

The Influence of Operating Strategies and Properties on Factor Productivity- Evidence from a Typical Small and Medium-sized Business in Taiwan

Huei-Fu Lu

Department of Sport Management,
Aletheia University
Taipei, Taiwan
E-mail address: hflu@mail.au.edu.tw

Abstract—This study attempts to demonstrate a more appropriate confirmatory model to analyze the influence of operating strategies on factor productivity for the lighting equipment industry in Taiwan. Structural equation model (SEM) is used to examine the relationship by sampling 367 members of Taiwan Lighting Fixture Export Association in 2009. The results show that the e-commerce strategy will lead to a negative effect on factor productivity, but internationalized strategy plays a powerful role on influencing the firm's factor productivity. In addition, the firm's properties would bring a positive moderating effect on the relationship between operating strategies and factor productivity.

Keywords—operating strategies; firm's properties; factor productivity; small and medium-sized Business; Structural Equation Model (SEM)

I. INTRODUCTION

Taiwan is an insular nation with scarce natural resources and small domestic market, so the main economic activities are oriented toward international trade. For the lighting equipment industry (LEI) in Taiwan, it is mostly composed of small and medium and even micro enterprises. These hard core firms have the characteristics of smaller scale capital, lower sales revenue and lower entry barrier, and are also categorized as a labor-intensive industry. In the last decade, facing the rapid development of the information technology and the booming economy in Taiwan, and also due to intensive international competition and transformation of the domestic industrial structure, the membership of Taiwan Lighting Fixture Export Association has drastically reduced from 963 to 367, and the share of LEI to the overall market has noticeably been coming down. The current survival firms are confronting with increasing labor and material cost and the competitors from neighboring low-labor cost countries. Under the impact of globalization, it should be required to further investigate whether the firms in LEI could suitably adopt current operating strategies to tide over the post-financial-crisis and raise productivity. Therefore, through constructing a proper structural equation model (SEM), this paper intends to analysis the comprehensive effects on factor productivity from the firms' properties and their operating strategies (including product diversification, e-commerce and internationalization) for the firms of LEI in Taiwan.

II. LITERATURE REVIEW AND HYPOTHESES

A. Factor Productivity and Operating Strategies

In general, the measurement of productivity is simplified as the labor productivity or factor productivity. Parkan and Wu [26] used total labor wage as the input variables and total production as the main output variables. Aw, Chung, and Roberts [3] used technology intensive, operating experience, capital stock quality, management capability, difference in economic scale or output quality difference and other production factors from the industrial and commercial surveys of the manufacturing industry in 1981, 1983 and 1991 to explore and compare the differences with the manufacturer's productivity.

Product diversification is usually regarded as the one of operating strategies when a firm entries into new market with new products or multiple different ways; it may be product, market or function change or through internal or external accomplishment, or relevant or irrelevant change [17]. Gollop and Monahan [14] consider product diversification can be directly calculated by the ratio of other businesses compared to the core business. Although production diversification strategy is generally regarded as a growth strategy for domestic manufacturers, previous researchers had the divergent aspect in the relation between product diversification and firm's productivity. For example, a number of evidences show that if the industry is oriented towards relative product diversification, it will result in lower transaction costs, higher productivity and the utility rate of resource so that the synergy will be fulfilled spontaneously [27]. Lin [24] also addressed the best product diversification strategy is vertical product diversification and has the best performance on corporate productivity. However, Lichtenberg [25] and Gollop [15] showed an opposite demonstration that the growth rate of firm's productivity shown a negative effect after adopting product diversification. Therefore, the hypothesis H_{1-1} could be developed:

H_{1-1} : Higher degree of product diversification would result in higher factor productivity for LEI firms.

