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Double spiral trajectory between retail, manufacturing and customers leads a way to service oriented manufacturing

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Abstract

Notwithstanding Japan's ineffective utilization of the potential benefits of the advancement of IT, certain self-propagating interaction between ERP (enterprise resources planning) firms and their customers has been observed. Advanced utilization of ERP enables firms to construct a virtuous cycle between the affluence in the commodities in sales, productivity and profits leading to an active involvement of the consumers, thereby constructing a double spiral trajectory between ERP customers and their customers (consumers).

These noteworthy trends can be observed in certain EEMRs (electric and electronic mega retail firms) which incorporate invaluable advantages as close not only to electric and electronic manufacturing industry but also to consumers.

These firms have constructed a virtuous cycle between the affluence in the commodities in sales, productivity and profit which suggests a double spiral trajectory between EEMRs, manufactures and consumers. This double spiral trajectory prompts us a new concept of manufacturing industry as SOM (service oriented manufacturing) corresponding to a ubiquitous society.

This paper, based on an empirical analysis taking Japan's leading EEMRs, attempts to demonstrate the foregoing hypothesis.

Keywords: IT; ERP; Double spiral trajectory; EEMRs; Service oriented manufacturing

1. Introduction

Japan has been successful in an industrial society by developing and applying its innovative manufacturing technology on broader areas in industry leading to its rapid economic growth in the 1960, 1970, and 1980s. Contrary to such a conspicuous achievement, Japan has not been corresponded to the paradigm shift from an industrial society to an information society which emerged in the 1990s (Kondo and Watanabe, 2003). This can be attributed to the differences of the features formation process between manufacturing technology and IT which incorporates self-propagating function (Watanabe, 2003a,b; Watanabe et al., 2003, 2004; Watanabe and Kondo, 2003).

Consequently, Japan is still behind the level of other advanced countries in terms of developing and applying innovative information technology (IT) resulting in decreasing the Japanese firms' competitiveness (OECD, 2001). This is particularly the case in service industry. In retail industry, the US firms are further advanced than the Japanese firms in terms of IT deployment. One of the exceptions is CVS (convenience store). While CVS system was developed in retail industry in the US, it has evolved in Japan in a different way from the US by adapting itself to Japan's indigenous institutional systems, market requirements and customer behaviors. Unique and advanced approach was taken particularly in IT utilization. Taking Seven-Eleven Japan (SEJ) as an example, it is the largest CVS chain in Japan and originally capitalized by Southland Inc., US. SEJ has applied IT to its store order management system connected to POS (Point of Sales) and series of technologies were integrated successively. From 1982, it first implemented POS system, then, SEJ has continuously improved its management efficiency by IT. Using the accumulating data collected from all stores in its chain, SEJ provides detail demand forecast by item, season, and region. Finally, SEJ has incorporated an ability to deal with top national brand food firms to provide the new product

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corresponding to its customers' requirements, which in turn has accelerated the innovation in food manufacturers (Ogawa et al., 1998).

Stimulated by such an interacting dynamism between retail firms with advanced IT and manufactures, this paper analyzes a possible self-propagating function initiated by IT equipped retail firms. Leading EEMRs (electric and electronic mega retail firms) are focused on the empirical analysis. The reasons why EEMRs are focused are:

(i) Electric and electronics (E&E) manufacturing are the significant contributor to Japan's industrial development in an industrial society,
(ii) EEMRs took the initiative in sales business process of E&E manufacturing industry, and
(iii) Noteworthy business model with conspicuous growth supported by extensive IT application in broad range of firm's business processes and involvement of manufactures can be observed in the top firms of EEMRs (Watanabe and Hobo, 2004a,b))

The shift of the power balance between retailers and manufacturers in supermarket, EEMRs and drug store is compared in Fig. 1. Compared with retailer–manufacturer relationship in other two cases, EEMRs have increased their sales growth than the manufacturers. After the middle of the 1990s, EEMRs took the initiative in the relationship with E&E manufacturers. It is more interactive and constructive. Since EEMRs are enabled to collect information with respect to customers preference which is very critical for manufacturers, they substitute for E&E manufacturers sales process. In addition, since EEMRs' order/procurement processes are simplified by using EDI (Electric Data Interchange) technology, the relationship with manufactures is more collaborative than other two cases.

Contrary to the US's EEMRs standardized business model common to Circuit City, CompUSA, BestBuy, etc. Japan's EEMRs incorporate unique and identical business model as each respective consumers' purchasing behavior, employment conditions, and store location are not necessary homogeneous. Therefore, each respective EEMRs firm evolves unique way and advances in Japan in terms of IT deployment. One of the conspicuous achievement with respect to IT deployment can be observed in Yodabashi Camera, Ltd (hereinafter calls Yodobashi) which is the second largest EEMRs in Japan with respect to sales volume. Similar to SEJ, in line with its business strategy, Yodobashi deploys IT in a comprehensive way, leading to developing its comprehensive supply–demand chain and involvement of manufactures. In addition, Yodobashi has been constructing a new business model with respect to the relationship with its vendors—chiefly Japanese E&E manufactures as SOM (service oriented manufacturing). This means that Yodobashi contributes to the manufacturers' R&D process by providing the customers' preference, trend and behaviors realized indigenously by analyzing its customers purchase data (Mayer and Ausbel, 1999; Dewan and Kraemer, 2000).

In the 1970s, Japanese E&E manufacturing industry achieved tremendous growth worldwide, as the result of successful deployment of industrial technology in Japan.

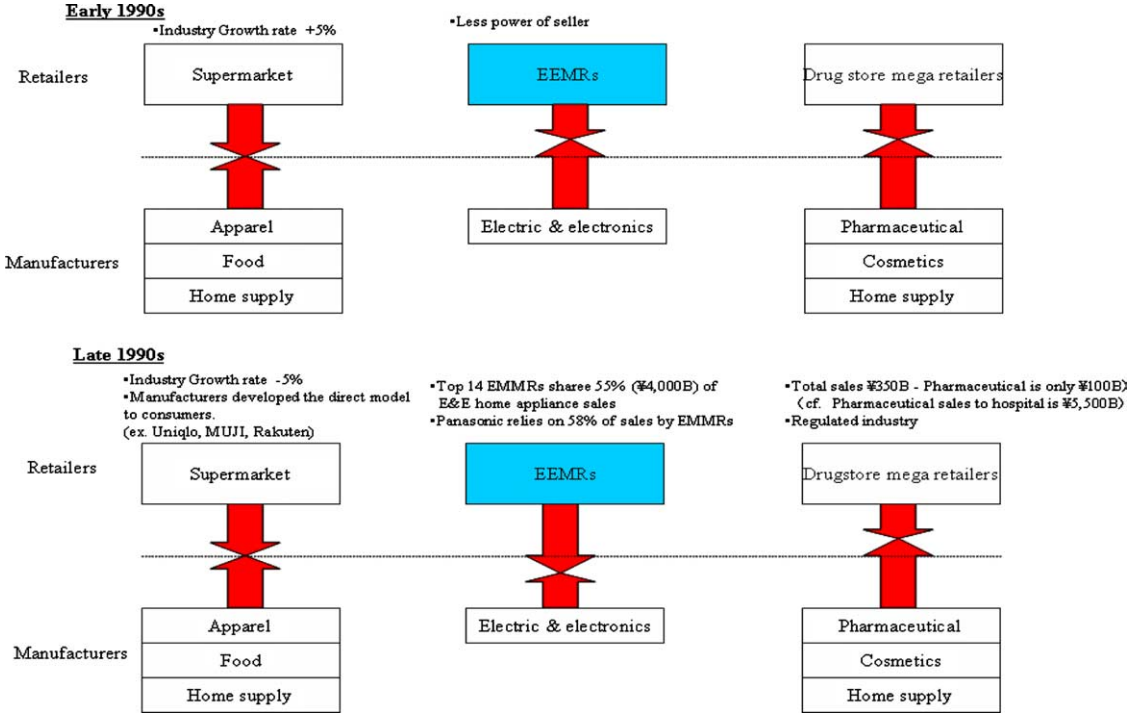

Fig. 1. Relationship between retailers and manufactures in Japan.

In this era, even in the consumer market, manufacturers have taken the leadership. Japanese manufacturers such as Panasonic and Toshiba have invested in building the small franchised dedicated shops, so called 'papa-mama shop' (shop with father and mother) nationwide and achieved the large volume of sales in these years. They believed a myths of manufacturer that "as long as they produce the high quality products, customers purchase them without any fail. " Therefore, they continue producing goods with low cost and high quality without analyzing consumers' demand and needs. Taking Panasonic as an example, Panasonic has been successful in the marketing approach explained above in the 1980s. Using this business model, headquarter has difficulty to capture the actual sales volume and price at the point of sales. As a nature of a manufacturing firm, its sales revenue recognized when it shipped goods to sales firms, resulting in putting less importance to monitor the actual goods sold in the market.

In the 1980s, market demand has been saturated. In domestic market, consumers have well fed. In overseas market, competition has become severe. Sales growth has stagnated and manufacturers suffered from big dead stocks. Facing such a situation, manufacturers were urged to shift from 'product-out' approach to 'market-in' under such a circumstance, EEMRs have gained power and gradually have taken the initiative, since they have acquainted with the customers' behavior much better than manufacturers. Thus, EEMR such as Yodobashi has become a key player in the market. Fig. 2 traces the trend in the sales volume of Japan's EEMRs over the period 1985–2002. Total sales amount by top 200 retailers increased from 1500 billions yen to 4100 billions yen over the 27 years examined in which EEMRs share increased from 3.8% in 1985 to 12% in 2002.

Consequently, EEMRs has currently played the significant role in the E&E consumer equipment market. Main products are PCs, audio and visual equipments such as TVs, videos, DVDs, digital camera. In 1993, 47% of Panasonic's sales revenue was generated by EEMRs channel. Moreover it grows to 58% in 2000. NEC Customax, NEC's sales firm, its 90% of sales revenue was generated by top 40 EEMRs, and two-third is made by top 10.

