

# CO-EVOLUTION BETWEEN CCC-DRIVEN CASH FLOW MANAGEMENT AND TRANSFORMATION OF R&D – AMAZON'S ENDEAVOR

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## ABSTRACT

*Amazon became the world R&D leader in 2017 by rapidly increasing R&D investment. The company's extremely large amount of R&D funds is the result of an ample free cash flow generated by sophisticated cash conversion cycle (CCC) management. Increased R&D induced business advancement and lean cost structure construction leading to further increase in cash flow which has stimulated interaction between vendors, customers, and Amazon via the Amazon marketplace. Activated interaction accelerated CCC advancement, a subsequent free cash flow increase, and user-driven innovation, thus accelerated the transformation of routine or periodic alteration activities into significant improvement simultaneously. All of these components function together as a consolidated sophisticated machine.*

*In light of the increasing concern to R&D resources development without the dilemma of a productivity decline that most digital economies are now confronting, this paper demonstrated the above hypothetical view.*

*An intensive empirical analysis focusing on the development trajectory of Amazon's techno-financing system over a period from 1997 to 2018 was conducted.*

*An insightful suggestion to neo open innovation that fuses financing management and R&D management was thus provided.*

## KEYWORDS

*R&D, Transformation, Cash flow management, Cash conversion cycle, Amazon*

## 1. INTRODUCTION

Contrary to the decisive role of R&D in the digital economy, dilemma between its expansion and productivity decline has become worldwide concerns [1, 2].

Notwithstanding such circumstances, Amazon demonstrated a conspicuous increase in its R&D and jumped up to the world top R&D firm in 2017 with a skyrocketing increase in its market capitalization. The authors in their preceding analysis elucidated a dynamism leading Amazon such a rapid jump within a short period of time [3, 4].

Such a miraculous model has shed light on the financial system supported and endorsed such a reckless challenge to risky investment as R&D that incorporates such nature as uncertainty, long lead-time, and successive huge amount of fund without interruption.

It is widely appreciated that Amazon has been endeavoring cash flow, particularly free cash flow management based on sophisticated cash conversion cycle (CCC) management [5, 6, 7]. In addition, in light of its notable business performance, a significant number of studies have analyzed the system of Amazon's notable performance [8, 9, 10].

However, none has provided convincing bridge between such CCC-driven cash flow management and unique R&D system leading Amazon to the world R&D leader without dilemma.

Following the preceding studies [3, 4, 11] this paper attempted to provide a convincing bridge between Amazon’s mysteries of CCC-driven cash flow management and transformation of R&D concept.

An empirical analysis focusing on Amazon’s techno-financing development trajectory over the last two decades was conducted.

It was identified that all functions as marketplace dynamism inducing CCC advancement, CCC-driven cash flow management, and R&D transformation from routine or periodic alteration into significant improvement during R&D process well-orchestrated as a consolidated sophisticated machine.

Thus, Amazon succeeded in fusing unique R&D transformation system endorsed by its institutional system as an R&D-driven company and sophisticated financing system centered on CCC-driven cash flow management exquisitely combining with debt financing depending on the capital market conditions as illustrated in **Fig. 1**.

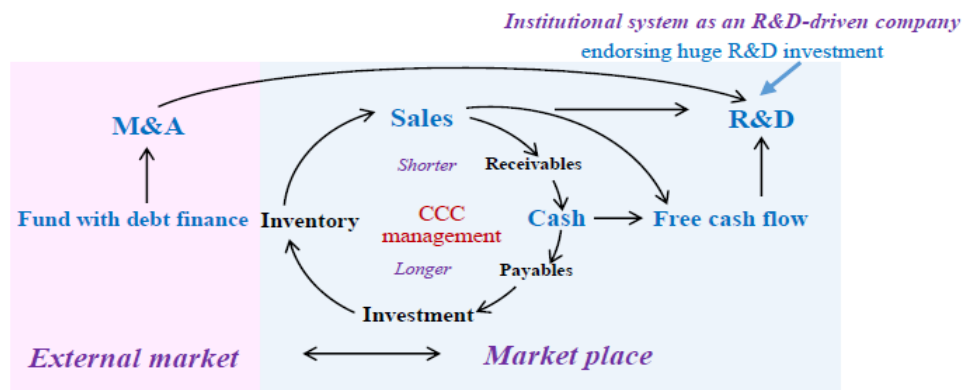


Figure 1. Scheme of Amazon’s cash flow management.