E-commerce is also a familiar operating strategy adopted by modern business that refers to all commercial activities utilizing computer as the medium to bring about commercial transaction [19]. Nevertheless, there was still a discrepancy

in the effect of e-commerce. For example, some empirical studies conclude that e-commerce may seize the opportunity of earning more profits [28]. Contrarily, Konings and Roodhooft [22] focused on the effect of e-commerce on operating performance of small, medium and large enterprises in Belgium, and found that it would advantage the large enterprises to apply e-commerce strategy, but not for small and medium enterprises. Clayton, Goodridge, and Waldron [9] also studied the British sales industry based on e-commerce strategy and found that on-line ordering strategy will enhance the productivity but on-line sale strategy will bring a negative effect on the productivity instead. Brown and Goolsbee [7] also indicated that for some particular industries, the higher usage rate of e-commerce would provide more varieties of options for consumers so that it would result in the revenue reduction. Therefore, the following hypothesis $H_{1,2}$ are proposed:

$H_{1,2}$: *The use of e-commerce strategy for the LEI firms would decrease the factor productivity.*

Based on the theory of product life cycle, Vernon [30] considered internationalization as a concept of continuous stage that the firms gradually increase their degree of internationalization for the evolution of the product life cycle. Traditionally, internationalization would be regarded as a dynamic continuous expansion strategy which would improve the productivity of domestic small and medium enterprises [31]. Hatemi-J and Irandoust [16] found a reciprocal causation existing between factor productivity and export activity. Geringer, Tallman, and Olsen [13] conducted a research on Japan's multinational firms by using the percentage of export to total sales as the measurement index of internationalization to verify that the raise of internationalization level will lead to a better operating performance. Also, Delgado, Farinas and Ruano [10] used the Spanish firms as the research samples to explore the influence of export on factor productivity. They found that the productivity of export firms is far higher than that of non-export firms. Afterward, Aw, Chung, and Roberts [3] showed the same conclusions for Taiwan and South Korea. Farnandes [12] further surveyed the manufacturers in Colombia to explore the influence of internationalization on productivity and showed that under the policy of trade liberalization, internationalization will improve the productivity. Therefore, the hypothesis $H_{1,3}$ could be developed as follows.

$H_{1,3}$: *Higher degree of internationalization would result in higher factor productivity for the LEI firms.*

B. Firm's Properties and Factor Productivity

Operating experience and firm size are usually regarded as the important measuring indices in analyzing firm's properties [3], where firm size is generally measured by capital, total sales or the number of employees [13]. Since the larger size firms have more abundant operating capital and can lower the operation costs through the application of a great deal procurement so that the production capacity and output could be expanded easily, and it will further bring more benefits for the improvement of productivity [21]. Aw [4] surveyed Taiwan's manufacture industry to explore the

influences of operating experience and firm size on productivity and found out the similar conclusion that the large, medium and small size manufacturers all have higher productivity than the micro size manufacturers. Especially, the productivity of the medium size manufacturers is significantly higher than that of the micro size manufacturers.

$H_{2,1}$: *Longer operating experiences of the LEI firms would result in the higher factor productivity.*

$H_{2,2}$: *Larger firm size of the LEI firms would result in the higher factor productivity.*

Besides operating experience and firm size, capital intensive and technology intensive are also incorporated to measure the firm's features. Generally, the higher the capital intensive means the firm may use higher ratio of capital equipment and has more capability in acquiring information and production technology, so the production efficiency of labor productivity could be further raised [1]. The higher capital intensive firms would utilize various methods to improve production efficiency and increase their productivity [20]. Christoffersen, Datta, and Malhotra [8] investigated the productivity of the textile manufacturers in North America and concluded that the higher capital intensive could lead to a higher growth rate of productivity. Johansson [18] also took the Sweden manufacturers to study the productivity of the export firms and found the same conclusions. Similarly, higher R&D expenditures imply that the firms have made every effort to invest in R&D to develop new technology to increase production efficiency. Therefore, the firms with higher R&D ratio may possibly use new technology in the production process and thereby generates higher productivity [1] [2] [6]. Tsai and Wang [29] classified listed companies into two major categories, high-tech industry and the traditional industry, to explore the influence of R&D expenditure on productivity and found that the high-tech industry has far higher average investment return rate than the traditional industry. Therefore, the following hypotheses could be developed:

$H_{2,3}$: *Capital intensive of the LEI firms would influence positively on their factor productivities.*

$H_{2,4}$: *Technology intensive of the LEI firms would influence positively on their factor productivities.*

