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Retraction

Retracted: The Macroreform of the Electronics Manufacturing Industry under the Industry 4.0 Wave Based on Financial Performance Indicators

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] Y. Wen, "The Macroreform of the Electronics Manufacturing Industry under the Industry 4.0 Wave Based on Financial Performance Indicators," *Mobile Information Systems*, vol. 2022, Article ID 6436112, 7 pages, 2022.

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Research Article

The Macroreform of the Electronics Manufacturing Industry under the Industry 4.0 Wave Based on Financial Performance Indicators

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This study uses financial indicators dismantled by DuPont's identity as evidence to invert the resource allocation of top companies in the electronics manufacturing industry and then delineates their strategic groups through factor analysis and cluster analysis. Also, the timeline is divided into two periods: from 2010 to 2013 and from 2014 to 2017. The impact of Industry 4.0 was determined by studying and comparing the strategic groups of top companies in these two periods. It is confirmed that the competitive environment in the electronics manufacturing industry did change in the period after the rollout of Industry 4.0, with the general trend being in capacity. In the late Industry 4.0 period, there was an increase in the number of top-performing companies in the group of companies whose competitive strategies were based on production management and supply chain management capabilities. Companies that invest more resources in fixed assets are able to use digitization, networking, and automation. Companies that achieve greater efficiency in their own factory's production facilities can reap more benefits and widen the gap with their competitors.

1. Introduction

Industry 4.0 is a very hot topic in recent years. Whether it is news media, newspapers and magazines, corporate executives, and politicians, all of them are chanting Industry 4.0 intelligent manufacturing. However, some people are also questioning whether this is another wave of hype. In the hype cycle chart for emerging technologies in 2018, the IoT Platform, virtual assistants, and augmented reality that are required by Industry 4.0 in the public slogans are included. The technology to be included in the downward trend stage needs to wait. Does this imply that the bubble of Industry 4.0 is coming?

In the field of electronics manufacturing, the life cycle of production equipment and test instruments is very long. Unlike general consumer products, which are updated for several generations in just one year, there are equipment and instruments with a life cycle of five to ten or even twenty years [1]. Therefore, industry changes are not so rapid. In the face of the impact of Industry 4.0, there may be no major short-term changes, but in fact, companies seem to be slowly changing.

In the past few years, for Industry 4.0, many large and small manufacturing conferences, forums, and exhibitions have been held all over the world. At the same time, many academic units and companies have also participated in industry 4.0-related research, adding R&D centers (such as Smart factory OWL, a research center for intelligent production systems, was jointly developed by Fraunhofer Research Institute and OWL University in Germany) or industrial applications (such as digital enterprise software suite and Siemens' comprehensive industrial software suite) [2–4]. But looking at their research topics, we can find that most of them are focused on specific topics in certain fields, such as cloud computing, industrial wireless networks, ERP systems, technology integration, virtual reality engineering, company strategies, and the use of big data [5]. Therefore, this study observes the changes in the entire Industry 4.0 and electronics manufacturing industries from a wide range of perspectives [6].

2. Industry Introduction

2.1. Review of Industrial Development. In the manufacturing sector, advances in science and technology are driving the development of industrialization around the world. Although there is no universally accepted definition of the composition of each industrial revolution, from the perspective of technological development, the first three stages are generally accepted to distinguish:

(1) develop water and steam-powered mechanical manufacturing facilities to break through the limitations of manpower and animal power
(2) electricity as power and dismantling manpower for mass production
(3) use electronic devices and information technology (IT) to support further automation of manufacturing

The main milestone of automation devices used in the third industrial revolution was the invention of the "programmable logic controller (PLC)." In 1978, the National Electrical Manufacturers Association (NEMA) defined a programmable controller as an electronic device that operates with numbers. It uses a programmable memory to store instructions, such as logic, sequence, timing, counting, and calculations [7, 8].

In short, PLC is an electronic system specially designed for applications in an industrial environment. It has the advantages of easy use, flexible design, and saving wiring manpower, so it is suitable for use in various control systems in industrial environments, as the core control task in automation control [9].

In the past 20 years, the actual labor force in the world's major industrial countries has grown rapidly, but now it has entered a bottleneck period. From the perspective of actual labor productivity in the United States, Germany, Britain, Japan, Italy, Canada, and France, excluding the depression caused by the financial tsunami in 2008 has now reached a level, which represents that, during the third industrial revolution, factory automation systems, such as programmable logic controllers (PLC), distributed control systems (DCS), and other functions that bring industrial production efficiency, are almost exhausted [10].