Prompted by the foregoing observations, the following hypotheses are postulated:

(i) Since the above noteworthy trend can be observed in certain EEMRs which incorporate both advantages as close to E&E manufacturing industry and consumers, EEMRs are considered to have gained advantageous position than manufacturing firms.
(ii) Success of EEMRs depends on the maximum utilization of network externalities, and the affluence in the commodities in sales plays a significant role to this utilization.
(iii) Certain EEMRs have constructed a virtuous cycle between the affluence in the commodities in sales, productivity and profit while other EEMRs have fallen into a vicious cycle between them.
(iv) A virtuous cycle demonstrated by certain EEMRs suggests a double spiral trajectory between EEMRs, manufactures and consumers.
(v) This double spiral trajectory prompts us a new concept of manufacturing industry, as SOM (Service Oriented Manufacturing) corresponding to a ubiquitous society.

Notwithstanding an increasing significance of the active role of IT enabling EEMRs substitute for E&E manufactures and a possible new business model as SOM toward a ubiquitous society, none has analyzed the co-evolutionary dynamism between EEMRs, manufactures and consumers.

This paper, based on an empirical analysis taking Japan's leading EEMRs, attempts to demonstrate the foregoing hypothesis.

Section 2 constructs an analytical framework. Section 3 demonstrates a comparative empirical analysis. Section 4 provides interpretation of the results of the empirical analysis. Section 5 briefly summarizes the key findings of the analysis and presents implications.

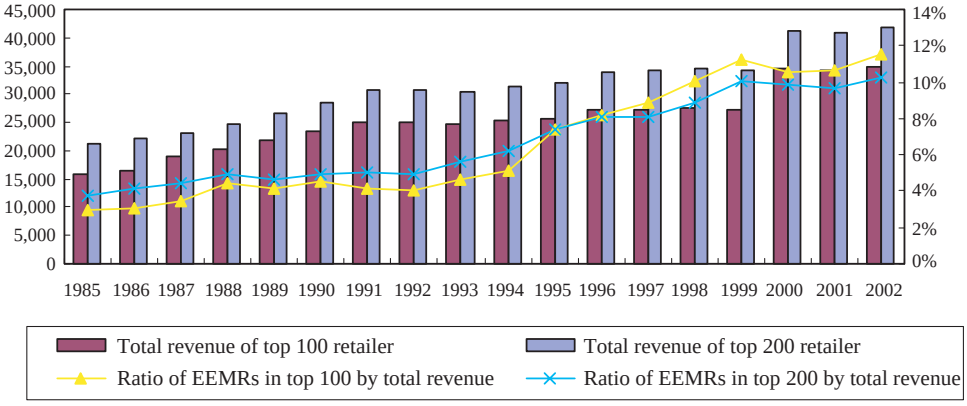

Fig. 2. Trends in sales and share EEMRs in top 200 retailers in Japan (1985–2002: 100 mils yen). Source: Nikkei Ryutsu Shinbun (1986–2003).

2. Analytical framework

2.1. Productivity function incorporating effects of learning and network externalities

It is generally demonstrated that the productivity can be expected by the learning effects depicted by the following equation

$$S/L = Ae^{\lambda t} \tag{1}$$

where S represents sales; L, number of employees; A, scale factor; λ, learning coefficient; and t, time trend.

Furthermore, expansion of the activities represented by the size of S also contributes to productivity increase. In case when network externalities functions, effects of the expansion of the activities provide multiplier impacts as S^n, where n represents multiplier of the network externalities effects.

Therefore, Eq. (1) should be developed as follows

$$S/L = Ae^{\lambda t}e^{aS^n} \tag{2}$$

where a is the coefficient.

Productivity S/L can be decomposed as follows

$$S/L = (S/L)_0 + S/L(t,S) \equiv y_0 + y \tag{3}$$

where $(S/L)_0$ is the initial level of productivity; and $S/L(t,S)$, productivity subject to the effects of learning and network externality.

Substituting Eq. (3) on the left-hand side of Eq. (2) and taking logarithm, the following equation can be obtained:

$$\ln(y_0 + y) = \ln A + \lambda t + aS^n \tag{4}$$

When $y_0 \gg y$, the left-hand side of Eq. (4) can be approximated as follows:

$$\ln y_0\left(1 + \frac{y}{y_0}\right) \approx \ln y_0 + y/y_0 \tag{5}$$

Combining Eq. (5) with Eq. (4), y can be developed as follows

$$y = y_0 \ln A/y_0 + y_0\lambda t + y_0 aS^n \equiv A' + \lambda' t + a'S^n \tag{6}$$

where y is the productivity subject to effects of learning and network externality; A', scale factor; and λ', a', coefficients.

Therefore, productivity of the firms can be analyzed by a function incorporating effects of learning (λ) and network externalities (S^n). Given the significant effect of productivity on firms' profit, productivity can also be depicted by the similar function.

2.2. Virtuous cycle between number of the commodities in sales, productivity and profit

It is generally postulated that the profit of the firm Z is governed by its productivity (y). In addition, it is also subject to the effective utilization of the network externalities which are subject to the affluence in the commodities in sales (w).

Therefore, profit of the firm can be depicted by the following function:

$$Z = f(y, w) \tag{7}$$

In line with the previous approaches (Chrinstensen et al., 1973), Eq. (7) is brought near $\ln y = \ln w = 0$, and when Taylor expansion is made to the secondary term in connection with $\ln y$ and $\ln w$, the following formula can be obtained:

$$\ln Z = a + b \ln y + c \ln w + d \ln y \cdot \ln w \tag{8}$$

where a, b, c, and d are coefficients.

It is also postulated that the affluence in the commodities in sales are influenced by the productivity and the state of the affluence in the commodities in sales in the preceding period. Therefore, the affluence in the commodities in sales

Table 1
Japan's leading EEMRs in 2002

Firm name	Abbreviation		Sales (¥ billions)	IBIT (¥ billions)	Employee (thousands)
1. Yamada Denki Co., Ltd	Yamada	(YMD)	753	22.33	4.70
2. Yodobashi Camera., Ltd	Yodobashi	(YDB)	516	30.13	1.40
3. Kojima Co., Ltd	Kojima	(KJM)	503	2.17	6.80
4. BICCAMERA Co., Ltd	Bic	(BIC)	387	8.70	1.60
5. Best Denki Co., Ltd	Best	(BST)	355	4.37	4.00
6. DEODEO Corporation	DEODEO	(DDO)	238	6.45	2.60
7. Joshin Denki Co., Ltd	Joshin	(JSN)	224	0.57	2.25
8. Midori Denka Co., Ltd	Midori	(MDR)	221	6.59	1.90
9. EIDEN Co., Ltd	Eiden	(EID)	199	1.71	1.70
10. GIGAS K's Denki Co., Ltd	K's	(GKS)	195	5.28	1.70[a]
11. Laox Co., Ltd	Laox	(LAX)	168	−1.66	1.80
12. Sofmap Co., Ltd	Sofmap	(SFM)	121	−0.21	1.50[a]
13. Matsuya Denki Co., Ltd	Matsuya	(MTY)	107	1.06	1.10[a]
14. WAKODENKI Co., Ltd	Wakou	(WAK)	107	1.00	1.10

[a] Estimated by comparing sales with compatible firms.

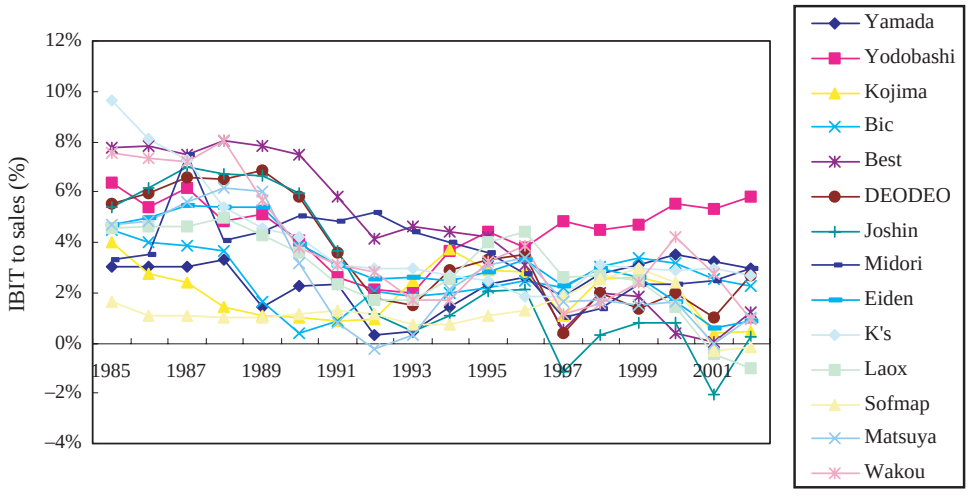

Fig. 3. Trends in income before income tax (IBIT) to sales in Japan's 14 EEMRs (1982–2002).

at time t (w_t) can be depicted by the following equation:

$$w_t = g(y, w_{t-1}) \tag{9}$$

From Eq. (8), elasticity of productivity to profit ($\varepsilon_{y,z}$) can be developed as follows:

$$\varepsilon_{y,z} = \frac{\partial \ln Z}{\partial \ln y} = b + d \ln w + (c + d \ln y)\frac{\partial \ln w}{\partial \ln y} \tag{10}$$

Furthermore, by combining Eq. (9), elasticity of the effluence in the commodities in sales to elasticity of productivity to profit ($\varepsilon_{w,\varepsilon_{y,z}}$) can be developed as follows:

$$\varepsilon_{w,\varepsilon_{y,z}} = \frac{\partial(\partial \ln Z/\partial \ln y)}{\partial \ln w} \tag{11}$$

From Eqs. (10) and (11), it is shown that a possibility of a virtuous cycle or a vicious cycle exists between the affluence in the commodities in sales, productivity and profit.

3. Empirical analysis

3.1. Structural change in Japan's industrial institutions

Facing a paradigm change from an industrial society to an information society, Japan's industrial institutions have been experiencing a structural change toward a 'service oriented manufacturing.' This can be typically observed in Japan's leading EEMRs.