Such a consolidated sophisticated machine can be attributed to a multi-virtuous cycles which have been constructed through the following phased efforts as illustrated in **Fig. 2**.

Phase I: Endeavor M&A by leveraging low interest rate market environment and raising fund with debt finance.

Phase II: Develop business activities by fully utilizing the fruits of the advancement of M&A and create CCC-oriented cash flow, thereby invest to R&D.

Phase III: Increase cash flow, particularly free cash flow, through advancement of business and topology. R&D thereby a virtuous cycle between them is constructed

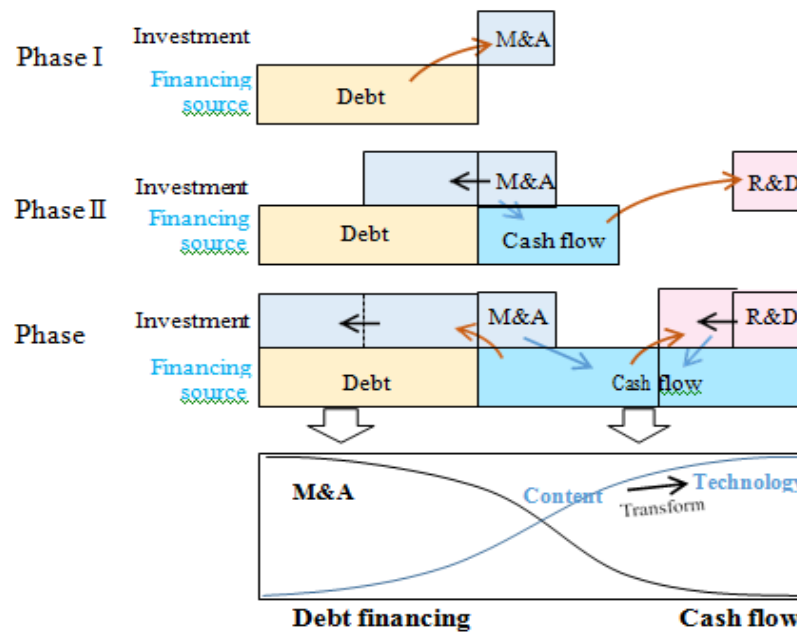


Figure 2. Scheme of Amazon's development trajectory of R&D financing.

→: Business / R&D emergence ; → : Cash flow creation ; → : Expansion

These findings give rise to insightful suggestions supportive to transformation of R&D model in the digital economy.

Section 2 over reviews dynamism of Amazon's virtuous cycle between ample cash flow and active R&D investment. Dynamism enabling noting R&D investment is analyzed in Section 3. Section 4 demonstrates optimal combination of acquisition and R&D. Section 5 summarizes the noteworthy findings, policy suggestions, and future research.

## 2. DYNAMISM OF AMAZON'S VIRTUOUS CYCLE BETWEEN AMPLE CASH FLOW AND ACTIVE R&D INVESTMENT

### 2.1. Amazon's Key Managerial Factors

**Table 1** overviews trend in Amazon's key managerial factors over a period from 1997 (the year of initial public offering: IPO) to 2018 focusing on its business outcome as revenues (sales), investment for future as R&D investment, and consequent incomes as operating income and net income. Table 1 also overviews its business performances by reviewing its cash flow (CF) management focusing on management of operating cash flow and free cash flow together with indebtedness by reviewing debt capital focusing on long-term debt.

Table 1. Trend in Amazon's key managerial factors (1997-2018) – US\$ mil.

