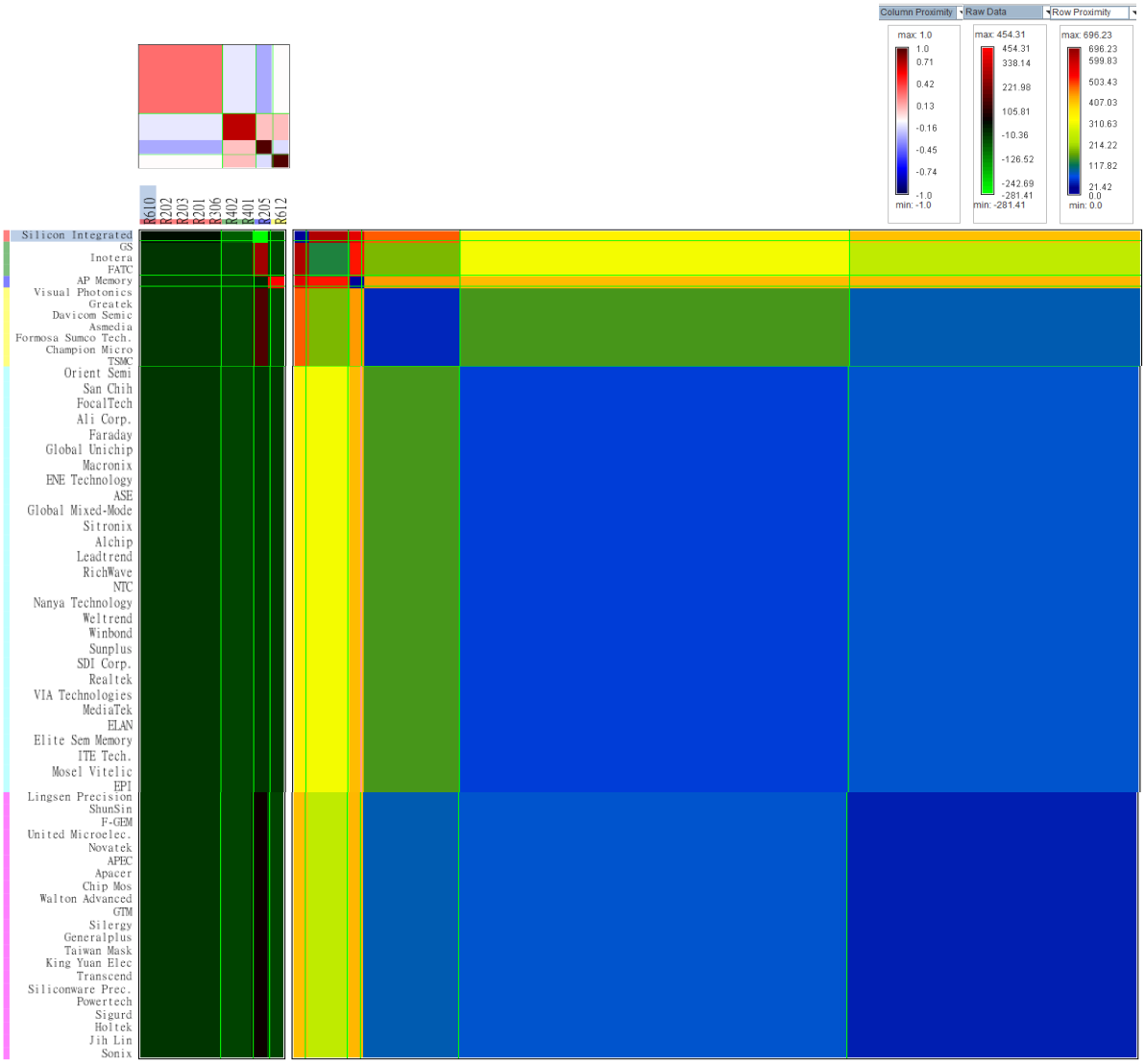

Figure 2. Summary sufficient maps

Source: data come from analysis conducted by the authors.

61 semiconductor firms (rows) with 9 variables (columns) are classified into summary sufficient maps as shown in Figure 2. Three color spectra are blue-white-red for 4*4 matrix, green-black-red for 4*6 matrix, and blue-yellow-red for 6*6 matrix.

The 4*4 matrix is Pearson's correlation coefficient results. On the right side of Figure 2 is column proximity. It means that red (blue) is a positive (negative) correlation, and dark (light) colors are strong (weak) correlation. The five red indicators are negatively correlated with the other four indicators. The two green indicators are positively correlated with R205 and R612. The R205 and R612 are negatively correlated with each other.

The 6*4 matrix is shown in green-black-red. It expresses that red (green) is higher (lower) than the median, and the light (darker) is closer to the extreme values (the median). The 6*6 matrix is shown in blue-yellow-red. It represents that red (blue) is more (less) distance, dark (light) colors are closer to the median (the extreme values).