Table 1 summarizes current state of Japan's leading EEMRs by order of sales volume in 2002.

14 EEMRs share 55% of whole sales in Japan's electric and electronic retail firms.

Fig. 3 demonstrates the trend in IBIT (income before income tax) to sales in 14 EEMRs over the period 1982–2002.

Looking at Fig. 3 we note that IBIT to sales of Japan's leading EEMRs stagnated during the period from the middle of the 1980s to the bubble economy

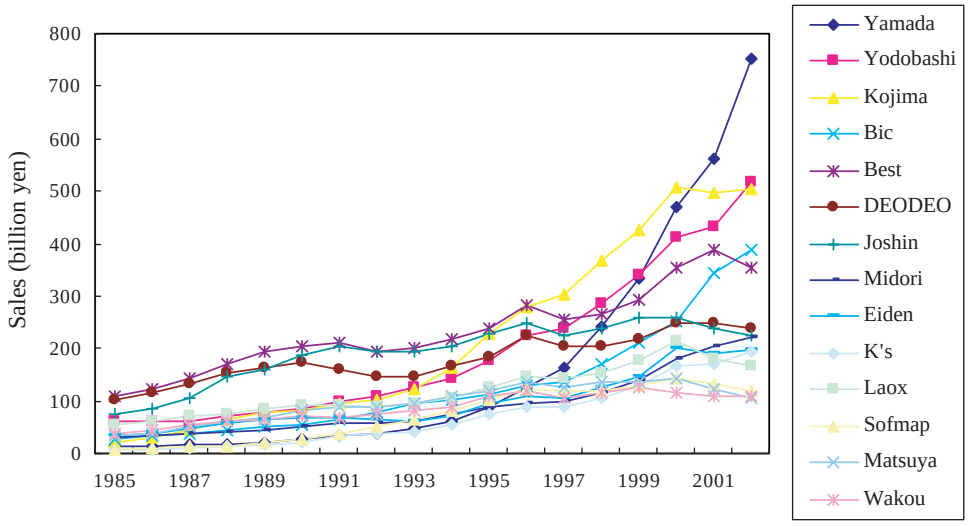

Fig. 4. Trends in sales in Japan's 14 EEMRs (1982–2002).

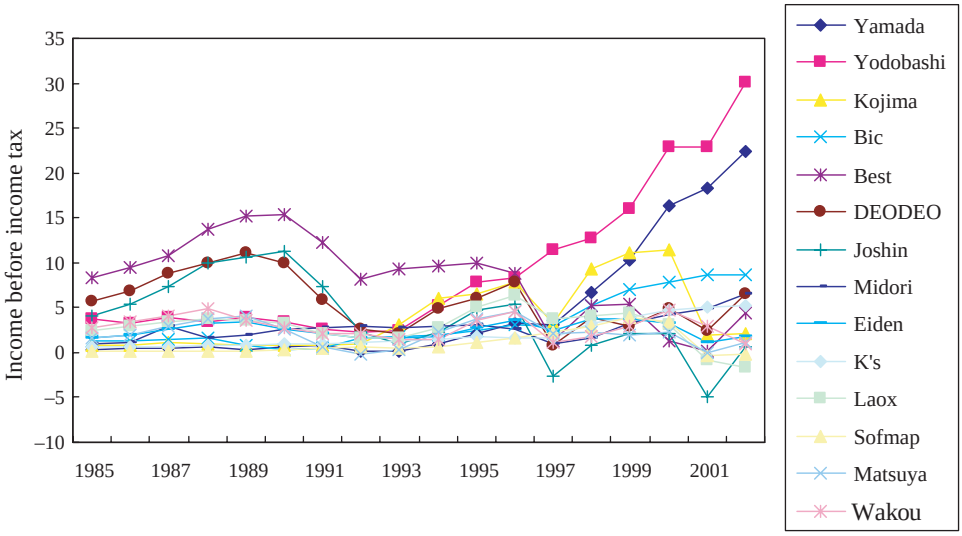

Fig. 5. Trends in income before income tax (IBIT) in Japan's 14 EEMRs (1982–2002).

(1987–1990), changed to decrease after the bursting of the bubble economy in 1991 and continued to decrease over the period of the 'lost decade' in the 1990s. Contrary to such a trend, Yodobashi displayed a noteworthy trend as it changed to increasing trend from the middle of the 1990s. Figs. 4 and 5 demonstrate the trends in sales and IBIT in 14 EEMRs over the period 1982–2002.

Comparing Figs. 4 and 5 we note that while Yodobashi has been increasing its sales, it still remains in the second position with respect to its sales ranking. Conspicuous is its IBIT as, contrary to its sales, it demonstrated the first position from the middle of the 1990s and has been maintaining this position.

Fig. 6 compares sales and operating income between Yamada, Yodobashi and Bic in 2003. Fig. 6 demonstrates Yodobashi's high level of operating income while its sales remain the second after Yamada.

Fig. 7 demonstrates the trend in number of employees in 11 EEMRs[1] out of 14 over the period 1982–2002.

Fig. 6 demonstrates that the level of number of employees in Yodobashi is extremely low than expected which leads to its conspicuously high level of productivity as demonstrated in Fig. 8.

Fig. 8 demonstrates that Yodobashi achieved high level of productivity from its initial activity, maintained and further increased from the late 1990s.

Table 2 summarizes the IT dependency between Yamada and Yodobashi.

Noteworthy findings obtained from the comparison in Table 2 are as follows:

(i) Yodobashi activity introduced IT facilities in its initial stage of its business starting and highly depends on IT.
(ii) This strategy leads Yodobashi cumulative learning on IT prior to its introduction of ERP in 1996 including POS from 1985, EDI from 1986 and member card system from 1990.
(iii) Such high dependency and cumulative learning on IT results in Yodobashi's conspicuously high level of productivity as well as the affluence in the commodities in sales (Watanabe and Hobo, 2004a,b).

Based on the foregoing observations, Fig. 9 analyzes the trend in the correlation between sales and IBIT in 14 EEMRs.

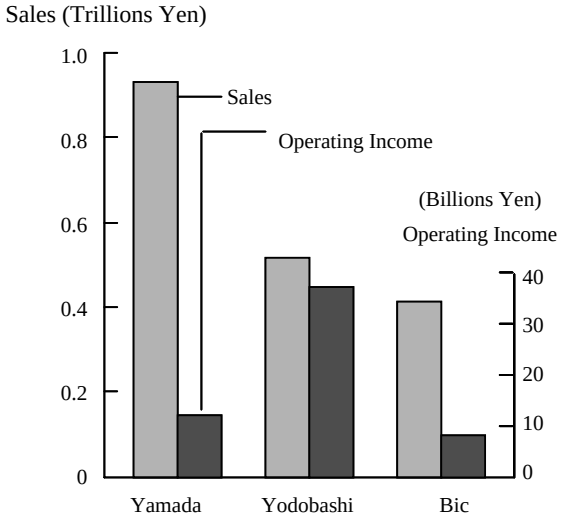

Fig. 6. Comparison of sales and operating income between Yamada, Yodobashi and Bic in 2003. Source: Nihon Keizai Shinbun (2005).

[1] K's, Sofmap and Wakou are excluded from 14 EEMRs as their successive data on the number of employees in the 1980 s are unavailable.

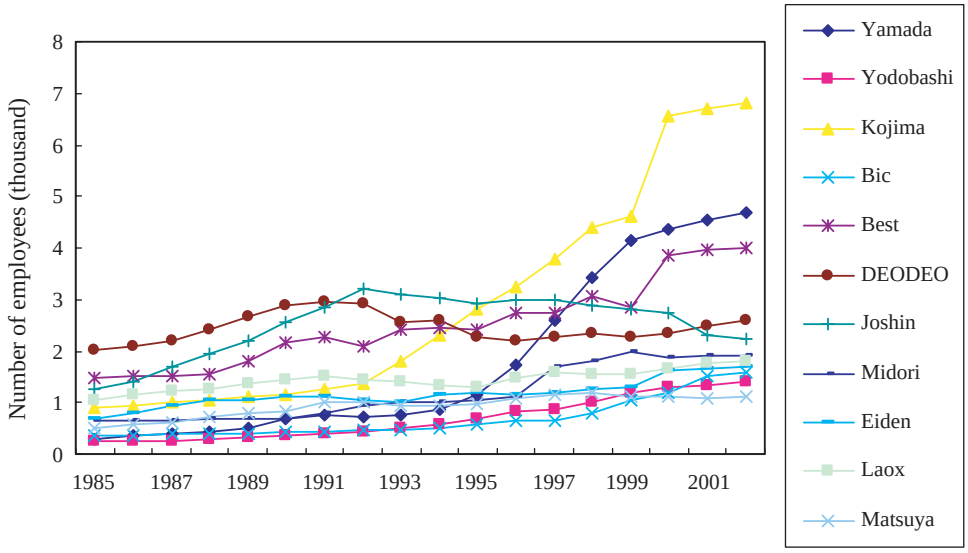

Fig. 7. Trends in number of employees in Japan's 11 EEMRs (1982–2002).

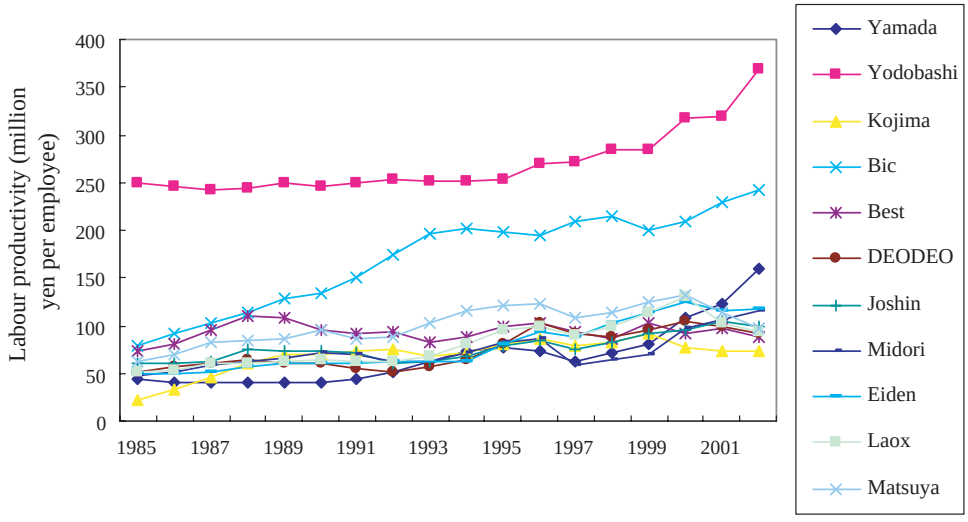

Fig. 8. Trends in labor productivity in Japan's 11 EEMRs (1982–2002).