Year	Sales	Operating income	R&D	Net income	Operating CF	Free CF	Long-term debt
1997	148	-32	13	-30	1	-7	77
1998	609	-109	46	-125	31	3	348
1999	1640	-606	159	-720	-91	-378	1,466
2000	2,762	-864	269	-1411	-130	-265	2,127
2001	3,122	-412	241	-567	-120	-170	2,156
2002	3,933	64	216	-149	174	135	2,277
2003	5,264	270	257	35	392	346	1,945
2004	6,921	440	283	588	566	477	1,855
2005	8,490	432	451	359	733	529	1,480
2006	10,711	389	662	190	702	486	1,247
2007	14,835	655	818	476	1,405	1,181	1,282
2008	19,166	842	1,033	645	1,697	1,364	409
2009	24,509	1,129	1,240	902	3,293	2,920	0
2010	34,204	1,406	1,734	1,152	3,495	2,516	1,561
2011	48,077	862	2,909	631	3,903	2,092	255
2012	61,093	676	4,564	-39	4,180	395	3,084
2013	74,452	745	6,565	274	5,475	2,031	3,191
2014	88,988	178	9,275	-241	6,842	1,949	8,265
2015	107,006	2,233	12,540	596	12,039	7,450	8,227
2016	135,987	4,186	16,085	2,371	17,203	10,466	7,694
2017	177,866	4,106	22,620	3,033	18,365	8,307	24,743
2018	232,887	12,421	28,837	10,073	30,723	19,400	23,495

Source: [11, 12].

Debt capital refers to the value of bonds, notes, term loans and other credit sources that are used to finance business operations. Amazon carried long-term debt of US\$ 8.2 bil. as of December 2015, with no short-term debt. This debt consisted primarily of notes with interest rates ranging from 1.2% to 4.95%, and maturity dates ranging from 2017 to 2044. Amazon's total debt was largely unchanged in 2016 as US\$ 7.7 bil., but the company's indebtedness increased sharply in 2017 and 2018 as US\$ 24.7 and 23.5 bil., respectively.

**Table 2** demonstrates Amazon's income statement over a period from 2014 to 2018 which presents the financial results of its business activities. This statement communicates how much revenue Amazon generated during the period and what cost it incurred in connection with generating that revenue. This statement also explains the relationship between sales, operating income, R&D, and net income. Amazon describes expenses for R&D as those for "technology and content" [3, 4].

Table 2. Amazon's consolidated income statement (2014-2018) – US\$ mil.

	2014	2015	2016	2017	2018
Net product sales	70,080	79,268	94,665	118,573	141,915
Net services sales	18,908	27,738	41,322	59,293	90,972
<b>Net sales</b>	<b>88,988</b>	<b>107,006</b>	<b>135,987</b>	<b>177,866</b>	<b>232,887</b>
[Operating expenses]	[88,810]	[104,773]	[131,801]	[173,760]	[220,466]
(Cost of sales)	(62,752)	(71,651)	(88,265)	(111,934)	(139,156)
(Fulfillment)	(10,766)	(13,410)	(17,619)	(25,249)	(34,027)
(Marketing)	(4,332)	(5,254)	(7,233)	(10,069)	(13,814)
(Technology and content)	(9,275)	(12,540)	(16,085)	(22,620)	(28,837)
(General and administrative)	(1,552)	(1,747)	(2,432)	(3,674)	(4,336)
(Other operating expense)	(133)	(171)	(167)	(214)	(296)
<b>Operating income</b>	<b>178</b>	<b>2,233</b>	<b>4,186</b>	<b>4,106</b>	<b>12,421</b>
Interest income	39	50	100	202	440
(Interest expense)	(210)	(459)	(484)	(848)	(1,417)
(Other balance)	(118)	(256)	90	346	(183)
(Provision for income taxes)	(167)	(950)	(1,425)	(769)	(1,197)
(Equity-method investment activity, net of tax)	37	(22)	(96)	(4)	9
<b>Net income</b>	<b>(241)</b>	<b>596</b>	<b>2,371</b>	<b>3,033</b>	<b>10,073</b>

Source: [11, 12].