2.2. Definition and Scope of Industry 4.0. According to the economist Carlota Perez's understanding of the technological revolution cycle, a new technology will have a life cycle. Compared with the industrial technology that had a main axis in the previous three industrial revolutions, the general-purpose technology of the fourth industrial revolution (General-Purpose Technologies) is still being explored, and many studies are exploring this technology, such as the Internet of Things (IoT), Cyber-Physical Systems (CPS), and artificial intelligence (AI), but there is still no recognized standard technology, which is one of the reasons why the public has different opinions on Industry 4.0 [11–13].

In 2018, the China Industry 4.0 Research Institute put forward the criteria for judging the fourth industrial revolution as "highly automated, highly networked, and highly digitized." Each has its own technical field. Automation lies in hardware equipment supplemented by artificial intelligence (AI). To help with the operation, networking lies in the establishment of communication facilities, such as the Internet of Things (IoT) and 5G; digitalization lies in the internal information systems of enterprises, such as Big Data and artificial intelligence (AI). When these three items are complete, the development of intelligence is shown in Figure 1.

2.3. Electronics Manufacturing Industry. The electronics manufacturing field is one of the Taiwan's key industries. It has a history of nearly 50 years. The government led the introduction of semiconductor technology around 1970 and then promoted the PC assembly and standardization of peripheral components and accumulated OEM/ODM manufacturing and R&D, the process of which is shown in Figure 2. Experience has gradually nurtured an ecological chain in the electronics industry. Since the components of the electronics industry are diversified and require many different technologies to be combined, the clustering effect is very important. Taiwan has formed a high-level group in the electronics manufacturing field through the foundation laid in the early days. The convergence effect, in turn, occupies a key position in the global electronics industry [14].

Electronic product manufacturers, such as Hon Hai, Delta, when producing products, not only themselves but also production equipment and measuring instruments, can complete the entire production process. Measuring instruments can check the produced products, provide objective measurement standards, and eliminate defective products. The birth of a new high-tech product is bound to be matched with a compatible precision instrument, such as the Galaxy Note launched by Samsung Electronics in 2016. After the advent of smartphones, explosions occurred in various parts of the world because of the rapid development of mobile phone batteries, but no measuring instruments and standards suitable for testing were found, resulting in failure to catch defective products [15, 16].

In the Industry 3.0 era, electronic product manufacturers, automation equipment, and measuring instruments are closely linked to each other to complete part of the automated manufacturing, but at this time, most of the equipment and instruments are doing their own work and taking care of their own parts.

In the next Industry 4.0 era, the primary goal is to use the network (physical connection or 5G communication) to connect production equipment, measuring instruments, and control hosts. At the same time, by adding some data capture or sensors to the production equipment to learn the current operating status of the equipment in real time, proactive protection can be achieved, that is, through real-time data analysis to know whether the equipment is

