Advances in Technology Innovation, vol. 4, no. 1, 2019, pp. 44 - 57

New Ventures, Internationalization, and Asymmetric Grin Curve: Analysis of Taiwan's Big Data

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Received 02 March 2018; received in revised form 18 July 2018; accepted 04 September 2018

Abstract

Under globalization, small and medium enterprises (SMEs) that predominate Taiwan's economy have been primarily original equipment manufacturers (OEMs) continuing to adjust operating strategies in order to extend supply chains and enhance competitiveness. This paper adopts the big data composed of 104,377 Taiwanese manufacturers from the 2011 Industry, Commerce, and Service Census to assess impact of the business life cycle, brand revenue, R&D spending, and internationalization on value creation. Major findings are as follows. First, the link of the firm's operating years with value creation is characterized by a quadratic U-shaped curve where the minimum point corresponds to 15 years of operation, suggesting a cost of lower value added for new ventures at the early stage of development. Second, a reversed U-shaped curve of value creation is found as regards brand revenue and R&D spending, with the greater impact of the latter. Third, the impact of overseas investment and export expansion is also captured by a reversed U-shaped curve, with greater impact for the former. Fourth, an asymmetric grin curve rather than a smile curve is found in Taiwan's manufacturers, whose value creation can be strengthened by strategies that focus on the learning curve, internationalization, internet, operating scale, and capital intensity.

Keywords: new venture, internationalization, grin curve, value creation

1. Introduction

The emergence of the Regional Comprehensive Economic Partnership (RCEP), which enlarges the trade link of the ten ASEAN members and six Asian countries, marks a new challenge as regards the cost advantage that most original equipment manufacturers (OEMs) in Taiwan have benefited over past decades. These firms are now forced to develop strategies that transform the current cost-based industry into the one with high value added through new ventures, brand benefit, R&D spending, and internationalization.

However, the 2011 Industry, Commerce, and Service Census conducted by Taiwan's Directorate-General of Budget, Accounting, and Statistics shows that the business operating years ranges from 1 to 100 and averages at 18 among the 104,377 firms surveyed. This seems to imply significant discrepancy in terms of the business life cycle. In addition, the number of firms that have been engaged in brand, R&D, overseas investment, and export activities are only 12,440, 10,062, 14,326, and 17,206, respectively accounting for 11.92%, 9.64%, 13.73%, and 16.49% of the total sample and leaving the ratio of the value added to total revenue at 36% only. This paper intends to deepen the issue on insufficient value creation observed in most small and medium enterprises (SMEs) that dominate Taiwan's manufacturing sectors and discuss relevant strategies for transformation in the business model.

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The remainder of this paper is structured as follows. Section 2 succinctly reviews theoretic foundations and relevant empirical evidence. Section 3 proposes the empirical model and hypotheses to be tested. Section 4 analyzes primary regression results and checks robustness of the empirical model. Section 5 concludes with discussion on research limitations and suggestion for future studies.

2. Theoretic Foundations and Literature Review

The smile curve characterizes the relation between value creation and supply chains. The value added is expressed on the vertical axis, whereas the supply chains from the upstream to the downstream are expressed from the left to the right on the horizontal axis. Over the supply chains, upstream, midstream, and downstream firms respectively play the role of original design manufacturers (ODMs), original equipment manufacturers (OEMs), and own branding manufacturers (OBMs). In Less Developing Countries (LDCs), the smile curve appears reversed, called the forced smile curve. In between, the grin curve raises the two ends of the smile curve and appears flatter to reflect the evolution in industry competition. The typical smile curve, forced smile curve, and grin curve are illustrated in Fig. 1.

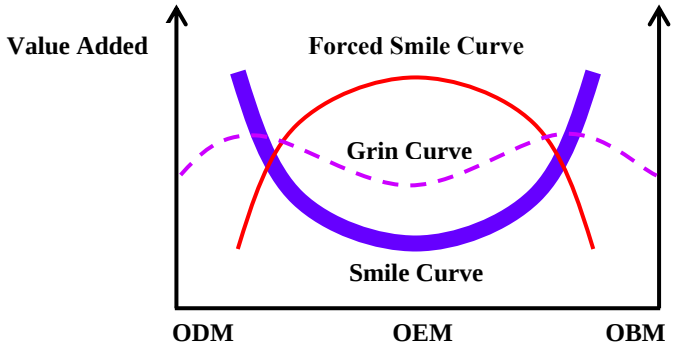

Fig. 1 Smile curve, forced smile curve, and grin curve

New ventures have grown rapidly over the past decades. Lussier [1] defines the new ventures as businesses established within 10 years. In Taiwan, the Start-Up and Incubation Center of the Small and Medium Enterprise Administration of the Ministry of Economic Affairs adopts instead a definition of 5 years, also applied to associated start-up loans open to the youth. But its Business Start-Up Award targets businesses of an age of not more than 3 years. Across relevant studies, businesses established within 3 to 14 years exhibit essential characteristics of new ventures. As this research employs data from the Industry, Commerce, and Service Census conducted every 5 years by Taiwan's Directorate-General of Budget, Accounting, and Statistics, subsequent analysis will define new ventures by an age of not more than five years. Businesses that have continuously operated over more than 5 years are regarded as survivors.