C. The relationship among operating strategy, firm's properties and factor productivity

From the previous literature, the relationship among operating strategy, firm's properties and factor productivity is very intricate. Some further studies addressed that more technology intensive will be beneficial for developing internationalization and further enhance firm's productivity [6]. Aw and Batra [2] found the similar conclusion, especially for the firm with larger scale. As to the application of E-commerce, Fariselli, Oughton, Picory, and Sugden [11] indicated that in the early operation period, the less capital intensive firms would have a better performance of productivity than the firms with more capital intensive; however, in the long run, the more capital intensive firms would construct a more sound arrangement of market sales network and surpass the firms with less capital intensive in the performance of productivity. Baily and Lawrence [5] also

pointed out that that more capital intensive firms have higher investment intentions in technology innovation than the less capital intensive firms, and after drawing into the e-commerce strategy, the firms with or without longer operating experience will attain a higher labor productivity. Also, Konings and Roodhooft [22], Wagner [31] [32] found that the greater firm size would lead to the more internationalization-oriented and has a positive influence on the performance of labor productivity. Windrum and Berranger [33] showed that large size firms have higher intention in investing e-commerce technology than the small size firms. The higher internationalized firms have a more significant level of applying e-commerce strategy than non-internationalized firms [23].

H_3 : Firm's characteristics have a moderating effect on operating strategy and factor productivity.

III. METHOD

A. Measurement Issues

Based on the previous literature, this study constructs the following conceptual model to confirm the influence of operating strategies and firm's properties on factor productivity for Taiwan's LEI as shown in Fig. 1.

In Fig. 1, each latent variable could be measured by 2-4 observable variables where X_1 : Product diversification; X_2 : E-commerce; X_3 : Level of internationalization; Y_1 : Operating experience; Y_2 : Firm size; Y_3 : Capital intensive; Y_4 : Technology intensive; Y_5 : Capital productivity; Y_6 : Labor productivity; ξ_1 : Operating strategy; η_1 : Firm's properties; η_2 : Factor productivity; ζ_i , ε_i , δ_i : Error terms; γ_{ij} , β_{ij} , $\lambda_{X_{ij}}$, $\lambda_{Y_{ij}}$: Factor loadings. The measures of observable variables are summarized as Table 1.

TABLE 1. VARIABLES MEASUREMENT

Latent variables	Observable variables	Measures
Operating strategy	Product diversification	The number of product line/Total average of firms
	E-commerce	Dummy variables: Nonuser= 0, User=1
	Degree of internationalization	Total export figures/ Total sales
Firm's properties	Operating experience	The number of years of operation by firms
	Firm size	\ln (Number of employees)
	Capital intensive	\ln (Capital / Number of employees)
	Technology intensive	The total number of patents acquired by R&D
Factor productivity	Capital productivity	Total sales / Total capital
	Labor productivity	Total output / Total salaries

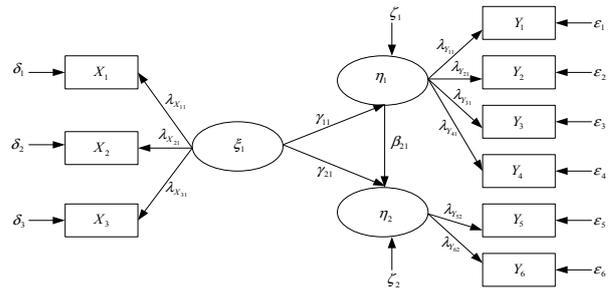


Fig. 1. Linear structure relations modeling

B. Data Collection and Analysis

There are 367 firms collected from the 2009 member directory of the Taiwan Lighting Fixture Export Association, and the secondary data are rearranged from the databases of Taiwan External Trade Development Council, Patent Gazette, and Industrial and Commercial and Service Industry Census. The linear structure relation model for operating strategy, firm's properties and factor productivity is constructed and shown as Fig. 1, and the causal relation between the various latent variables will be further verified.

IV. RESULTS AND DISCUSSIONS

A. The Goodness of Fit for the Constructed Model

The total evaluation results for the goodness of fit of the hypothetical model are shown in Table 2.