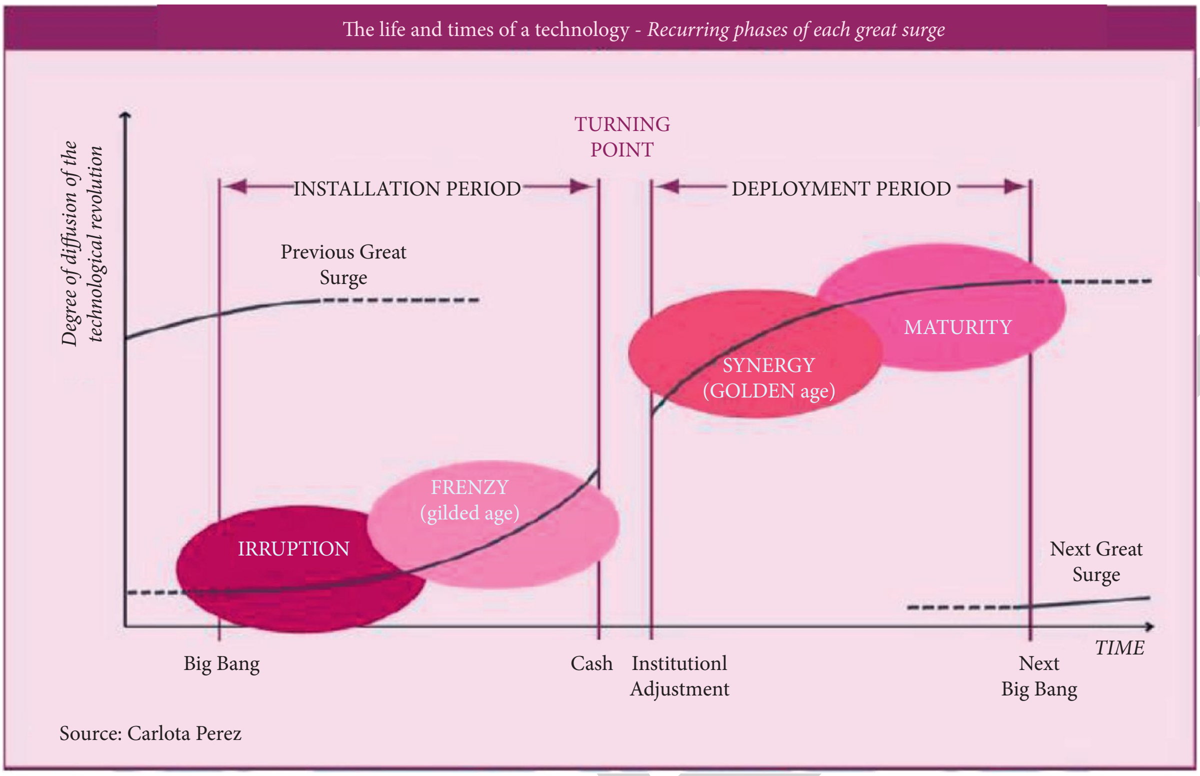

Figure 1: Analysis of Carlota Perez's technological revolution cycle.

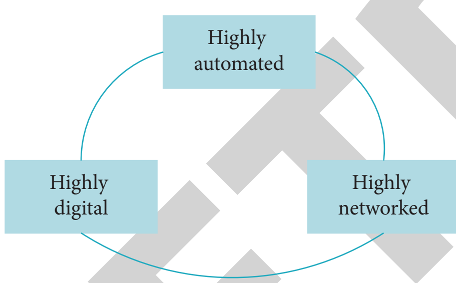

Figure 2: Characteristics of the fourth industrial revolution.

damaged [17]. It can improve the efficiency of operation while maintaining a safe working environment. Semiconductors are upstream suppliers, and they are also manufacturers of electronic components, and they will also be included in the network.

When the network (Network) layer is completed, smart (Smart) is shown in Figure 3. Artificial intelligence and cloud services can integrate the information of the entire production process and feedback given by distributors to achieve better productivity.

Intelligent manufacturing technology is a technology that governments and industries around the world are gradually paying attention [18–20]. The following is a chronology of the national development strategies proposed by various governments for intelligent manufacturing:

(1) In 2011, the US government initiated a series of national-level discussions and recommendations on the "Advanced Manufacturing Partnership" to ensure that the United States can lead the next manufacturing industry.

(2) In 2012, the German government adopted the "High Tech Strategy 2020" action plan, which sets out to provide billions of euros each year to develop cutting-edge technologies and at the same time incorporate Industry 4.0 into ten future projects.

(3) 2013, the French government launched a strategic review called "La Nouvelle France Industrielle" to define France's industrial policy priorities.

(4) In 2013, the British government proposed a long-term blueprint for manufacturing until 2050, which is called "the future of manufacturing."

(5) In 2014, under the framework of a public-private partnership, the European Union convened proposals for the "Factory of the Future" and "Permanent Processing Industry" to help develop and deploy the necessary key technologies to support the EU's wide range of manufacturing industries.