Marco et al. [2] examine a sample of Italian companies between 1982 and 1992. Firm characteristics before and after the public initial offerings (IPO) are compared in order to find determinants for listing on exchanges. The authors adopt the competitive theory to distinguish cost-side and benefit-side determinants and classify new ventures and survivors by firm age. The empirical evidence indicates lower capital demand reflected by a lower debt ratio for new ventures as these businesses have shorter operations and/or funds provided by establishing shareholders are able to meet the demand. Erel et al. [3] turn to a larger sample of European companies involved with mergers and acquisitions from 2001 to 2008 and investigate the sensitivity of cash holdings and investment to cash flows. They find that it is the survivor rather than the new venture which significantly increase cash holdings one year after the IPO. In addition, positive sensitivity of investment to cash flows is found among new ventures, which implies that investment by financially constrained firms mainly relies on own funds as post-IPO firm characteristics cannot not be changed immediately.

Relevant studies such as Maine et al. [4] discuss value creation by startup- and science-based businesses such as biotechnology firms and deepen the specifics inherent in value creation by companies producing high-end materials. The authors apply hierarchical clustering to differentiate various types of material technology and observe differences in value creation driven by decision incorporating uncertainty, commercialization of products, target-market-tailored R&D, and value chain integration across the sample firms. Chemmanur et al. [5] advance by connecting the venture capital firm with corporate innovation. The authors substantiate a higher degree of innovation in venture capital firms established and supported by parent firms than in those which operate independently, suggesting the key role played by industrial knowledge and greater room for failure in value creation achieved by external venture capital. Yang et al. [6] continue the studies in corporate growth and find a U-shaped relation between diversification by venture capital businesses and value creation of new ventures. Quentier [7] deepens with analysis of self-employment by the unemployed through creation of new ventures and find that government subsidies in the form of loans better increase quality and selection of new ventures than direct subsidies. The loans also serve to solve financial constraint faced by these new ventures.

Fig. 2 synthesizes the theoretical foundations inherent in the technology gap theory suggested by Posner [8] with illustration of strategies by the OEM, ODM, and OBM. The firm is not established over the period of T0~T1 for lack of competitiveness and starts to imitate other firms by operation in the form of OEM regarding conditions such as the economies of scale, production standardization, and initial capacity over the period of T1~T2. Then the firm gradually raises operation performance (OP) along the path of T1A under the imitation lag. However, the firm which keeps the OEM strategy may face stagnant or decreasing OP and enjoy the marginal profit only under the agency problem caused by high concentration of buyers or an increase in competitors as suggested by the transaction cost theory. To avoid such a strategic problem for OEM, the firm should adopt the ODM strategy by an increase in spending on research and development to gain patents at the initial expense of the design lag and failure in the early state of innovation, making OP fall along the path of AB over the period of T2~T3. Beyond T3, the firm's OP gradually rises along the path of BC with advantages from technological improvement and creation of new product. If other OEMs also experience imitation and design lags to catch the firm's ODM strategy, the firm's OP may become stagnant or declining beyond T4 under the love for varieties by consumers. As suggested in the product differentiation theory by Krugman [9] and attribute differential theory by Lancaster [10], the ODM's gross margin will decrease with mass customization. To increase OP, the OBM strategy should be adopted, but the firm has to experience the demand lag and substantial branding investment over the period T4~T5 where OP falls along the path of CD. Only as the capability for product differentiation, operational digitalization, investment in intangible assets, and internationalization reach a stable level, the firm's OP grows along the path of DE.

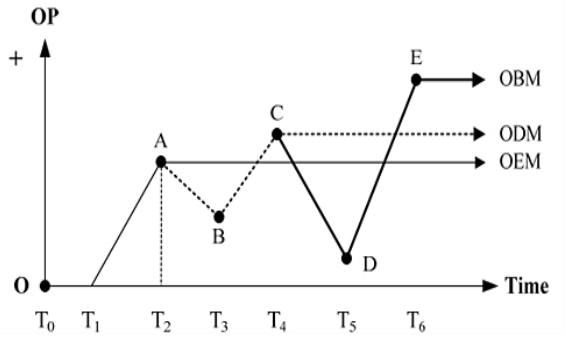

Fig. 2 Strategies by OEM, ODM, and OBM

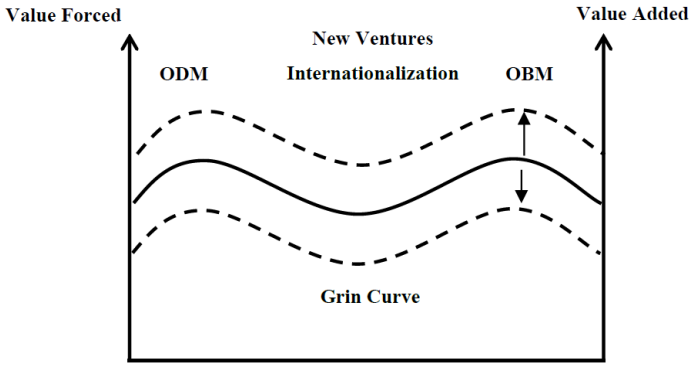

Fig. 3 Business life cycle, internationalization, and value creation

In literature, Dunning [11], Wagner [12], Bhide [13], Zahra et al. [14], Kuo and Li [15], Head and Ries [16], and Hmieleski and Baron [17] discuss from various dimensions the strategies for business evolution and expansion in the context of international competition. Kumar and Siddharthan [18] place focus on the Indian enterprises, whereas Chen [19], Lundquist [20], Lin [21], and Lin et al. [22] examine businesses in Taiwan. This paper attempts to evaluate whether the firm's operating

years (business life cycle) and internationalization (overseas investment and export) shift the smile curve up to strengthen value creation, illustrated by Fig. 3. Subsequent analysis is to construct a regression model of value creation and assess the impact of the operating years, brand, R&D, internationalization, and other control variables of management on the value added for Taiwan's manufacturers in addition to proposing appropriate strategies.