TABLE 2. FIT MEASURES STATISTICS

Index	Ideal Value	Model Value
<i>Absolute fit measures statistics</i>		
d.f.	-	24
χ^2		62.77(P<0.05)
χ^2 /d.f.	≤ 3.0	2.615
GFI	≥ 0.9	0.96
RMR	≤ 0.05	0.014
SRMR	≤ 0.10	0.051
RMSEA	≤ 0.08	0.066
<i>Incremental fit measures statistics</i>		
AGFI	≥ 0.8	0.93
NFI	≥ 0.9	0.90
NNFI	≥ 0.9	0.91
CFI	≥ 0.9	0.94
RFI	≥ 0.9	0.86
IFI	≥ 0.9	0.94
<i>Parsimonious fit measures statistics</i>		
PNFI	≥ 0.5	0.60
PGFI	≥ 0.5	0.51
CN	≥ 200	254.15

B. Path Analysis for the Structural Equation Modeling

In Fig. 2, the chi-square ratio of this theoretical model is $\chi^2 / df = 2.615 < 3$. It means that there is a substantial interpretative capability for the theoretical model to interpret the observed data. According to the results of estimation,

firm's operating strategies have positive influence on factor productivity and through the moderate effect of firm's properties and operating strategies will also positively influence the factor productivity. The relations between the latent independent variables and the dependent variables and corresponding observed variables show that the effect of product diversification is not significant, and e-commerce showing a negative effect and the degree of internationalization showing positive significant effect. However, there are positive significant effects on the four measured variables of firm's properties and the two dimensions of factor productivity.

According to the significance of path coefficient (i.e. β and γ), the firm's properties play an important moderating role on the relationship between operating strategies and factor productivity.

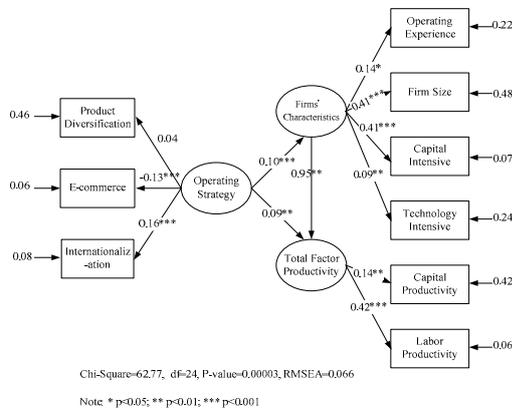


Fig. 2. Path analysis results for the structural modeling

V. CONCLUSIONS

A. Managerial Implications

The empirical results are similar to Gollop [15] that the effect of product diversification strategy on the LEI firms' factor productivity is insignificant. It is because Taiwan's LEI firms have a higher production cost than other Asian nations, and the firms' operating type tend toward small volume but elaborate and tailor-made products. Taiwan's suppliers have been classified and positioned by foreign procurement groups as firms with professional, sophisticated, high technology, and high value-added products in the supply chain. If the LEI firms' product lines become more complicated, the various costs such material cost, manpower cost and production cost will subsequently result in lower productivity. Therefore, Taiwan's LEI firms can no longer rely on low-price and large-volume orders to cover their production costs, even to compete with other neighbor Asian nations. Based on this, it appears that the product diversification strategy cannot effectively raise the productivity.

For the use of e-commerce strategy, the result is consistent with Brown and Goolsbee [7]. Taiwan's LEI firms seem only suitable to deal with simply B2B information communication, mail delivery, internal personnel, production and material management by using computer software

packages. As to the further application of high level computer technology such as B2B ordering, payment and other e-commerce usage are unsuitable; it might be harmful to the LEI firms' productivity. It is because there is a comparative small inner-demand in Taiwan's domestic LEI market. As to export, facing the rapid change in the overall investment environment, maladjustment of the supply chain, rising costs of materials and manpower, and other restrictions, the industrial ecology is becoming more conservative and the entire LEI industry's external competitiveness is descended rapidly. While the firms cannot make breakthrough to develop into the large enterprises, the orders are mostly small or extremely small quantity and amount with more varieties in design; thereby the e-commerce strategy cannot be effectively developed and application. Consequently, the use of e-commerce for B2B can no longer help firms increase the operating revenue, instead only increases personnel and equipment costs, and eventually results in a negative effect on firms' productivity.

Regarding the effect of internationalization on productivity, this result is also consistent with Farnandes [12] in which Taiwan's LEI firms should actively focus on the internationalization strategy. It also implies that Taiwan's LEI would inherit the past export-oriented experience to expand the global competitions and the internationalization depth of LEI firms would be continuously increased.