Looking at the trend we note that the elasticity of sales to IBIT in 14 EEMRs has been decreasing as 1.42 in 1985–1990, 1.21 in 1991–1996 and 1.01 in 1997–2002. However, contrary to such a decreasing trend, Yodobashi increased its elasticity and gained a conspicuously high level position in 1997–2002. Such a conspicuously high level of the elasticity of sales to IBIT can be attributed its affluence in the commodities in sales.

Fig. 10 demonstrates the correlation between number of the commodities in sales and IBIT in 11 EEMRs.[2] Number of the commodities (N) are computed by means of the numbers of the major commodities demonstrated in the latest website of respective firms as they are considered to represent the affluence in the commodities in sales of respective firms in 2002.[3]

Looking at Fig. 10 we note that Yodobashi's high level IBIT can be attributed to its high level of the affluence in the commodities in sales.

[2] Considering its business structure change, IBIT of Joshin is 1998–2002 average.

[3] NEBA (Nippon Electric Big-stores Association) is the association consisting of Japan's 34 EEMRs which share one third of the nation's electric and electronics retail firms' sales. NEBA publishes monthly sales data encompassing five major commodities (TVs, PCs, air-conditioners, refrigerators and laundries) as proxies of the sales trend in the Association's business field. Sales of these five commodities share 35% of the whole sales in the business consistently. Thus, these commodities can be treated as a proxy of the affluences in the commodities in sales of the firms examined.

Table 2
Comparison of IT dependency between Yamada and Yodobashi (2002)

	Yamada	Yodobashi
Sales (¥ bil.)	753	516
IBIT (¥ bil.)	22	30
IBIT per sales (%)	2.9	5.8
Employee (thousand)	4.7	1.4
Number of stores	109	20
Sales/employee (¥ million)	160.2	386.6
Sales/store (¥ million)	3050	17,050
IBIT/employee (¥ million)	4.7	21.4
IBIT/store (¥ million)	90	800
Number of commodities in sales (thousand)	30	500[a]
(with SCM) (thousand)	(0.1)	(450)
Inventory turn over ratio (times p.a.)	11	30
POS (point of sales)	1986 and again1997	1985
EDI (electric data inter-change)	–	1986
Member card	2001	1990
Number of card member (million)	1	14
ERP	(199 system improvement)	1996
SCM	2003	1999

Sources: Nikkei Ryutsu Shinbun (2001–2003), Reports by Yodobashi (2003).
[a] 400 in 1997–99, 250 in 1992–93 (Yodobashi) and estimated 30–50 in 1985.

3.2. Factors contributing to the increase in productivity

Factors governing productivity of Japan's leading electric and electronic mega retail firms (EEMRs) can be depicted by the following equation representing effects of learning and network externality

$$aS/L = a_1 + b_1 D_x S^n + \lambda_1 t + c_1 D_y \quad (12)$$

where S represents sales; L, number of employees; D_x, coefficient dummy valuable; t, time trend; D_y, dummy valuable for constant term; a_1, b_1, c_1, and λ, coefficients; and n, multiplier of the network externality.

Table 3 summarizes the result of the regression analysis in top five EEMRs with respect to sales over the period 1982–2002.

Multiplier of the network externality was identified by means of a heuristic approach depending on the best AIC (Akaike information criteria). In case of Yodobashi as an example can be compared as follows

	b_1	λ_1	Adj. R^2	DW	AIC
$n=2.6$	9.43×10^{-6} (19.64)	0.83 (2.84)	0.987	2.38	54.57
$n=2.7$	5.17×10^{-6} (29.53)	0.81 (4.16)	0.994	1.76	41.00
$n=2.8$	2.68×10^{-6} (19.68)	1.02 (3.61)	0.987	2.30	54.50

Looking at Table 3 we note that Yamada, Yodobashi and Bic achieve high productivity based on effects of learning and network externalities. Multiplier of the network externality in Yodobashi starting from 1996 corresponding to the introduction of ERP in 1996 is conspicuous while its dependency on learning effect is the lowest among five firms examined.

Contrary to Yamada, Yodobashi and Bic, other two firms solely depend on learning effect rather on network externalities.

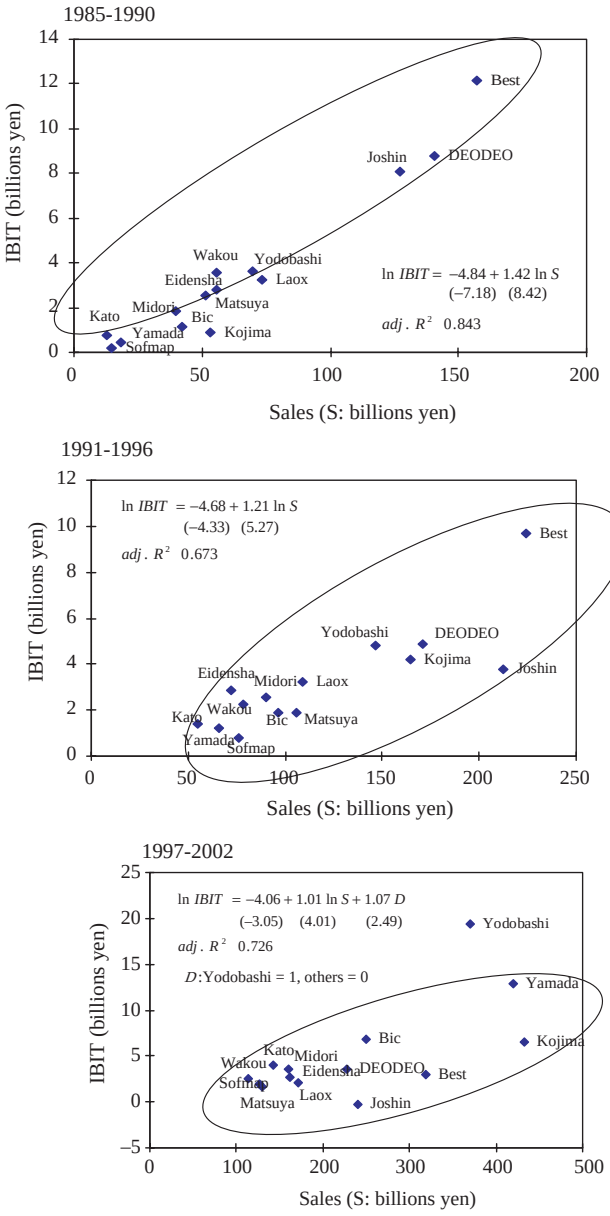

Fig. 9. correlation between sales and income before income tax (IBIT) to sales in Japan's 14 EEMRs.

3.3. Factors contributing to the increase in IBIT (income before income tax)

Similar to Eq. (12), factors governing IBIT of Japan's leading EEMRs can be depicted by the following equation:

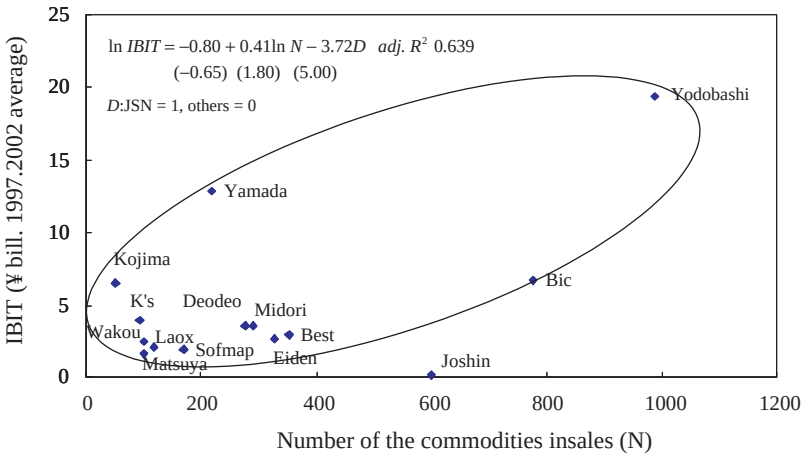

Fig. 10. Correlation between number of the commodities in sales and income before income tax (IBIT) in Japan's 14 EEMRs.

$$\text{IBIT} = a_2 + b_2 D_x S^n + \lambda_2 t + c_2 D_y \quad (13)$$

where a_2, b_2, c_2 and λ_2 are coefficients.

Table 4 summarizes the result of the regression analysis in top five EEMRs over the period 1982–2002.

Looking at Table 4 we note that, in addition to Yamada and Yodobashi, Bic also depends on network externalities for its IBIT increase while dependency on learning effects in these firms is statistically insignificant. Conspicuous is Yodobashi's high dependency on network

Table 3
Governing factors to productivity in Japan's top 5 EEMRs (1982–2002)

	b_1	λ_1		c_1	n	D_x	D_y	Adj. R^2	DW
Yamada	9.83×10^{-6} (13.37)	3.00 (9.50)		13.70 (3.98)	2.4	902 = 1[a]	85,94,95 = 1	0.977	1.72
Yodobashi	5.17×10^{-6} (29.53)	0.81 (4.16)		−6.74 (−4.34)	2.7	96–02 = 1[b]	87–99, 01 = 1	0.994	1.76
Kojima		2.92 (11.45)		−22.62 (−7.64)			85,86, 00–02 = 1	0.906	1.58
Bic	1.23×10^{-5} (1.33)	11.05 (9.90)		67.43 (3.41)	2.5	99–02 = 1	99–02 = 1	0.887	1.71
Best		1.25[c] (2.46) 19890	1.24[d] (2.73) 1991–02	−15.48 (−5.36)			85,86,93 98,00,02 = 1	0.641	2.22

[a] Correspond to the period after the system improvement (see Table 2).
[b] Correspond to the period after the introduction of ERP (see Table 2).
[c] Before the bursting of the bubble economy in 1991.
[d] After the bursting of the bubble economy in 1991.