Figure 2 indicates that Silicon Integrated Systems Corp. belongs to pink group. There is a big difference between the firms of pink group and the light green group. It is followed by the firms of blue group and the yellow group. There is a little difference between the firms of pink group and purple group. Finally, there is intermediate difference between the firms of pink group and light blue group. All the indicators of the firms of pink group are negative because its color is green in the green-black-red spectral color. Especially, it shows negative sign in the blue group index (R205).

As shown in Figure 2, the firms of light green group have three firms: Giga Solution Tech. Co., Inotera Memories, Inc., and Formosa Advanced Technologies Co., Ltd. There is a big difference between the firms of light green group and the pink group. It is followed by the firms of blue group and the light blue group. There are a little difference between the firms of yellow group and the purple group. R205 indicator of the firms of light green group is positive. The other indicators are negative because their colors are in green-black-red spectral color.

Figure 2 also shows that AP Memory Technology Corp belongs to blue group. There is a big difference between the firms of blue group and the light green group. There is a big difference between the firms of blue group and the pink group. There are intermediate difference between the firms of blue group and the other color groups. R612 indicator of the firms of blue group is most positive. On the other hand, the other indicators are negative because their colors are green in green-black-red spectral color.

There are also intermediate difference between the firms of yellow group and the blue group. It is followed by the firms of light green group. There is a little difference between the firms of yellow group and light blue group. Finally, there is hardly any difference between the firms of yellow group and purple group. R205 indicator of the firms of yellow group is positive. In contrast, the other indicators are negative because their colors are green in green-black-red spectral color.

The firms of yellow group are Visual Photonics Epitaxy Co., Ltd., Greatek Electronics Inc., Davicom Semiconductor, Inc., Asmedia Technology Inc., Formosa Sumco Technology Corp., Champion Microelectronic Corp., and Taiwan Semiconductor Mfg. Co., Ltd. In short, R205 indicators of the firms of pink, light green, blue, and yellow group show a positive sign.

Step 4: the sediment maps

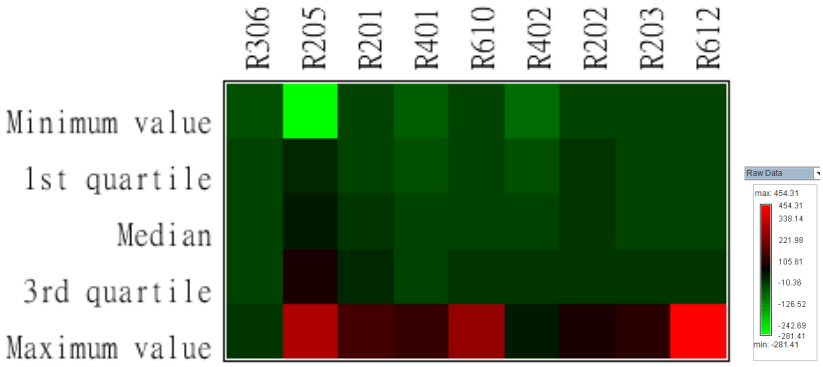

Figure 3. Sediment maps
Source: data come from analysis conducted by the authors.

Figure 3 is drawn from Table 1. The green-black-red represents that red (green) is higher (lower) than the median, and the light (darker) is closer to the extreme values (the median). Therefore, R612 (Fixed asset turnover), R205 (Operating cash flow ratio) and R610 (Inventory turnover) have salient maxima and minima. R205 is negative. However, Figure 3 shows that each firm in the R360 (Pretax income per share) shows the middle and steady result.

Nine variables are R306 (Pretax income per share), R205 (Operating cash flow ratio), R201 (Operating expense ratio), R401 (Sales growth), R610 (Inventory turnover), R402 (Gross margin growth), R202 (Employee fee %), R203 (R&D %), and R612 (Fixed asset turnover).

Table 1. The quartile

Variable	R306	R205	R201	R401	R610	R402	R202	R203	R612
Minimum value	-18.53	-281.41	1.5	-47.46	1.83	-58.88	6.94	0	0.29
1st quartile	1.16	32.55	8.91	-11.6	3.72	-20.06	12.42	2.77	1.32
Median	2.7	62.09	16.38	-4.82	5.15	-1.8	18.09	8.41	2.97
3rd quartile	4.19	115.32	29.75	7.01	9.36	9.41	24.68	19.73	9.43
Maximum value	18.78	332.63	172.62	153.82	295.39	62.92	111.85	125.73	454.31

Source: data come from analysis conducted by the authors.