Operating income (*OI*) measures the amount of profits realized from a business's operations, after deducting operating expenses such as wages, depreciation, and cost of goods sold including expenses for R&D (which Amazon describes technology and product) from revenues (sales: *S*).

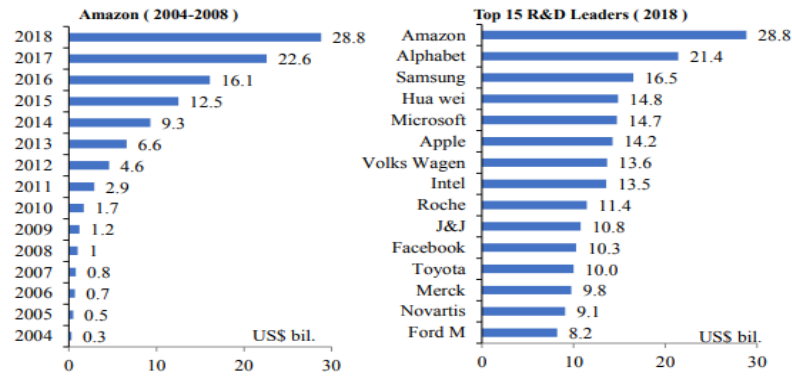


Figure 3. Amazon’s conspicuous jump into world top R&D leader.

Original sources: [12, 13, 14].

In Amazon these profits have been reinvested in its business and employees, not in dividends and buybacks. Amazon has not paid a dividend since its IPO in 1997, nor has it done any buybacks of its shares since 2012. That strategy is reflected in spending on R&D activities, which has led to Amazon becoming the world’s top R&D firm over a short period of time [3, 4] as demonstrated in

**Fig. 3.** Such R&D seeking resource allocation strategy is distinct as demonstrated in **Fig. 4** by comparing that of Apple. Amazon has been endeavoring to be an R&D-driven company since its inception in 1994. Consequently, Amazon maintains extremely low ratio of *OI/S* and extremely high ratio of *R/OI* as demonstrated in **Fig. 5**.

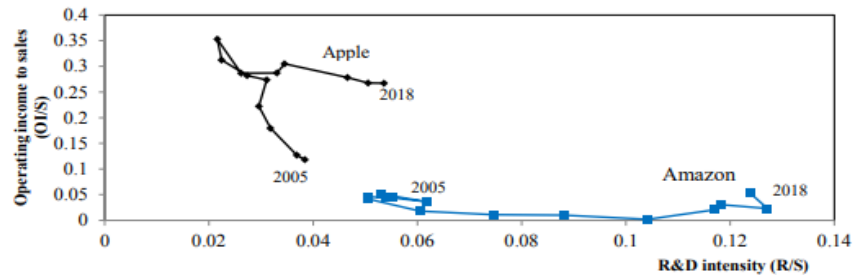


Figure 4. Comparison of resource allocation strategy between Amazon and Apple (2005-2018).

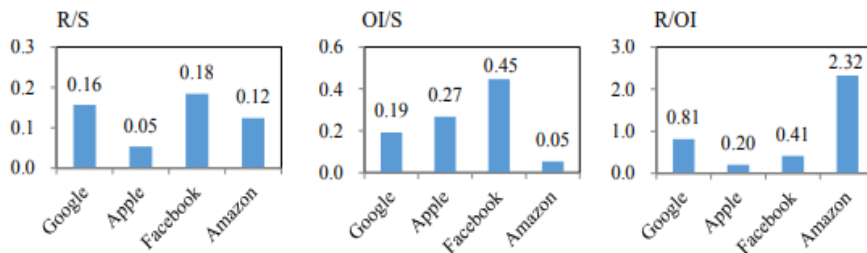


Figure 5. Comparison of R/S, OI/S and R/OI between GAFA (2018).