Table 4
Governing factors to IBIT in Japan's top 5 EEMRs (1982–2002)

	b_2	λ_2		c_2	n[a]	D_x	D_y	Adj. R^2	DW
Yamada	1.54×10^{-2} (15.86)	1.58×10^{-2} (0.19)[b]			1.1	902 = 1[c]		0.978	1.40
Yodobashi	1.87×10^{-4} (19.53)	5.37×10^{-2} (0.68)[b]			1.9	96–02 = 1[c]		0.988	1.93
Kojima		6.83×10^{-1} (7.13)		−6.28 (−5.25)			92,97,01, 02 = 1	0.759	1.58
Bic	1.10×10^{-3} (8.62)	2.88×10^{-1} (8.81)		1.57 (6.19)	1.4	99–02 = 1	887, 98–00 = 1	0.971	1.94
Best		-4.80×10^{-1}[d] (−2.35) 19890	-4.82×10^{-1}[e] (−4.28) 1991–02	−589 (−7.99)			887, 00,01 = 1	0.905	1.68

[a] See footnote 15 in Tables 5–3.
[b] Indicates statistically insignificant.
[c] See footnote in Table 3.
[d] Before the bursting of the bubble economy in 1991.
[e] After the bursting of the bubble economy in 1991.

externalities immediately after the introduction of ERP in 1996.

Contrary to these three firms, Kojima and Best solely depend on learning effect.

3.4. Contribution of productivity increase to IBIT increase

In order to identify the contribution of productivity increase to IBIT increase, the following correlation analysis is conducted taking coefficient dummy variables representing the effect of the introduction of supply chain management (SCM) system including ERP:

$$\ln \text{IBIT} = a_3 + b_{31} \ln S/L + b_{32} D_x \ln S/L + c_3 D_y \quad (14)$$

Looking at Table 5 we note that elasticity of productivity to IBIT (b_{31} and $b_{31}+b_{32}$) in Yodobashi demonstrates extremely high level. Yodobashi's high level of elasticity has been maintained before its introduction of ERP in 1996.

This suggests that Yodobashi's conspicuously high level of elasticity can be attributed to the double spiral between its cumulative efforts and the effect of the introduction of ERP in 1996 as demonstrated in Table 6. This resembles the double spiral in the dramatic dissemination of i-mode (NTT DoCoMo's mobile Internet access service) based on cumulative learning exercise by means of message exchange, PHS and cellular phone without Internet access service (Kondo et al., 2005).

Fig. 11 demonstrates Yodobashi's IT deployment and its effects on its business processes. It demonstrates that ERP and SCM[4] deployment especially encouraged Yodobashi's business activities. It is clear that in 2002, after ERP and SCM were deployed in Yodobashi, outcomes from IT deployment effect to business benefits (Hobo and Watanabe, 2003). In 1995, Yodobashi already deployed POS system and combined the sales data gathered by POS with member card information, they were enabled to trace the buying behavior of individual customers. However, Yodobashi could not use this information to supply chain. After 1997, when SCM was deployed, sales forecast based on customers buying behavior is used as the input of sales planning and Yodobashi and manufacturers exchange this sales planning and manufacturers' production planning.

In addition, Yodobashi places the final one week order, four weeks in advance and guaranteed. This enabled Yodobashi to get commitment from manufacturing firms to deliver the products with promised amount and delivery dates. By these activities Yodobashi has gained the stronger power in retailer- manufacturer relationship.

3.5. Factors governing the elasticity of productivity to IBIT

As demonstrated in the preceding section, Yodobashi's unique strategy can be characterized by its affluence in the commodities in sales, Fig. 12 compares number of the commodities in sales in Japan's 14 EMMRs[5] in April 2004.

Fig. 12 demonstrates the conspicuous affluence in Yodobashi's commodities in sales. Combining Yodobashi's conspicuously high level of elasticity of productivity to IBIT as demonstrated in Table 5 and this conspicuous affluence in the commodities in sales, it is postulated that there exists a certain virtuous cycle between the affluence in the commodities in sales, productivity and IBIT.

3.6. Virtuous cycle between number of the commodities in sales, productivity and IBIT

3.6.1. IBIT function and elasticity of productivity to IBIT

Prompted by this postulate, demonstration of this virtuous cycle is attempted. IBIT is considered to be governed by productivity and the affluence in the commodities in sales and depicted by the following function

$$\text{IBIT} = F(S/L, N) \quad (15)$$

where N is the number of the commodities in sales.

Taylor expansion to the second term obtains the following equation

$$\ln \text{IBIT} = a_4 + b_4 \ln S/L + c_4 \ln N + d_4 \ln S/L \cdot \ln N \quad (16)$$

where a_4, b_4, c_4, d_4 are coefficients.

Table 7 summarizes the result of the regression analysis taking Japan's 14 EEMRs in 1997–2002.

Table 7 indicates statistically significant and demonstrates the significance of Eq. (16) in depicting the governing structure of IBIT by means of S/L and N.

Partial differentiation of Eq. (16) by $\ln S/L$ leads to the elasticity of productivity to IBIT as follows:

[4] Yodobashi starts a new system which transfers information on over-the-counter sales or accounting information online and in real time. Realizes an ordering system with the prospect of component procurement by a manufacturer and cycle of production process. Since Yodobashi intends to change the inventory turnover ratio per month from current 2 to 3, it endeavors to eliminate the loss of a chance due to stock-out and to minimize any useless stock. While information system for the purpose of improvement of accuracy of in-house single-item control is promoted in several EMMRs, Yodobashi is the first company that discloses its sales situation information fully to the manufacturers in real time. Target of the new system focuses on 80 companies among approximately 700 business partners. The products of those 80 companies make up approximately 90% of all the items handled by Yodobashi in the purchased amount. When a product has passed through a cash register, sales information is sent to Yodobashi's host computer and every business partner can always check the sales of its own products. Also, Yodobashi shows the status of inventory in every store to business partners. Accounting information including accounts payable and payment can be exchanged real-time. Ordering a single item from Yodobashi's distribution center, each store has been improved according to the production process of manufacture. First, information such as the details of component procurement obtained in advance from a manufacturer and the production cycle of factory is input to grasp the date of product delivery and the quantity of product. Then, check the shortest delivery and make an order of products which each store requires (June 15, 1999, The Nikkei Ryutsu Shinbun).

[5] Matsuya and Wakou are estimated based on sales and IBIT trends.

Table 5
Correlation between productivity and IBIT in Japan's top 5 EEMRs (1982–2002)

	Before firm-wide IT deployment b_{31}	After firm-wide IT deployment $b_{31}+b_{32}$	c_3	D_x	D_y	Adj. R^2	DW
Yamada	0.65 (2.19)	1.25 (10.71)	−1.25 (−8.03)	902 = 1[a]	92,93, 997 = 1	0.970	2.63
Yodobashi	1.57 (4.04)	1.78 (13.90)	0.54 (6.14)	96–02 = 1[a]		0.962	1.98
Kojima	1.06 (2.79)	1.33 (4.55)	−1.05 (−4.39)	902 = 1	87,94, 99–02 = 1	0.820	2.04
Bic	1.33 (3.26)	1.63 (5.04)	0.92 (3.33)	99–02 = 1	887, 96–98 = 1	0.746	1.53
Best	1.10[b] (2.20) 19890	0.94[c] (0.60)[d] 1991–2002	−4.11 (−5.85)	890 = 1	01 = 1	0.713	1.58

[a] Before the bursting of the bubble economy in 1991.
[b] After the bursting of the bubble economy in 1991.
[c] Indicates statistically insignificant.
[d] See footnote in Table 3.

Table 6
Comparison of the introduction of supply chain management (SCM) system in Japan's top 5 EEMRs

	POS	POS + member card	EDI	ERP	SCM	E-commerce
Yamada	1986 and 1997	2001	N/A	None	2003	2001
Yodobashi	1985	1990	1986	1996	1999	1998
Kojima	1990	2003	N/A	None	2003	2001
Bic	1986	1993	N/A	None	2002	1998
Best	1986	N/A	N/A	None	N/A	2001