3. Empirical Model and Hypotheses

3.1. Data

The empirical analysis adopts the 2011 Industry, Commerce, and Service Census conducted by Taiwan's Directorate-General of Budget, Accounting, and Statistics. The original sample covers 167,840 firms. With the deletion of firms whose variable values are erroneous or omitted, the final sample contains 104,377 firms regrouped into ten classes. Table 1 recapitulates variable definitions.

Table 1 Variable Definitions

Variable	Definition	Remark
Panel A: Value Creation		
LVA	Value Added	In Logarithm
Panel B: Business Life Cycle		
AGE	Operating Years	
AGE^2	Squared AGE	
Panel C: Asymmetric Grin Curve		
BR	Brand Revenue to Total Revenue	In Percentage
RD	R&D Spending to Total Spending	In Percentage
FI	Overseas Investment to Net Fixed Assets	In Percentage
EX	Export Revenue to Total Revenue	In Percentage
Panel D: Operation Digitalization		
EC1	Information Disclosure on Internet	Dummy
EC21	Purchases on Internet	Dummy
EC22	Internet Purchases to Total Spending	In Percentage
EC31	Sales on Internet	Dummy
EC32	Internet Sales to Total Revenue	In Percentage
Panel E: Control Variable		
OPR	Manufacturing as Main Business	Dummy
LSIZE	Net Assets	In Logarithm
KLR	Net Fixed Assets to Number of Employees	Capital-Labor Ratio
Panel F: Industry Class		
INDA	Food and Drink	Dummy
INDB	Textile, Clothing, and Leather	Dummy
INDC	Paper and Printing	Dummy
INDD	Oil, Coal, and Chemistry	Dummy
INDE	Rubber and Plastics	Dummy
INDF	Metal	Dummy
INDG	Electronics and Computer	Dummy
INDH	Machinery	Dummy
INDI	Car and Other Vehicle	Dummy
INDJ	Furniture	Dummy

3.2. Model and hypotheses

To measure the impact of innovation, brand revenue, R&D spending, and internationalization on value creation for Taiwan's manufacturers, the model of Eq. (1) is constructed by the following regression equation.

$$\begin{aligned} LVA = {} & a_0 + a_1 AGE + a_2 AGE^2 + a_3 BR + a_4 BR^2 + a_5 RD + a_6 RD^2 + a_7 FI + a_8 FI^2 + a_9 EX + a_{10} EX^2 + a_{11} EC1 \\ & + a_{12} EC21 + a_{13} EC22 + a_{14} EC31 + a_{15} EC32 + a_{16} OPR + a_{17} LSIZE + a_{18} KLR + a_{19} KLR^2 + a_{20} INDB \\ & + a_{21} INDC + a_{22} INDD + a_{23} INDE + a_{24} INDF + a_{25} INDG + a_{26} INDH + a_{27} INDI + a_{28} INDJ + e \end{aligned} \quad (1)$$

LVA is taken in logarithm and measure value creation. The parameters a_1 and a_2 serve to assess the role played by the business life cycle in the firm's value added, whereas the parameters from a_3 to a_6 respectively focus on the impact of OBMs (a_3 and a_4) and ODMs (a_5 and a_6). The parameters from a_7 to a_{10} serve to assess the role played by internationalization in terms of overseas investment (a_7 and a_8) and export (a_9 and a_{10}). The parameters from a_{11} to a_{15} serve to evaluate the contribution of operation digitalization through internet to value creation. Finally, the influence of the control variables and industry class dummies are captured by the parameters from a_{16} and a_{28}. The last term e represents the error term.

The Model of Eq. (1) is preliminarily estimated by the ordinary least squares method. The White test suggests significant heteroscedasticity in residuals, with a chi-squared value of 58,305. Hence, subsequent analysis substitutes the robust standard errors for standard errors estimated by the ordinary least squares method. Besides, results from parameter estimation of the Model of Eq. (1) are used as foundations for testing the seven core hypotheses summarized from Eqs. on (2) to (8).