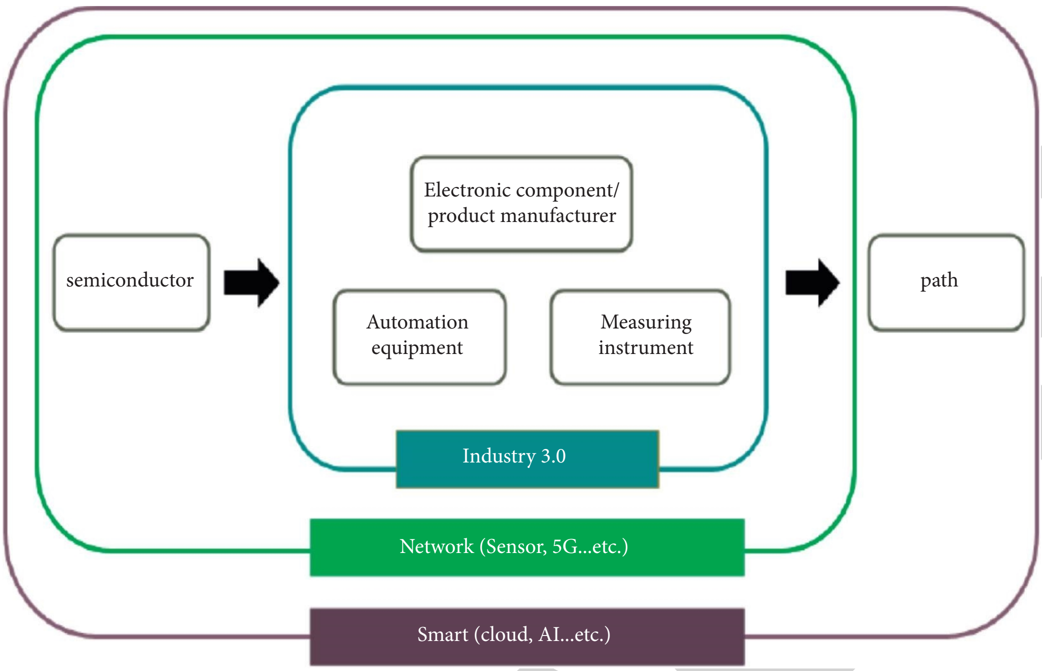

Figure 3: Conceptual diagram of the electronics manufacturing industry.

(6) 2014, the South Korean government announced “Manufacturing Innovation 3.0,” emphasizing the strategy and task of promoting a new leap in South Korean manufacturing.
(7) 2015, the Chinese government released the “Made in China 2025” strategy and the “Internet +” plan. It gives priority to ten areas of manufacturing to accelerate China’s informatization and industrialization.
(8) In 2015, the Japanese government adopted the “Fifth Basic Plan for Science and Technology (2016–2020),” which paid special attention to the “Super Intelligent Society” that creates a new value in the direction of future industrial innovation and social change.
(9) In 2016, Singapore launched the 6th “Research, Innovation, and Entrepreneurship 2020 Plan,” which clearly announced that it would invest $19 billion. The four main strategies implemented include advanced, manufacturing, technology, and engineering.
(10) In 2018, the US government issued the “Strategy for American Leadership in Advanced Manufacturing,” which continued the advanced manufacturing strategy promoted by the Obama administration.

2.3.1. Measuring Instruments. Measuring instruments are instruments used to detect, observe, and calculate various physical quantities and material components. They are mainly used in the field of electronics manufacturing for two purposes: when developing products, measuring instruments are needed to confirm the material and performance of new products etc. When producing products, measuring instruments are needed to confirm the quality and safety of products. Measuring instruments are the cornerstone of industrialization [21].

Globally, with the continuous improvement of the industrial technology level, the rapid development of the information industry, and the increasing consumer demand for electronic products, the market for measuring instruments has also developed to a certain scale. According to Technavio, by 2021, the global electronic test and the measurement instrument market is expected to reach 23 billion U.S. dollars, mainly using semiconductors and other electronic components most commonly found in Asian manufacturers [22].

The demand for measurement instruments is driven by the growth of industries, such as electronics and semiconductor manufacturing, telecommunications, aerospace, and defense. The profitability of each company depends on controlling manufacturing costs and maintaining continuous and rapid product innovation. Large companies enjoy economies of scale in sourcing parts and product distribution, and small companies can compete by focusing on equipment in niche markets or developing a reputation for high-quality products. This industry is quite concentrated. In the United States, the revenue of the 50 largest instrument companies in 2018 accounted for about 70% of the overall instrument industry [23].

2.4. Semiconductor. Integrated circuit (IC) was invented in 1958. It is a major invention in the field of electronics manufacturing. It is indispensable for 3C products such as mobile phones, home appliances, and automobiles. Now,

Table 1: Preliminary narrative statistical analysis.