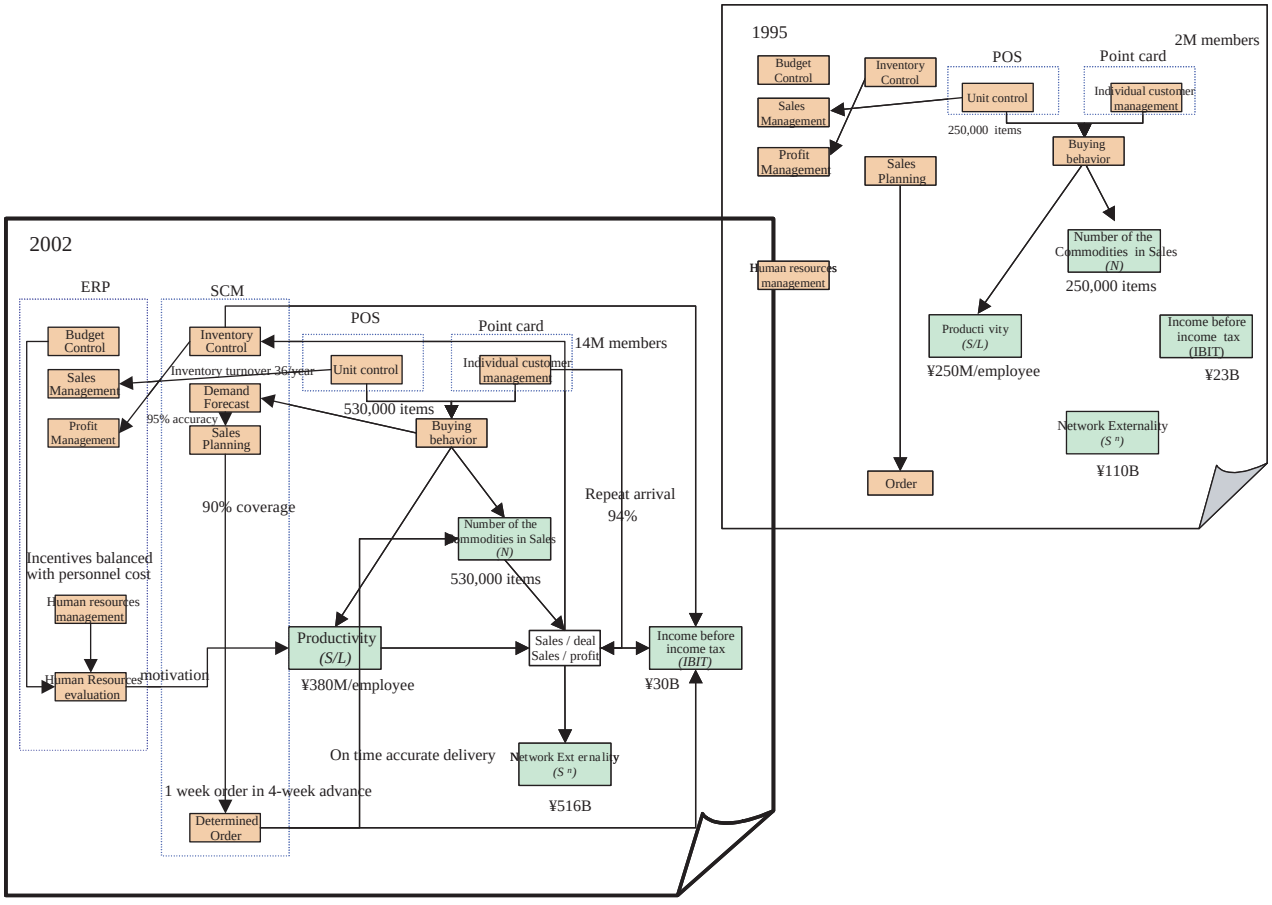

Fig. 11. Yodobashi's IT deployment and its business advancement (1995 vs. 2002).

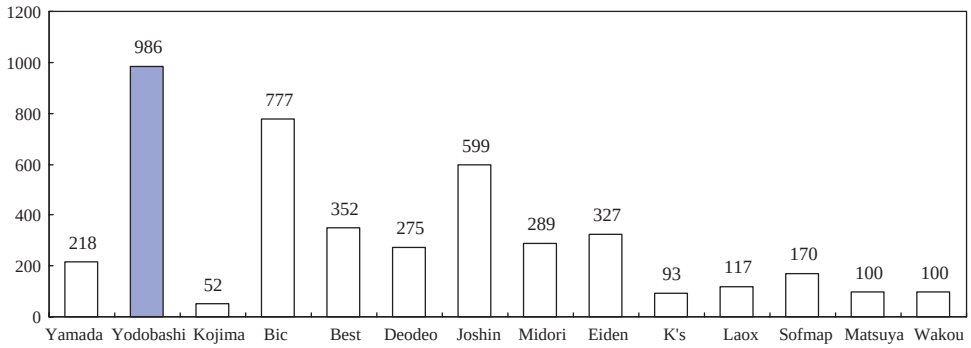

Fig. 12. Number of the commodities in sales in Japan's 14 EEMRs (April 2004). Estimates based on IBIT trends.

Table 7
Governing factors of IBIT in Japan's 14 EEMRs (1997–2002[a])

$\ln \text{IBIT} = 40.87_{(1.97)**} - 8.66 \ln S_{(-1.94)**}/L - 6.70_{(-2.10)*} \ln N + 1.46_{(2.15)*} \ln S/L \cdot \ln N - 3.07_{(-4.39)} D$	Adj. R^2 0.751
where D: dummy variables (JSN = 1, other firms = 0)	

Due to changes in business structure relevant to number of the commodities in sales, IBIT in LAX and SFM are reconstructed by examining relevant data. In addition, L in GKS and SFM are estimated by comparing their sales with compatible firms. *Significant at the 5% level, **significant at the 10% level.
[a] Number of the commodities in sales is represented by that of April 2004.

Table 8
Governing factors of the affluence in the commodities in sales in Japan's 12 EEMRs (2002)

$\ln N = 0.173_{(0.796)} + 0.960_{(2.88.03)} \ln N_{t-1} - 0.0451_{(-9.21)} \ln S/L + 0.007 \ln N_{t-1(-10.76)} \cdot \ln S/L_{(-5.22)} + 0.003D$	Adj. R^2 0.995

D: dummy variables (JSN = 1, other firms = 0).

$$\frac{\partial \ln \text{IBIT}}{\partial \ln S/L} = b_4 + d_4 \ln N + (c_4 + d_4 \ln S/L)\frac{\partial \ln N}{\partial \ln S/L} \quad (17)$$

3.6.2. Function depicting numbers of the commodities in sales

It is generally postulated that the affluence in the commodities in sales are influenced by the productivity and, given the foregoing virtuous cycle, state of the affluence in the commodities in sales in the preceding period. Therefore, N can be depicted by the following equation:

$$N_t = G(N_{t-1}, S/L_t) \quad (18)$$

where N_t and S/L_t: N and S/L at time t; and N_{t-1}: N at the preceding period.

Taylor expansion to the second term obtains the following equation:

$$\ln N_t = a_5 + b_5 \ln N_{t-m} + c_5 \ln S/L_t + d_5 \ln N_{t-m} \cdot \ln S/L_t \quad (19)$$

where a_5, b_5, c_5, and d_5 are coefficients.

Table 8 summarizes the result of the regression analysis taking Japan's 14 EEMRs in 2002.[6]

Table 8 indicates statistically significant and demonstrates the significance of Eq. (19) in depicting the governing structure of the affluence in the commodities in sales.

Partial differentiation of Eq. (19) by $\ln S/L$ leads to the elasticity of productivity to the affluence in the commodities in sales as follows:

$$\frac{\partial \ln N_t}{\partial \ln S/L} = b_5 \frac{\partial \ln N_{t-1}}{\partial \ln S/L_t} + c_5 + d_5 \ln N_{t-1} + d_5 \frac{\partial \ln N_{t-1}}{\partial \ln S/L_t} \ln S/L_t \quad (20)$$

Given short preceding period as can be approximated by $N \approx N_{t-1}$, Eq. (20) can be approximated as follows:

$$(1 - b_5 - d_5 \ln S/L)\frac{\partial \ln N}{\partial \ln S/L} = c_5 + d_5 \ln N$$

$$\frac{\partial \ln N}{\partial \ln S/L} = \frac{c_5 + d_5 \ln N}{1 - b_5 - d_5 \ln S/L} \quad (21)$$

From Table 8

$$1 - b_5 - d_5 \ln S/L = 1 - 0.960 - 0.007 \ln S/L > 0$$

$$c_5 + d_5 \ln N = -0.045 + 0.007 \ln N \begin{cases} > 0 \ \ln N > 6.43 \ (N > 620) \\ < 0 \ \ln N < 6.43 \ (N < 620) \end{cases}$$

This suggests that productivity increase contributes to increase in the level of the affluence in the commodities in sales when N is bigger than 620. Fig. 11 demonstrates that

[6] N at the preceding period (N-1) is estimated as follows: $N_t = N_0 e^{\lambda t}$ where N_0: N at the initial period; λ: increase rate of N. $\lambda = gN$ where g: scale factor. $N_t = N_0 e^{gN_t t}$.

Yodobashi and Bic satisfy this condition. While in case when N is smaller than 620, selection and convergence by decreasing N is indispensable for increasing productivity.

3.6.3. Contribution of the affluence in the commodities in sales to the elasticity of productivity to IBIT

Partial differentiation of Eq. (17) by $\ln N$ leads to the elasticity of the affluence in the commodities in sales to productivity elasticity to IBIT as follows:

$$\frac{\partial}{\partial \ln N}\left(\frac{\partial \ln \mathrm{IBIT}}{\partial \ln S/L}\right) = d_4 + d_4 \frac{\partial \ln S/L}{\partial \ln N}\frac{\partial \ln N}{\partial \ln S/L} + (c_4 + d_4 \ln S/L) \times \frac{\partial}{\partial \ln N}\left(\frac{\partial \ln N}{\partial \ln S/L}\right) \quad (22)$$

Provided that there exists a reverse function between N and S/L, and also utilizing Eqs. (21) and (22) can be developed as follows:

$$\frac{\partial}{\partial \ln N}\left(\frac{\partial \mathrm{IBIT}}{\partial \ln S/L}\right) = 2d_4 + (c_4 + d_4 \ln S/L)\frac{2d_5}{1 - b_5 - d_5 \ln S/L} = 2\left(\frac{d_4 - b_5 d_4 + c_4 d_5}{1 - b_5 d_5 \ln S/L}\right) = \frac{2[(1 - b_5)d_4 + c_4 d_5]}{(1 - b_5 - d_5 \ln S/L)} \quad (23)$$

Applying coefficients obtained from Tables 4 and 7, Eq. (23) can be computed as follows:

$$1 - b_5 - d_5 \ln S/L = 1 - 0.960 - 0.007 \ln S/L > 0$$

$$2[(1 - b_5)d_4 + c_4 d_5] = 0.0234 > 0$$

$$\frac{\partial(\partial \ln \mathrm{IBIT}/\partial \ln S/L)}{\partial \ln N} > 0$$

This result suggests that the elasticity of the affluence in the commodities in sales to productivity elasticity to IBIT in Japan's 14 EEMRs demonstrates positive and the elasticity of productivity to IBIT increases as the affluence in the commodities in sales increases.

As suggested by Table 8, when the affluence in the commodities in sales N is bigger than 620, productivity increase contributes to increase in N while this changes to reverse when N is smaller than 620.