Similar to [4], this study find that operating experience is beneficial to operating strategy has a positive influence on productivity. The accumulation of firm's operating experience is an intangible knowledge asset and competitiveness. Due to the industry characteristics, Taiwan's LEI firms usually adopt the strategy of small volume and tailor-made, the accumulation of operating experience could lower firms' production cost and greatly improve productivity. In addition, while the firm's internationalization degree is increased, the firm size should be also required to expand along with the degree of internationalization so as to improve firm's productivity. Therefore, the firm's properties would play a moderating role on the relationship between operating strategy and factor productivity. That is the LEI firms may further raise the growth rate of productivity through developing the internationalization strategy and collocating firm's properties.

As to the effect of capital intensive on firm's productivity, our finding is similar to [8] and [18]. It implies that if the LEI firms can invest more capital assets, they will have greater capability in acquiring information and production technology so that the labor productivity and the production efficiency would be subsequently improved. Therefore, a higher capital intensive LEI firm would be good at utilizing the various methods to improve production efficiency and raise productivity. On the other hand, technology intensive also positively influence on firm's productivity, which is similar to [1]. The number of patents obtained from R&D is generally used to measure a firm's technology intensive. The possession of more patent rights indicates the firm is devoted to invest in R&D to develop new technology so as to improve production efficiency. Hence, the more patent rights are acquired, the more new technology would be employed

in the production processes so that the firms will generate comparatively higher productivity than the firms with low technology intensive.

In the insular nation, Taiwan's LEI faces the awkward situations of scarce natural resources and a small domestic market, firm's operation must therefore depend on the overseas market. Once the markets reach maturity period, it will be necessary for the LEI firms to adopt appropriate operating strategies and through the adjustment of firm's properties, so as to achieve the goal of sustainably growth.

B. *Suggestions for Further Studies*

For the further researches, the operating types could be incorporated to classify the firms into up, middle, or downstream; or high, medium and low technology firms; or involving the other nations' LEI firms for comparing the competitive edge of the LEI to capture a full view on the global scenarios of LEI for carrying out the comparative analysis. As to the effect of product diversification, it may reconsider to classify the product items into related and non-related product diversification as well.