H1: Value creation is a U-shaped quadratic function of business life cycle, implying increasing marginal benefit, or $a_1 < 0$ and $a_2 > 0$. (2)

H2: Value creation is a reversed U-shaped quadratic function of brand revenue, implying decreasing marginal benefit, or $a_3 > 0$ and $a_4 < 0$. (3)

H3: Value creation is a reversed U-shaped quadratic function of R&D spending, implying decreasing marginal benefit, or $a_5 > 0$ and $a_6 < 0$. (4)

H4: The impact of brand revenue and R&D spending on value creation is asymmetric, or $a_3 + 2a_4 BR \neq a_5 + 2a_6 RD$. (5)

H5: Value creation is a reversed U-shaped quadratic function of overseas investment, implying decreasing marginal benefit, or $a_7 > 0$ and $a_8 < 0$. (6)

H6: Value creation is a reversed U-shaped quadratic function of export, implying decreasing marginal benefit, or $a_9 < 0$ and $a_{10} < 0$. (7)

H7: The impact of overseas investment and export on value creation is asymmetric, or $a_7 + 2a_8 FI \neq a_9 + 2a_{10} EX$. (8)

4. Empirical Results

4.1. Descriptive statistics

Table 2 summarizes descriptive statistics for the value creation, business life cycle, brand, R&D, internationalization, operation digitalization, and other control variables of management across 104,377 manufacturers in Taiwan in 2011.

For value creation (VA), the mean for the original values is at $39,043 thousand new Taiwan dollars across surveyed manufactures in Taiwan. The gap between the maximum value and the minimum value appears substantial, confirmed by a high level of its standard deviation. A similar pattern is observed in the business life cycle (AGE) ranging from new ventures (1 year) to sustainable operating firms (100 years). The average of AGE is close to 18 years.

The ratios of brand revenue to total revenue (BR), R&D spending to total spending (RD), overseas investment to net fixed asset (FI), and export to total revenue (EX) are respectively 8.8812%, 0.3251%, 0.0511%, and 8.3778%, showing strong bias to OEMs and insufficient internationalization for most manufacturers in Taiwan.

As regards operation digitalization, the ratios of internet purchases to total spending (EC22) and internet sales to total revenue (EC32) are 1.3210% and 1.3337% only, suggesting that purchases and sales through internet remain at its early stage of development in Taiwan's manufacturing industry.

In terms of control variables, the dispersion for the value of net assets (LSIZE) that reflects the firm's operating scale remains significant in logarithm. The capital-to-labor ratio (KLR) measured by net fixed assets over the number of employees is averaged at 1.5335.

Table 2 Descriptive Statistics

Variable	Mean	Maximum	Minimum	Std. Dev.
Panel A: Value Creation				
LVA	8.5416	19.4878	5.0626	1.3276
Panel B: Business Life Cycle				
AGE	17.5632	100	1	0.2784
Panel C: Asymmetric Grin Curve				
BR	8.8812	100	0	25.6504
RD	0.3251	74.5755	0	2253.051
FI	0.0511	224.4135	0	2.0569
EX	8.3778	100	0	80.3330
Panel D: Operation Digitalization				
EC1	0.6122	1	0	1.3542
EC21	0.1136	1	0	227.8531
EC22	1.3209	99.5421	0	22.1068
EC31	0.0847	1	0	1774.022
EC32	1.3337	99.9995	0	0.4872
Panel E: Control Variable				
OPR	0.8308	1	0	0.3173
SIZE	248,994	1.53E+09	169	6.4962
KLR	1.5335	63.8248	0.0016	0.3749
Panel F: Industry Class				
INDA	0.0382	1	0	0.1917
INDB	0.0681	1	0	0.2519
INDC	0.0964	1	0	0.2951
INDD	0.0338	1	0	0.1806
INDE	0.0882	1	0	0.2836
INDF	0.2933	1	0	0.4553
INDG	0.0755	1	0	0.2642
INDH	0.2135	1	0	0.4098
INDI	0.0464	1	0	0.2103
INDJ	0.0466	1	0	0.2107

4.2. Estimation results

Table 3 below summarizes major results from estimation of Equation (1) with adjustment in heteroscedasticity. With additional regression for independent variables, the variance inflation factor (VIF) appears low except for AGE, AGE2, BR, BR2, EX, and EX2 whose VIF exceeds 10. Therefore, there is, overall, no serious problem of collinearity. The adjusted R2 is around 0.6533, substantiating sufficient explanatory power of the model specified. The chi-squared value for the White test is at 58,305, implying significant heteroscedasticity in residuals. Therefore, the t-values reported in Table 3 are adjusted by robust standard errors.

Table 3 Estimation Results

Variable	LVA	t-Value	VIF
Constant	3.2936***	104.3353	NA
AGE	-0.0029***	-3.4095	11.8816
AGE^2	1.01E-0.4***	4.7657	11.7598
BR	0.0041***	6.0753	40.9094
BR^2	-3.08E-05***	-4.0718	39.8211
RD	0.0805***	22.0287	3.8738
RD^2	-0.0016***	-12.6025	3.4283
FI	0.0255***	3.5577	4.3578
FI^2	-1.28E-04***	-3.4249	4.2128
EX	0.0119***	26.6641	13.6124
EX^2	-9.36E-05***	-17.0069	12.4328
EC1	0.0393***	7.5535	1.1698
EC21	0.1310***	10.1139	2.6106
EC22	-4.72E-05	-0.0358	10.4591
$EC22^2$	-3.83E-05*	-1.8291	7.8524
EC31	0.0175	1.1186	2.8294
EC32	-7.47E-04	-0.6356	11.0646
$EC32^2$	8.26E-06	0.5897	7.9876
OPR	-0.0441***	-6.4857	1.0724
KLR	-0.0942***	-16.0990	4.8555
KLR^2	1.72E-04***	5.5128	1.4425
LSIZE	0.5627***	139.6625	5.6422
INDB	0.0771***	4.4743	3.0369
INDC	0.1214***	7.5717	4.5435
INDD	0.1636***	7.5286	1.7445
INDE	0.1141***	6.9995	3.9985
INDF	0.1983***	13.2852	8.7908
INDG	0.1771***	9.7818	2.8244
INDH	0.0903***	5.9271	6.8611
INDI	0.2896***	15.6108	2.5161
INDJ	-0.0217	-1.2003	2.5268
Adjusted R^2	0.6533		
White Test	58,394***		

Note: ***, **, * for significance at the 1%, 5%, 10% level.