4. Interpretation of the result of the empirical analysis

Findings in the previous section lead to a virtuous or a vicious cycle between the affluence in the commodities in sales (N), productivity (S/L) and IBIT depending on the level of N as demonstrated in Fig. 13.

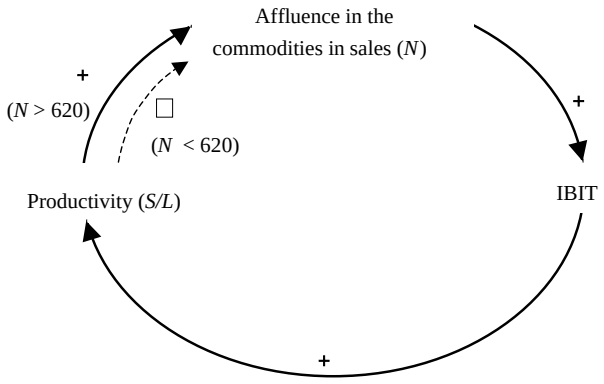

Fig. 13. Virtuous or vicious cycle between productivity, affluence in the commodities in sales and IBIT in Japan's 14 EEMRs.

Currently, Yodobashi and Bic satisfy $N > 620$ condition leading to a virtuous cycle between S/L, N and IBIT. All these factors in Yodobashi and Bic are all conspicuous than other EEMRs.

In Yodobashi, a vicious cycle has been generated by IT driven self-propagating trajectory based on ERP's self-propagating structure. Thus, this virtuous cycle directly connects the network externalities which enable Yodobashi to drive a virtuous cycle together with labor productivity, the affluence in the commodities in sales, and IBIT.

Thus, we can conclude that the high level of the affluence in the commodities in sales plays a significant role in Yodobashi and Bic, particularly in Yodobashi, for constructing a virtuous cycle leading to high levels of productivity and IBIT.

Since high level of multiplier of the network externalities plays a significant role in leveraging high levels of productivity and IBIT as demonstrated in Tables 2 and 3, strong correlation between high level of the affluence in the commodities in sales (N) and higher level of the multiplier of the network externalities (n) can be realized in Yodobashi as demonstrated in Fig. 14 by comparing interaction dynamism between productivity, affluence of the commodities in sales, IBIT, sales and network externalities in Japan's top 5 leading EEMRs.[7] This strong correlation is considered to be the source of Yodobashi and Bic's,

[7] 'Yamada's business model has a blind spot. That is the point service system introduced in 2001. 'Return 26% to you' is shown on the leaflet. This percentage exceeds Bic and Yodobashi. However, an officer of a major consumer-electronics manufacturer says firmly, 'The point service system is unsuitable sales promotion for Yamada. It breaks down soon.' Why? Because the affluence of the commodities in sales necessary to the point of sales is poor. Yodobashi covers approximately thirty thousand items even in a large-sized store of which floor space is more than 3,000 square meters. Yodobashi falls a long way short of Bic, which covers five hundred thousand items. 'Because the assortment of accessories is poor, the clients select an article of which gross margin rate is low and this is not profitable for Yamada. Moreover, the clients cannot enjoy their choice. Furthermore, the effect of attracting many users may not be expected and this is the intended purpose of point service system.' (March 17, 2004, The Nikkei Business).

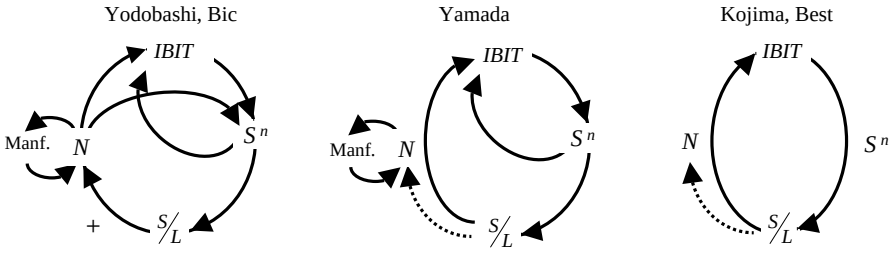

Fig. 14. Variation of the interacting dynamism between productivity, affluence in the commodities in sales, IBIT, sales and network externalities in Japan's top 5 EEMRs.

particularly Yodobashi's, virtuous cycle between *S*/*L*, *N* and IBIT. This can be attributed to Yodobashi's success in consumers' involvement depending on a self-propagating development between *N* and *n* which suggests a prospect of 'service oriented manufacturing' (SOM).

As summarized in Fig. 15, Yodobashi demonstrated remarkable results after ERP introduction in 1996. Clear virtuous cycle between productivity, the affluence in commodities in sales and number of customers can be observed.

Fig. 16 demonstrates the steps to generate self-propagating functions in the introduction of ERP (Austin and Nolan, 1998; Davenport, 2000; Koch, 2001).

As noted in the previous section EEMRs share more than a half of the industry's sales. In this situation, EEMRs substitute manufacturing firms' sales function. Fig. 17 illustrates this dynamism. The first figure demonstrates that a manufacturing firm generates the self-propagating function with ERP vendors and its own customers (consumers). At this stage, a retail firm demonstrates the similar behavior. As explained in the previous section, second figure demonstrates Yodobashi's model. Yodobashi takes initiative in coordinating manufacturing firm and its customers (consumers), together with ERP vendor as illustrated in the third figure in Fig. 16 (Sakakibora, 1999; Yucean et al., 1999). From consumers' point of view, manufacturing firms are invisible while brand image is still important for consumers, actual solution or product proposal, pricing and offering are initiated by retailer, in contrast, a manufacturing firm has been loosing its initiative to the customers' purchasing behavior.

This co-evolutionary dynamism provides a reasonable interpretation why Yodobashi has been successful in its SCM deployment. Manufacturing firms can be provided the actual sales data from Yodobashi's SCM system. It is generally difficult for manufacturing firms to collect such data by themselves as can be envisaged by the model in Fig. 17 (BinsWanger and Ruttan, 1978; Ruttan, 2001).

5. Conclusion

In light of the significance of a virtuous cycle between labor productivity, the affluence in the commodities in sales driven by network externalities generated by co-evolution between IT driven self-propagating trajectory and institutional spiral trajectory, an empirical analysis aiming at

(i) Improvement in productivity → Increase of affluence in the commodities in sales (S/L → N)

Inventory turnover 24→36 times/year
Increase of affluence in the commodities in sales 0.25M items→53M items

$$N = a + b_1 S/L + b_2 D_x S/L$$

ERP Installation	Dummy Coefficient (D_x)	b1	b2	adj. R^2	DW	AIC	Multiplier Before ERP (b1)	Multiplier After ERP (b1+b2)
1995	95-02 = 1, Other = 0	0.179 (2.38)	0.078 (4.66)	0.879	1.35	70.71		
1996	96-02 = 1, Other = 0	0.082 (1.19)	0.106 (6.50)	0.924	1.34	62.50	0.082 →	0.188
1997	97-02 = 1, Other = 0	0.175 (1.55)	0.078 (2.92)	0.809	1.12	78.97		

(ii) Increase of affluence in the commodities in sales → Increase of the customers (N → S)

Number of membership 1400M
Repeat ratio 94%

$$\ln S = a + b_1 \ln N + b_2 D_x \ln N$$

ERP Installation	Dummy Coefficient (D_x)	sdb1	b2	adj. R^2	DW	AIC	Multiplier Before ERP (b1)	Multiplier After ERP (b1+b2)
1995	95-02 = 1, Other = 0	0.380 (5.24)	0.226 (6.42)	0.938	1.61	-55.65		
1996	96-02 = 1, Other = 0	0.403 (8.18)	0.233 (9.45)	0.967	1.82	-66.93	0.403 →	0.636
1997	97-02 = 1, Other = 0	0.470 (6.82)	0.192 (5.74)	0.927	1.28	-52.72		

Fig. 15. Yodobashi's remarkable advancement as a consequence of the introduction of ERP.

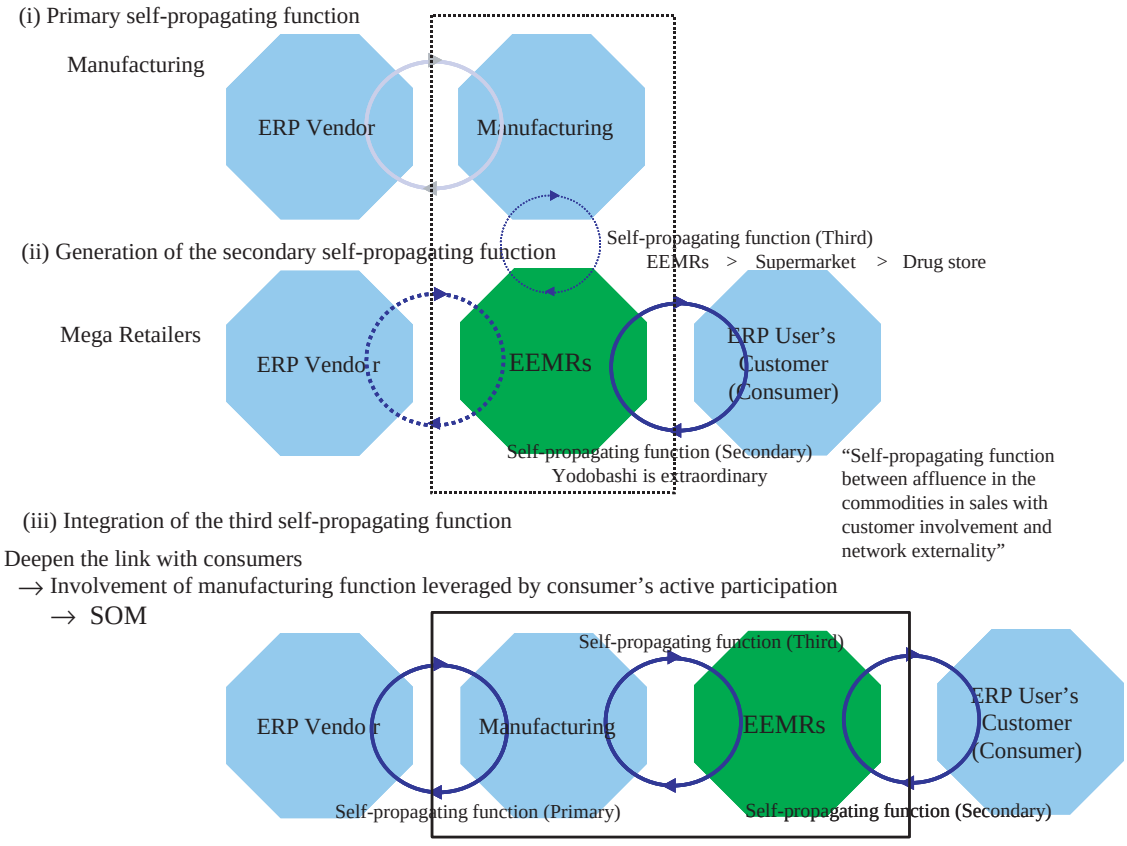

Fig. 16. Co-evolution of self-propagating functions as a consequence of the active ERP introduction.

identifying the source of Yodobashi's conspicuous achievement was attempted.