REFERENCES

- [1] S. Ahn, "Does exporting raise productivity? Evidence from Korean microdata," ADB Institute Discussion Paper No. 11, 2004.
- [2] B. Y. Aw and G. Batra, "Technology, exports and firm efficiency in Taiwanese manufacturing," *Economics of Innovation and New Technology*, 1998, vol. 7, pp. 93-113.
- [3] B. Y. Aw, S. Chung, and M. J. Roberts, "Productivity, output, and failure: A comparison of Taiwanese and Korean manufacturers," *Journal of Developing Economics*, 2002, vol. 66, pp. 51-86.
- [4] B. Y. Aw, "Productivity dynamics of small and medium enterprises in Taiwan," *Small Business Economics*, 2002, vol. 18, pp. 69-84.
- [5] M. N. Baily and R. Z. Lawrence. "Do we have a new E-economy?" *American Economic Review*, 2001, vol. 9, no. 2, pp. 308-312.
- [6] P. Braunerhjelm, "The relation between firm specific intangibles and exports," *Economics Letters*, 1996, vol. 53, pp. 213-219.
- [7] J. R. Brown and A. Goolsbee, "Does the internet make markets more competitive? Evidence from the life insurance industry," NBER Working Paper, 2000, w7996, unpublished.
- [8] S. Christoffersen, A. Datta, and D. K. Malhotra, "Productivity in the textile industry," paper presented at the meeting of the North American Productivity Workshop at Union College, 2002.
- [9] T. Clayton, C. C. P. Goodridge, and K. Waldron, "Enterprise e-commerce; Measurement and impact," paper presented at the United Nations Conference on Trade and Development, Geneva, 2003.
- [10] M. A. Delgado, J. C. Farinas, and S. Ruano, "Firm productivity and export markets: A non-parametric approach," *Journal of International Economics*, 2002, vol. 57, no. 2, pp. 397-422.
- [11] P. Fariselli, C. Oughton, C. Picory, and R. Sugden, "Electronic commerce and the future for SMEs in a global market-place: Networking and public policies," *Small Business*, 1999, vol. 12, no. 3, pp. 261-275.
- [12] A. M. Farnandes, "Trade policy, trade volumes and plant-level productivity in Colombian manufacturing industries," *Journal of International Economics*, 2007, vol. 71, pp. 52-71.
- [13] J. M. Geringer, S. Tallman, and D. M. Olsen, "Product and international diversification among Japanese multinational firms," *Strategic Management Journal*, 2000, vol. 21, no. 1, pp.51-80.
- [14] F. M. Gollop and J. L. Monahan, "A generalized index of diversification: Trends in U.S manufacturing," *The Review of Economics and Statistics*, 1991, vol. 73, pp. 318-337.
- [15] F. M. Gollop, "The pin factory revisited: Product diversification and productivity grow," *Review of Industrial Organization*, 1997, vol. 12, pp. 317-334.
- [16] A. Hatemi-J and M. Irandoust, "Productivity performance and export performance: A time-series perspective," *Eastern Economic Journal*, 2001, vol. 27, no. 2, pp. 149-164.
- [17] L. R. Jauch and W. F. Glueck, *Strategic management and business policy*. N.Y.: McGraw-Hill, 1988.
- [18] S. Johansson, "Export-biased productivity growth in Swedish manufacturing," A preliminary draft for the ETSG conference in Nottingham, 2004.
- [19] R. Kalakota and A. B. Whinston, *Electronic commerce: A manager's guide*. NY: Addison-Wesley Professional, 1996.
- [20] S. Kaya and Y. Ucdogruk, "The dynamics of entry and exit in Turkish manufacturing industry," ERC Working Papers in Economics, September, 2002, unpublished.
- [21] A. Kokko, R. Tansini, and M. C. Zejan, "Local technological capability and productivity spillovers from FDI in the Uruguayan manufacturing sector," *The Journal of Development Studies*, 1996, vol. 32, no. 4, pp. 602-611.
- [22] J. Konings and F. Roodhooft, "The effect of e-business on corporate performance: Firm level evidence," *De Economist*, 2002, vol. 150, pp. 569-581.
- [23] K. Lal, "E-business and export behavior: Evidence from Indian firms," *World Development*, 2004, vol. 32, no. 3, pp. 505-517.
- [24] J. Lin, *Strategy management*. Taipei City: Chi Sheng, 2003.
- [25] F. R. Lichtenberg, "Industrial de-diversification and its consequence for productivity," *Journal of Economic Behavior and Organization*, 1992, vol. 18, pp. 427-439.
- [26] C. Parkan and M. L. Wu, "Measuring the performance of operations of Hong Kong's manufacturing industries," *European Journal of Operational Research*, 1999, vol. 118, pp. 235-258.
- [27] V. Ramanujam and P. Varadarajan, "Research on corporate diversification: A synthesis," *Strategic Management Journal*, 1989, vol. 10, no. 6, pp. 523-551.
- [28] A. Rincon, C. Robinson, and M. Vecchi, "The productivity impact of e-commerce in the UK, 2001: Evidence from micro-data. ZIESR Discussion Paper, 2003, pp. 523-551.
- [29] K. H. Tsai and J. C. Wang, "R&D productivity and the spillover effects of high-tech industry on the traditional manufacturing sector: The case of Taiwan," *World Economy*, 2004, vol. 27, no. 10, pp. 1555-1570.
- [30] R. Vernon, "International investment and international trade in the product cycle." *Quarterly Journal of Economics*, 1966, vol. 80, pp. 190-207.
- [31] J. Wagner, "The causal effects of exports on firm size and labor productivity: First evidence from a matching approach," *Economics Letter*, 2002, vol. 77, pp. 287-292.
- [32] J. Wagner, "Exports and productivity: A survey of the evidence from firm level data," *The World Economy*, 2007, vol. 30, no. 1, pp. 60-82.
- [33] P. Windrum and P. Berranger "Actors Affecting the Adoption of Intranets and Extranets by SEMs: A UK Study," The 10th International J. A. Schumpeter Society Conference, Universita Bocconi, Milan, 2004.