Early stage (2010~2013)							
Financial indicator	Average	Minimum	Max	Variance	Standard deviation	Skewness	Kurtosis
Return on invested capital (ROIC)	0.206	0.131	0.495	0.004	0.063	1.906	4.716
Accounts receivable turnover rate	5.759	1.457	34.160	16.425	4.053.	3.828	21.452
Accounts payable turnover rate	13.254	3.330	61.558	91.219	9.551	2.308	6.756.
Inventory turnover	8.622	2.246	57.125	40.883	6.394.	4.309	28.191
Turnover rate of fixed assets	5.704	0.769	80.257	81.603	9.033	5.848	41.887
Cost of goods sold/net sales	0.572.	0.242	0.899	0.025	0.158	0.011	−0.681
R&D expenses/net sales	0.050	−0.001	0.231	0.003	0.057	1.192	0.591
Selling and administrative expenses/net sales	0.187	0.017	0.427	0.012	0.108.	0.456.	−1.008
Depreciation and amortization/net sales	0.033	0.003	0.244	0.001	0.030	3.766	22.042
Business income tax/net sales	0.030	−0.049	0.115	0.001	0.024	0.726.	2.105

Table 2: Postdescriptive statistical analysis.

Late (2014~2017)							
Financial indicator	Average	Minimum	Max	Variance	Standard deviation	Skewness	Kurtosis
Return on invested capital (ROIC)	0.191	0.106	0.617	0.006	0.079	2.637	9.401
Accounts receivable turnover rate	5.437	1.076	25.643	8.105	2.847	3.305	20.608
Accounts payable turnover rate	14.101	1.839	51.521	88.346	9.399	1.566	2.744
Inventory turnover	7.970	2.554	24.945	17.208	4.148	1.699	3.315
Turnover rate of fixed assets	5.157	0.523	59.745	69.757	8.352	5.102	29.441
Cost of goods sold/net sales	0.566	0.199	0.950	0.025	0.158	−0.052	−0.329
R&D expenses/net sales	0.065	0.000	0.246	0.004	0.061	1.135	0.793
Selling and administrative expenses/net sales	0.180	0.025	0.643	0.013	0.116	1.088	1.382
Depreciation and amortization/net sales	0.038	0.001	0.257	0.001	0.035	3.296	15.681
Business income tax/net sales	0.030.	−0.029	0.117	0.001	0.023	0.806	1.915

Table 3: Descriptive statistical analysis and comparison.

The rate of change in the later period relative to the previous period							
Financial indicator	Average	Minimum	Max	Variance	Standard deviation	Skewness	Kurtosis
Return on invested capital (ROIC)	−7%	−19%	25%	57%	25%	38%	99%
Accounts receivable turnover rate	−6%	−26%	−25%	−51%	−30%	−14%	−4%
Accounts payable turnover rate	6%	−45%	−16%	−3%	−2%	−32%	−59%
Inventory turnover	−8%	14%	−56%	−58%	−35%	−61%	−88%
Turnover rate of fixed assets	−10%	−32%	−26%	−15%	−8%	−13%	−30%
Cost of goods sold/net sales	1%	−18%	6%	1%	0%	−557%	−52%
R&D expenses/net sales	31%	−100%	7%	15%	7%	−5%	34%
Selling and administrative expenses/net sales	−4%	47%	50%	14%	7%	139%	−237%
Depreciation and amortization/net sales	18%	−63%	5%	42%	19%	−12%	−29%
Business income tax/net sales	0%	−40%	2%	−3%	−2%	11%	−9%

one of the drivers of the rapid evolution of electronic technology is IC. As the IC industry continues to produce smaller and faster chips and the applicable fields continue to expand, IC can be said to be the source of all electronic products.

The IC industry leads the continuous technological innovation in the field of electronics manufacturing, and Taiwan, as an important town in semiconductor design and manufacturing, has a complete upstream, midstream, and downstream industry chain. At the same time, it has established IC design, IC manufacturing, IC packaging, and testing foundry models. Professional division of labor is used to accelerate semiconductor R&D and production efficiency and to promote the vigorous development of the integrated circuit industry worldwide.

In 2019, affected by the Sino-US trade war, coupled with the slowdown in global smartphone sales growth, the semiconductor industry's market challenges have increased. However, with the gradual progress of AI, 5G, and other technologies, the semiconductor industry will only be able to face different technologies. The integrated design challenges of functions are generally expected to be just around the corner for the explosive growth of the semiconductor industry.

3. Research Results

In this study, the four industries of factory equipment/components, measuring instruments, electronic products, and semiconductors are divided according to the time interval from 2010 to 2013 (early period) and 2014 to 2017 (late period). The top 30 companies are taken in ROIC. A total of 120 companies will be taken in each period.