The empirical analysis suggests that:

(i) There exists a certain virtuous cycle between the affluence in the commodities in sales, productivity and IBIT.

(ii) The elasticity of the affluence in the commodities in sales to productivity elasticity to IBIT in Japan's leading 12 EEMRs demonstrates positive and the elasticity of productivity to IBIT increases as the affluence in the commodities in sales increases.

(iii) When the affluence in the commodities in sales is bigger than certain level, productivity increase

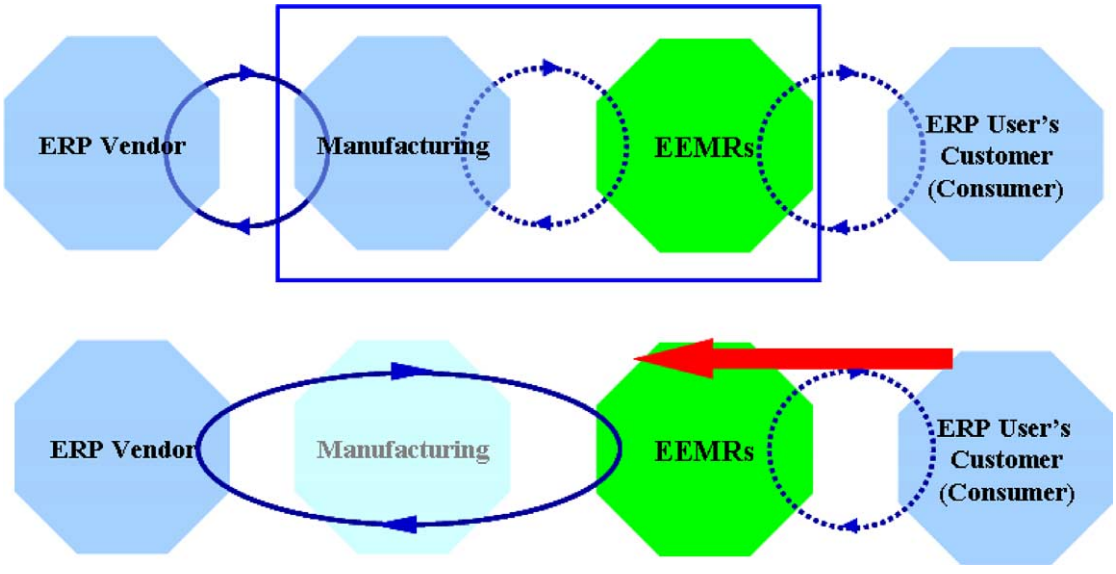

Fig. 17. Double spiral trajectory leading to a concept of service oriented manufactures.

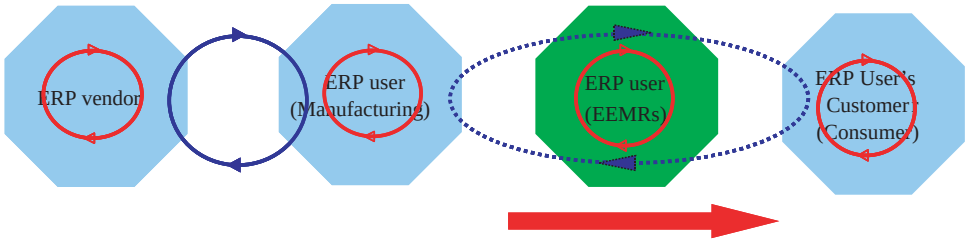

Fig. 18. Possible option to service oriented manufacturing (1).

contributes to increase in the commodities in sales while this changes to reverse when the commodities in sales is smaller than that level.

(iv) The above findings lead to a virtuous cycle between the affluence in the commodities in sales, productivity and IBIT depending on the level of the commodities in sales.

Thus, we can conclude that:

(i) The high level of the affluence in the commodities in sales plays a significant role in Yodobashi and Bic, particularly in Yodobashi, for constructing a virtuous cycle leading to high levels of productivity and IBIT.

(ii) Since high level of multiplier of the network externalities plays a significant role in leveraging high levels of productivity and IBIT, strong correlation between high level of the affluence in the commodities in sales and higher level of the multiplier of the network externalities can be realized in Yodobashi and Bic by comparing interaction dynamism between productivity, affluence in the commodities in sales, IBIT, sales and network externalities in Japan's top 5 EEMRs.

(iii) This strong correlation in (ii) is considered to be the source of Yodobashi and Bic's, particularly Yodobashi's, virtuous cycle between productivity, affluence in the commodities in sales, and IBIT.

(iv) This can be attributed to Yodobashi's success in consumers' involvement depending on a self-propagating development between affluence in the commodities in sales and network externalities which suggests a prospect of 'service oriented manufacturing' (SOM).

Noteworthy suggestions include:

(i) Currently, the path toward 'Service Oriented Manufacturing' is suggested by the retail firms, particularly by Yodobashi.

(ii) By learning this examination, two possible solutions can be offered to manufacturing firm to initiate 'Service Oriented Manufacturing' in their own initiative:

(a) First, as demonstrated in Fig. 18, manufacturing firms should tie up with retail firms by using the similar model which Yodobashi implemented. How to take back the initiative from retail firms is the key for the manufacturing firms. This model again enables manufacturing firms to offer the solution oriented product offering. In a coming ubiquitous society, customers' focus will move from 'what they want to buy' to 'what they want to do.' Yodobashi's model enables this solution oriented product offering even at current stage. This solution offers a model encouraging consumers' active participation, leading to 'Service Oriented Manufacturing' corresponds to a ubiquitous society (Ogawa, 2002).

(b) Second, as demonstrated in Fig. 19, manufacturing firms take the direct access to the consumers. This is very effective to take the initiative and collect the customers' information. Manufacturing firms' web store is an excellent example of this option. It is also better for IBIT point of view in manufacturing firms, since they do not have to consider the retail firms as the middle man. However, disadvantage of this model is the offer

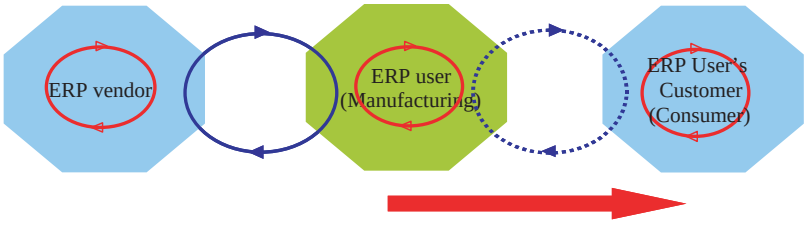

Fig. 19. Possible option to service oriented manufacturing (2).

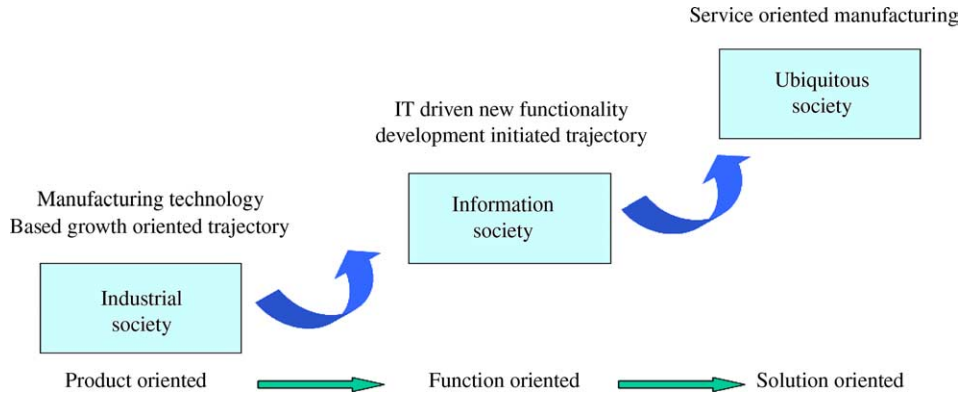

Fig. 20. Paradigm shift and consequent development trajectory from an industrial society to an information society and to a ubiquitous society.

can be made by this model are limited. Principally, since manufacturing firms' web stores sell only their own products, their offers are limited. Customers cannot complete their shopping to satisfy their requirement at one time one place. Thus, this is not the optimal model.

(iii) In a ubiquitous society, customer's focus moves from 'what they want to buy' to 'what they want to do.' In this situation, identifying the customers' demand in appropriate way and prepare the offers to correspond to their demand is critical. Traditional single product oriented marketing cannot be effective and loses to catch the trend. Fig. 20 illustrates the paradigm shift towards a ubiquitous society. Japanese firms have faced a difficulty in adjusting their business model to correspond to the paradigm shift from an industry society to an information society. However, there will be an opportunity to revitalize their business in the coming ubiquitous society by applying customer-oriented approach in IT deployment as demonstrated by the Yodobashi model.

Further works should focus on the structure of the institutional systems diffusing the Yodokashi model in broad MRs (mega retail firms) leading to SOM toward a ubiquitous society.

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