5. CONCLUSIONS

It can be shown that which firms should be merged by Operating cash flow ratio in the analysis process. The findings show firms which need to be reformed through classification by GAP. The findings help firms to reach more outstanding results. Firm value related to integration risk also help to separate firms which should be merged (Chen & Wang, 2014).

REFERENCES

Ahmadi, M., Arasi, I. S., & Garajafary M. (2012). Studying the relationship between working capital management and profitability at Tehran stock exchange: a case study of food industry. *Research Journal of Applied Sciences, Engineering and Technology, 4*(13), 1868-1874.

Bluszcz, A. (2016). European economies in terms of energy dependence. *Quality and Quantity,* 1-18.

Chen, F., & Wang, Y. (2014). Integration risk in cross-border M and A based on internal and external resource: empirical evidence from China. *Quality and Quantity, 48*(1), 281-295.

Chen, Y. S., Shih, C. Y., & Chang, C. H. (2012). The effects of related and unrelated technological diversification on innovation performance and corporate growth in the Taiwan's semiconductor industry. *Scientometrics, 92*(1), 117-134.

Daraio, C., and Glänzel, W. (2016). Grand challenges in data integration-state of the art and future perspectives: an introduction. *Scientometrics, 108*(1), 391-400.

Fang, H. K., Chen, C. S., & Su, Y. S. (2014). A study on the operational performance of IC packaging and testing industrious in Taiwan. *Journal of Chinese Trend and Forward, 10*(1), 63-65+67.

Han, I., & Chuang, C. M. (2015). The antecedents and consequences of local embeddedness: a framework based on the rice industry in Taiwan. *Asian Business and Management, 14*(3), 195-226.

Hsieh, W. S., Huang, Y. F., & Ho, C. T. (2013). A study of improvement for performance in IC assembly industry-T Company as example. *Journal of Commercial Modernization, 7*(2), 199-214.

Hsu, L. H., & Hsu, H. H. (2009). The efficiency of integrated circuit design industry in Taiwan area measured by three-stage DEA Approach. *Ling Tung Journal, 12*(26), 93-114.

Hsu, T. H., & Peng, T. K. (2006). A study on impact factors of business values of biotechnology industries in Taiwan. *Asian Journal of Management and Humanity Sciences, 1*(1), 37-52.

Iqbal, A., & Zhuquan, W. (2015). Working capital management and profitability evidence from firms listed on Karachi stock exchange. *International Journal of Economics and Finance, 7*(2), 231-235.

Kita, M. (2001). How the EMS (Electronics Manufacturing Service) business model can help Japanese corporations revolutionize their factories? *JBIC Review,* 4, 1-24.

Kosten, J. (2016). A classification of the use of research indicators. *Scientometrics, 108*(1), 457–464.

Kuo, M. H., & Yang, C. (2012). Does intellectual capital matter? Assessing the profitability and marketability of IC design companies. *Quality and Quantity, 46*(6), 1865-1881.

Lean, H. H., & Ting, I. (2016). Will Penang based companies perform better than the market? *Economics Bulletin, 36*(1), 528-536.

Liu, Y. H. (2010). Acquisition synergies in the high-tech industry-a multi-perspective evaluation. *Journal of National Taichung Institute of Technology, 10*(2), 75-94.

Mahlich, J. (2007). The Japanese pharmaceutical industry in transition: has higher research orientation resulted in higher market value? *Asian Business and Management, 6*(1), 75-94.

Taiwan Economic Journal. (1990. April). *TEJ DATABASE*. Retrieved July 8, 2016, from http: //www.tej.com.tw

Torng, C. C., Tseng, C. C., Lee, P. H., & Chang, S. C. (2009). Constructing supplier performance evaluation model on IC design industry in Taiwan and empirical study. *Journal of Technology Management, 14*(2), P1-26.

Tsai, M. J., & Huang, T. Y. (2012). Are there big cities in taiwan? *Journal of Data Analysis, 7*(1), 19-35.

Wang, G. Y. (2010). The impacts of free cash flows and agency costs on firm performance. *Journal of Service Science and Management, 3*(4). 408-418.

Wang, M. S., & Kang, J. P. (2010). Financial information quality and cash slack level-agency theory perspective. *Taiwan Bank Quarterly, 61*(3), 76-93.

Wu, H. M. (2012. May). *Generalized Association Plots (GAP)*. Lab for Information Visualization. Retrieved July 12, 2016, from Http://www.hmwu.idv.tw/gapsoftware

Wu, H. M., Tien, Y. J., & Chen, C. H. (2010). GAP: a graphical environment for matrix visualization and cluster analysis. *Computational Statistics and Data Analysis, 54*(3). 767-778.

Zhou, C., Van Witteloostuijn, A., & Zhang, J. (2014). The internationalization of Chinese industries: overseas acquisition activity in Chinese mining and manufacturing industries. *Asian Business and Management, 13*(2), 89-116.