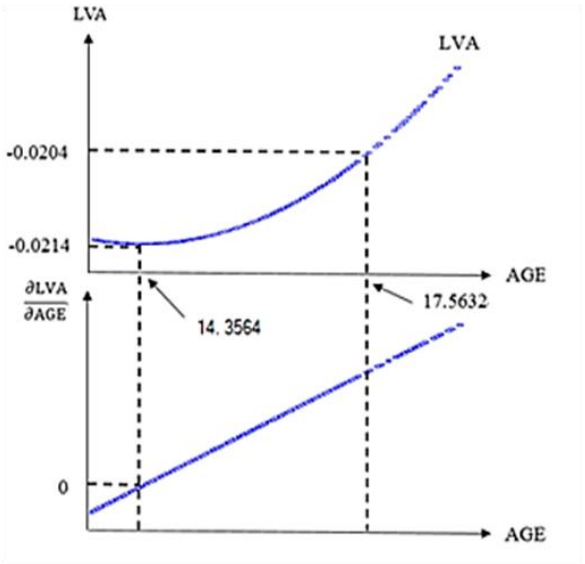

Fig. 4 Marginal impact of business life cycle

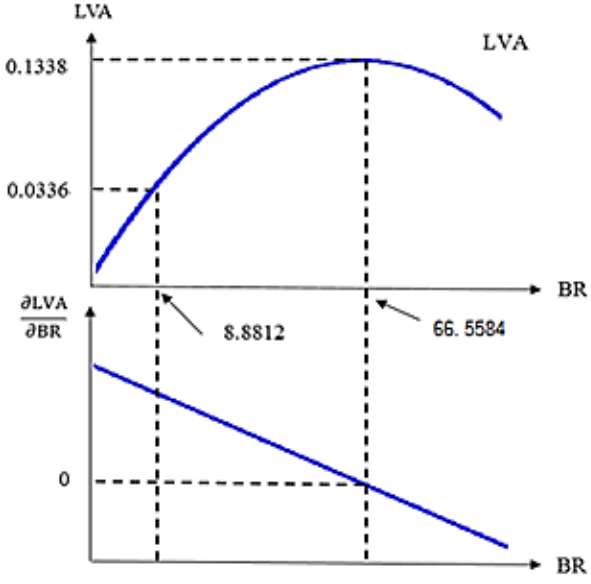

Fig. 5 Marginal impact of brand revenue

Next, the seven hypotheses summarized from (2.1) to (2.7) are each examined. For H1, the estimated coefficient for AGE is significantly lower than zero and that for AGE2 is significantly greater than zero. This confirms that the relation between value creation (LVA) and the business life cycle can be portrayed by a U-shaped curve which decreases first before increasing. This link can be illustrated by Fig. 4.

In Fig. 4, the minimum point of the LVA curve corresponds to around 15 years of the business life cycle. Hence, new ventures have to pay a cost of lower value creation at the early stage of corporate development, supporting H1 (2.1).

For H2, the marginal impact of BR on LVA is observed from a reversed U-shaped curve that rises first before falling, illustrated by Fig. 5. The maximum point of the LVA curve is at 66.5584%, far above the sample mean (8.8812%). Therefore, the role of branding in value creation is captured by a grin curve and there seems great room for improvement in Taiwan's current OBMs, supporting H2 (2.2).

As regards H3, the coefficient for RD is positive whereas that for RD2 is negative. This can be illustrated by Fig. 6, where the relation between R&D spending and value creation is presented by a reversed U-shaped curve. The maximum point of the LVA curve is at 25.1563%, far above the mean for RD (0.3251%). Hence, on the left side of supply chains, the strategies for ODMs are subject to a rising-then-falling grin curve, supporting H3 (2.3). Comparing the marginal impact of brand (Fig. 5) and the marginal impact of R&D (Fig. 6), it is observed that the former impact is smaller than the latter impact. In other words, we observe an asymmetric grin curve whose left-side peak is higher than the right-side peak, supporting H4 (2.4).

With respect to H5, the estimated coefficients for FI and FI2 also supports H5 (2.5), which implies a reversed U-shaped LVA curve illustrated by Fig. 7. The maximum point of this curve corresponds to a ratio of overseas investment to net fixed assets at 99.6094%, far above the industry mean (0.0511%), suggesting current underinvestment overseas by most SMEs in Taiwan's manufacturing industry.

The finding for H6 is analogous to that for H5. As illustrated by Fig. 8, the optimal export ratio is at 63.5684% and also far above the industry mean (8.3788%). Hence, Taiwan's manufacturers which aim to strengthen the value creation need to substantially raise the weight of export in total revenue. Comparing Fig. 7 and Fig. 8, the marginal impact of overseas investment is also higher than that of the export, implying an asymmetric grin curve and substantiating H7 (2.7).