A narrative statistical analysis of the financial indicators of these companies was performed. The narrative statistical analysis results include average, minimum, maximum, variation, standard error, and skewness.

Kurtosis (skewness): Tables 1 to 3 compares the changes of various financial indicators in these two periods before and after. By narrating the results of statistical analysis and comparison, we can understand the differences between the high-performance companies in the electronics manufacturing industry and the previous high-performance companies from the data side:

(1) The average value of ROIC in the later period decreased by 7%, the variance increased by 57%, the maximum value increased by 25%, and the minimum value decreased by 19%. This may be due to the addition of new competitors and changes in the environment. Front-end companies are challenged. Some companies can maintain excellent performance and continue to grow, and some companies have begun to decline in performance.

(2) accounts receivable turnover rate, accounts payable turnover rate, inventory turnover rate, and fixed asset turnover rate show the capital leverage application (capital leverage) of the enterprise. The variance number is decreasing, which means the degree of dispersion is shrinking, showing that the application of capital leverage by top enterprises in the later period tends to be similar.

(3) The average ratio of late R&D expenses to net sales was increased by 31%, while the variance difference was 15%, indicating that the dispersion of the company's R&D expenses to the net sales ratio increased and thus the overall R&D. The increase in costs shows that the importance of R&D and innovation in the electronics manufacturing industry is increasing, which is also in line with the intelligent development trend mentioned in Industry 4.0.

(4) In the later period, the average turnover rate of fixed assets decreased by 10%, while the average ratio of depreciation and amortization to net sales increased by 18%. Generally, the capital invested in the machinery and equipment and other activities is relatively large, that is, commonly known as asset-heavy enterprises. The ratio of period depreciation to net sales is relatively high, while the ratio of fixed asset turnover rate is relatively low. From this point, it can be estimated that there are more asset-heavy players in the top enterprises in the later period than in the early period.

(5) The late skewness is positive skewness except for the cost of goods sold/net sales, that is, the right skewness, the tail on the right is longer, and the main body of the distribution is concentrated on the left. Although the cost of goods sold/net sales is negative skewness, the value is very close to 0. It can be seen that, in addition to the cost of goods sold/net sales, the remaining financial indicators, that is, the corresponding corporate capabilities, will have outliers business exists.

4. Conclusion

This study analyzes the strategic changes and growth trends of companies with high performance in the electronics manufacturing industry during the two periods from 2010 to 2013 and 2014 to 2017. From the research results gradually obtained in the analysis process of this research to make an overall summary, the research conclusions of this research can be divided into the following key points.

Industry 4.0 is not just a slogan: the ecology of top companies in the electronics manufacturing industry has indeed changed during the Industry 4.0 period. This research is based on the Industry 4.0 slogans from 2010 to 2013 in the early period and from 2014 to 2017 in the later period. In these two periods, the four major industrial equipment/components, measuring instruments, electronic products, and semiconductors related to Industry 4.0 in the field of electronics manufacturing industry, a study of 120 companies with 30 excellent front-end operations found strong evidence that the ecology of top companies is changing. It can be clearly seen from Figure 1 that, in the Industry 4.0 era, the major trend is production capacity.

This study uses the financial indicators dismantled by the DuPont identity as evidence to invert the resource allocation of top companies in the electronics manufacturing industry and outline their strategic groups through factor and cluster analysis. The impact of Industry 4.0 was determined by studying and comparing the strategic groups of top companies in these two periods. Companies that invest more resources in fixed assets are able to use digitization, networking, and automation. Companies that achieve greater efficiency in the production facilities of their own factories can gain more and widen the gap with their competitors.

The analysis results of narrative statistics show that the ratio of companies with good performance in the later stage of betting on R&D increased by 31% on average compared with the previous stage, showing a significant increase. At the same time, with the analysis of changes in the previous and late strategy groups, it can be seen that the smart asset strategy groups with high research and development in the early stage have a good chance of maintaining good performance in the later stage. This shows the importance of technology and innovation in the Industry 4.0 era. If a company can obtain a unique competitive advantage in smart assets through research and development, it has a higher chance of continuing to occupy a place in the electronics manufacturing industry.

Data Availability

The experimental data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The author declares no conflicts of interest regarding this work.

Acknowledgments

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