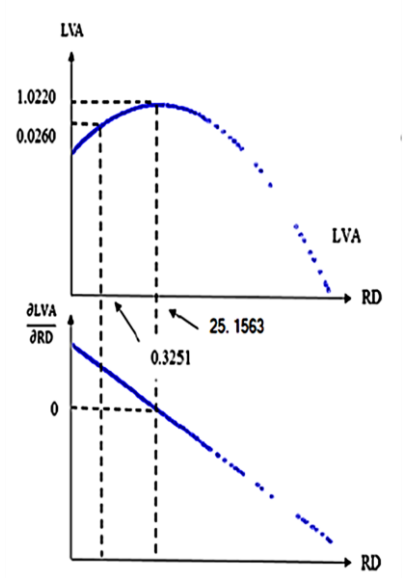

Fig. 6 Marginal impact of R&D spending

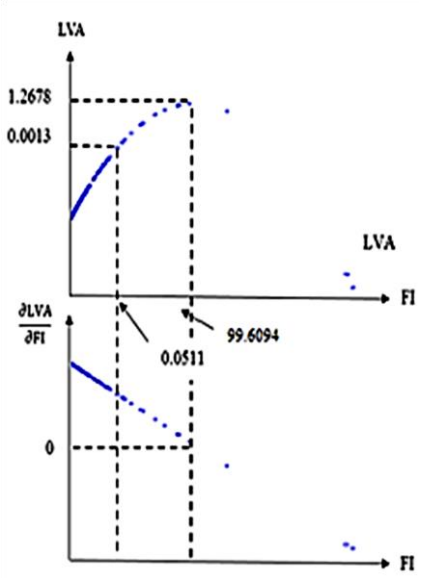

Fig. 7 Marginal impact of overseas investment

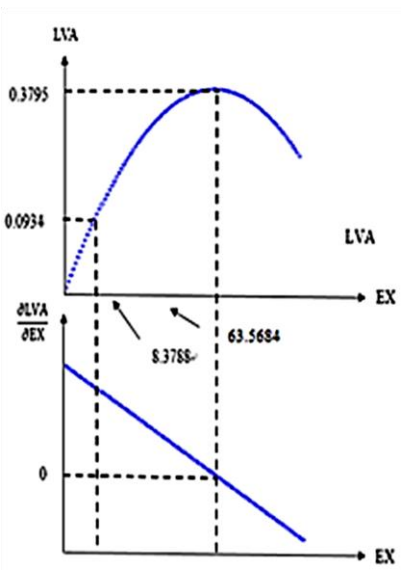

Fig. 8 Marginal impact of export

In terms of operation digitalization, the positive coefficients for the two dummies, EC1 and EC21, suggest that information disclosure and purchases on the internet serve to improve value creation by significant cost cut. However, the coefficients for EC22 significant negative and the coefficient for EC 31 and EC 32 are found insignificant. Therefore, at least at the current stage, internet activities may not effectively contribute to value creation in Taiwan's businesses in the manufacturing sector.

Finally, the empirical findings with respect to control variables can be analyzed from five aspects. First, the coefficient for OPR is significantly negative, implying that whether the firm's main activity involves manufacturing or not cannot effectively increase the level of value creation. Second, the positive sign for the firm's size (LSIZE) confirms that value creation rises with corporate expansion. Third, the capital-to-labor ratio (KLR) exerts a U-shaped impact on value creation. Capital intensity hence plays an important role in the firm's value added. Four, as regards the dummies for the various classes in Taiwan's manufacturing industry, the value added appears higher among INDB～INDI as we adopt Food and Drink (INDA) as the benchmark industry class for comparison.

Fig. 9 integrates previous findings and analysis illustrated by Fig. 5 to Fig. 8 and presents an overall grin curve for Taiwan's manufacturing industry. Figure 9 suggests that the grin curve shifts down as the firm's operating years are less than 15 years. Only as the firm's life cycle exceeds 15 years will value creation be raised.

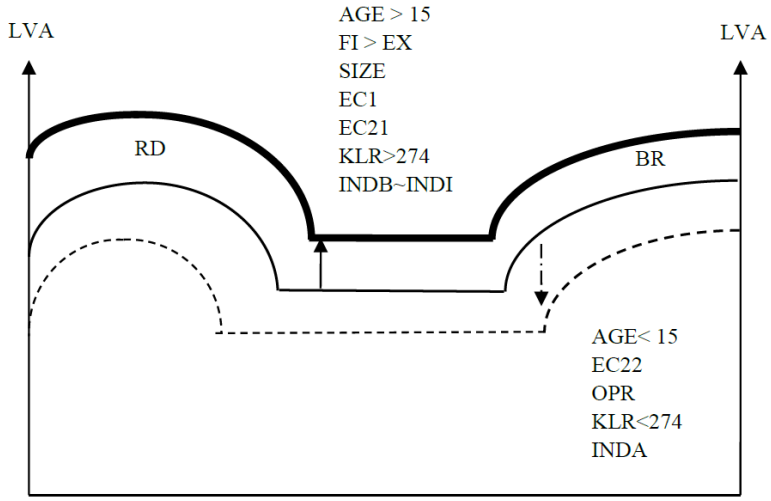

Fig. 9 Asymmetric grin curve

Moreover, the marginal impact of R&D on value creation is higher than that of the brand, leading to an asymmetric grin curve where the left-side peak is higher than the right-side peak. The marginal impact of overseas investment is greater than that of exports, too. Overall, the seven hypotheses stated in (2.1) to (2.7) are in line with Fig. 9, which highlights graphic asymmetry in the grin curve for Taiwan's manufacturers.

4.3. Robustness check

To check the robustness of the previous analysis, we conduct three additional tests. Table 4 summarizes results of testing the differences in means for major variables between new venture and survivors on the basis of two definitions for new ventures: defined by 12 years against definition by 15 years. Overall, all variables except for EC31, EC32, INDF, and INDI exhibit significant differences between new ventures and survivors regardless of the definition for new ventures adopted, substantiating robustness of our analysis framework and results.

Table 5 compares coefficients respectively estimated with linear, quadratic, and cubic forms for selected variables for regression of LVA. The estimation results appear consistent across the three regression models, further confirming the

robustness of our model specification. More specifically, the adjusted R2 remains around a similar level across the three models, implying that the respectively effect of key variables included in Table 3 on value creation (LVA) all holds regardless of the functional form adopted. For variables such as AGE, BR, RD, FI, and EX, the impact on LVA is consistently significant. In contract, the role for dummies such as E31 and E32 keeps absent.

Table 4 Differences in Means between New Ventures and Survivors

	New Venture Defined by 12 Years		**New Venture Defined by 15 Years**	
Variable	**Age≤12**	**Age≥12**	**Age≤15**	**Age≥15**
LVA	8.3191	8.6497	8.3599	8.6698
	(1443.683***)		(1397.573***)	
AGE	6.3419	23.0156	7.7371	24.5002
	(134293.5***)		(175364***)	
BR	7.2344	9.6813	23.6322	26.9382
	(209.4597***)		(233.1375***)	
RD	0.3677	0.3045	0.3831	0.28426
	(21.6962***)		(58.4488***)	
FI	0.0210	0.0657	0.0244	0.0700
	(25.0707***)		(28.7915***)	
EX	6.4475	9.3157	6.7972	9.4936
	(388.1113***)		(378.0316***)	
OPR	0.7816	0.8547	0.7869	0.8619
	(880.1822***)		(1022.868***)	
LSIZE	8.8140	9.3984	8.8743	9.4423
	(2377.543***)		(2477.660***)	
KLR	1.4360	1.5809	1.4419	1.5982
	(32.2502***)		(41.4143***)	
EC1	0.5523	0.6414	0.5705	0.6417
	(773.5952***)		(543.8418***)	
EC21	0.1175	0.1117	0.1191	0.1097
	(7.5348***)		(22.3491***)	
EC22	1.3690	1.2976	1.3943	1.2691
	(2.7802*)		(9.3998***)	
EC31	0.0853	0.0843	0.0864	0.0834
	(0.2861)		(2.8233*)	
EC32	7.6027	7.4995	0.0864	1.3224
	(0.1274)		(0.1645)	
INDA	0.2150	0.1791	0.0459	0.0328
	(148.7985***)		(119.8543***)	
INDB	0.0588	0.0726	0.0609	0.0732
	(68.5690***)		(60.6506***)	
INDC	0.0882	0.1003	0.0898	0.1010
	(38.5585***)		(36.6144***)	
INDD	0.0319	0.0344	0.0305	0.0361
	(5.5848**)		(23.6399***)	
INDE	0.0712	0.0965	0.0725	0.0993
	(183.2514***)		(227.4697***)	
INDF	0.4542	0.4558	0.2954	0.2918
	(1.3431)		(1.5731)	
INDG	0.0942	0.0664	0.0936	0.0627
	(254.5745***)		(347.7844***)	
INDH	0.2275	0.2067	0.2228	0.2070
	(58.7679***)		(37.4631***)	
INDI	0.0465	0.0463	0.0463	0.0465
	(0.0275)		(0.0216)	
INDJ	0.0420	0.0487	0.0423	0.0496
	(23.2437***)		(30.7220***)	
Observations	34,132	70,245	43,194	61,183

Note: ***, **, * for significance of the F-value at the 1%, 5%, 10% level.

Table 5 Robustness Test by Function Form

	Linear	Quadratic	Cubic
Variable	LVA	LVA	LVA
Constant	3.3533*** (53.0204)	3.2936*** (104.3353)	3.1809*** (108.8993)
AGE	0.0014*** (5.0475)	-0.0029*** (-3.4095)	0.0019 (1.3231)
AGE^2	NA	0.0001*** (4.7657)	-0.0001** (-1.9651)
AGE^3	NA	NA	2.48E-06*** (3.0442)
BR	0.0019*** (14.3199)	0.0041*** (6.0753)	2.00E-05 (0.0090)
BR^2	NA	-3.08E-05*** (-4.0718)	5.57E-05 (0.9852)
BR^3	NA	NA	-4.84E-07 (-1.3533)
RD	0.0296*** (10.5057)	0.0805*** (22.0287)	0.1573*** (33.8342)
RD^2	NA	-0.0016*** (-12.6025)	-0.0077*** (-23.9350)
RD^3	NA	NA	7.84E-05*** (18.7086)
FI	0.0081** (2.3060)	0.0255*** (3.5577)	0.0594*** (6.1528)
FI^2	NA	-0.0001*** (-3.4249)	-0.0012*** (-5.3520)
FI^3	NA	NA	4.38E-06*** (5.0506)
EX	0.0052*** (29.7733)	0.0119*** (26.6641)	0.0159*** (13.3506)
EX^2	NA	-9.36E-05*** (-17.0069)	-0.0003*** (-6.9366)
EX^3	NA	NA	1.17E-06*** (4.5717)
EC1	0.0496*** (8.6773)	0.0393*** (7.5535)	0.0306*** (6.0460)
EC21	0.1578*** (13.3077)	0.1310*** (10.1139)	0.1059*** (7.3308)
EC22	-0.0024*** (-3.9812)	-4.72E-05 (-0.0358)	0.0064*** (2.7088)
$EC22^2$	NA	-3.83E-05* (-1.8291)	-0.0003*** (-3.7794)
$EC22^3$	NA	NA	2.29E-06*** (3.5345)
EC31	0.0137 (0.9719)	0.0175 (1.1186)	0.0178 (1.0281)
EC32	0.0005 (0.9216)	-0.0007 (-0.6356)	-0.0003 (-0.1436)
$EC32^2$	NA	8.26E-06 (7.9876)	-1.58E-05 (-0.2124)
$EC32^3$	NA	NA	2.38E-07 (0.4314)
OPR	-0.0362*** (-0.0588)	-0.0441*** (1.0724)	-0.0438*** (-6.5869)
KLR	-0.0497*** (-3.4393)	-0.0942*** (4.8555)	-0.1414*** (-21.8759)
KLR^2	NA	0.0002*** (1.4425)	0.0009*** (6.3332)
KLR^3	NA	NA	-1.13E-06*** (-5.2410)
LSIZE	0.5423*** (52.5408)	0.5627*** (5.6422)	0.5823*** (161.4039)

Table 5 Robustness Test by Function Form (Continued)

	Linear	Quadratic	Cubic
Variable	LVA	LVA	LVA
INDB	0.0965*** (4.9269)	0.0771*** (3.0369)	0.0556*** (3.2904)
INDC	0.1321*** (7.7247)	0.1214*** (4.5435)	0.1075*** (6.8314)
INDD	0.1857*** (8.6562)	0.1636*** (1.7445)	0.1520*** (7.0760)
INDE	0.1360*** (7.6700)	0.1141*** (3.9985)	0.0943*** (5.9018)
INDF	0.2177*** (13.2065)	0.1983*** (8.7908)	0.1779*** (12.1368)
INDG	0.2373*** (11.3780)	0.1771*** (2.8244)	0.1301*** (7.3822)
INDH	0.1175*** (6.9732)	0.0903*** (6.8611)	0.0637*** (4.2661)
INDI	0.3201*** (15.6212)	0.2896*** (2.5161)	0.2529*** (13.9078)
INDJ	-0.0113*** (-0.5899)	-0.0217 (2.5268)	-0.0414** (-2.3481)
Adj. R^2	0.6332	0.6533	0.6696
White Test	90341.73***	58,394***	34,574***

Note: ***, **, * for significance at the 1%, 5%, 10% level.

5. Conclusions

This paper empirically adopts the big data obtained from the 2011 Industry, Commerce, and Service Census conducted by Taiwan's Directorate-General of Budget, Accounting, and Statistics and examines the link between the business life cycle, brand, R&D, internationalization, and value creation for Taiwan's manufacturers. Regression results based on 104,377 observations in the prescreened sample can be recapitulated in seven points.

(1) A relatively low level of the value added, brand revenue, R&D spending, and internationalization suggests that Taiwan's manufacturing industry is currently subject to a business environment dominated by OEMs mainly oriented to the local market.

(2) New ventures whose business life is less than 15 years have to face a low level of value creation. Only beyond 15 years will value creation be strengthened by greater efficiency in operation.

(3) The marginal impact of brand revenue and R&D spending on value creation is captured by a reversed U-shaped curve. The decreasing marginal effect is higher for R&D than for brand revenue.

(4) The marginal impact of the two gauges for internationalization (overseas investment and export) on value creation is captured by a reversed U-shaped curve, too. The decreasing marginal effect is higher for overseas investment than for export.

(5) Operation digitalization remains at a low level for Taiwan's manufacturers and its impact on value creation appears insignificant as of 2011.

(6) The average business life cycle is around 18 years in the sample. Under intensifying competition from globalization and e-business, the business life cycle is anticipated to be further shortened, creating more challenges to Taiwan's manufacturing industry.

(7) Businesses in the manufacturing industry in Taiwan face an asymmetric grin curve rather than a smile curve. Therefore, value creation can be strengthened through enhancement in the business life cycle, internationalization, internet activity, operating scale, and capital intensity.

This study is conditioned on a few limitations, though. The big data obtained from the government census are based on five-year surveys. The problem associated with potentially lagged information appears unavoidable. Besides, discontinuity in our data makes it difficult to analyze the stock value and lagged effect for activities associated with the brand, R&D, and overseas investment. Availability of a more complete dataset will benefit future research, which can also extend analysis to issues such as income distribution and equality under intensified globalization.

Acknowledgement

The authors would like to acknowledge a research grant (MOST 103-2632-H-029-002-MY2) from the Ministry Science and Technology in Taiwan, ROC.

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