Since R&D is such risky investment incorporating uncertainty, lengthy successive work with huge amount of money without interruption, and long lead-time before commercialization, lack of cash obliges to return all of previous efforts to blisters. Therefore, intensive R&D investment can only

be enabled by fueling ample and sustainable funding rich in mobility which can be expected by net cash flow, rather by net income (net profit).

While net income indicates revenues left over after all expenses have been paid by adjusting due

income and expense from operating income as explained in Table 2, in conducting actual risky challenge, timely ample fuel that endorses companies such challenge is indispensable. Net cash flow is the fuel that helps companies expand, develop new products, buy back stock, pay dividends, or reduce debt. It is what allows companies to conduct their day-to-day business, particularly risky heavy business successively as it includes all transactions that transfer cash.

Amazon as a world leading R&D-driven company depends highly on this flow as demonstrated in Fig. 6.

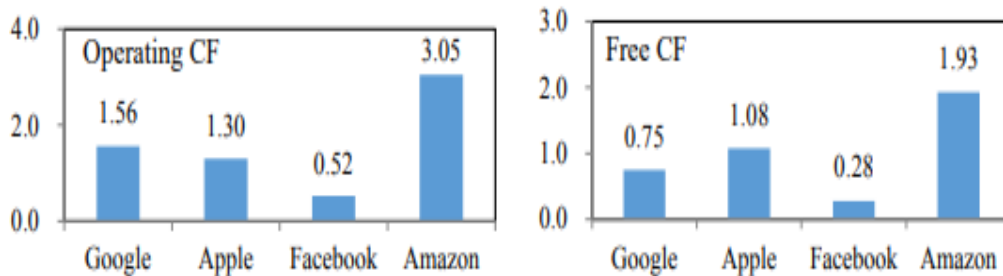


Figure 6. Comparison of cash flow per income between GAFA (2018).

## 2.2 Amazon’s Cash Flow Structure

- Based on the analysis in the preceding section which inspired the significance of cash flow management in fueling the company to conduct actual business, particularly risk-taking challenge as R&D investment without interruption, Amazon’s cash flow structure is analyzed in this section.

**Table 3** demonstrates trend in Amazon’s cash flow together with its sales and net income over a period from 2004 to 2017.

As reviewed in the preceding section, net income (net profit) is the amount of total revenues that deducted total expenses (how much revenues are left over all expenses have been paid from sales). This is the amount of money that the company can use to pay off debt, invest in new projects, distribute to shareholders, or save.

However, in conducting risky heavy challenge as long lasting big R&D successively without interruption, in order to avoid a fear of shortage of cash that may return all previous efforts to blisters, endorsement of ample and sustainable funding rich in mobility is indispensable. This can be expected by net cash flow. Net cash flow is the sum of operating cash flow, investment cash flow, and financing cash flow. Cash for R&D investment is used from operating cash flow by deducting certain expenditures in investment cash flow.

Table 3. Trend in Amazon's cash flow structure (2004-2018) – US\$ mil.

	Sales (Revenue)	Net income	Operating CF	Capital expenditures	Free CF
2004	6,921	588	566	-89	477
2005	8,490	359	733	-204	529
2006	10,711	190	702	-216	486
2007	14,835	476	1,405	-224	1,181
2008	19,166	645	1,697	-33	1,364
2009	24,509	902	3,293	-373	2,920
2010	34,204	1,152	3,495	-979	2,516
2011	48,077	631	3,903	-1,811	2,092
2012	61,093	-39	4,180	-3,785	395
2013	74,452	274	5,475	-3,444	2,031
2014	88,988	-241	6,842	-4,893	1,949
2015	107,006	596	12,039	-4,589	7,450
2016	135,987	2,371	17,203	-6,737	10,466
2017	177,866	3,033	18,365	-10,058	8,307
2018	232,887	10,073	30,723	-11,323	19,400

Source: [12, 13].

Operating cash flow is measured by deducting the expenses for purchases from the sales, or in other means, adding such values as depreciation, depletion and amortization to net income. This flow demonstrates how much cash is generated by the business. Table 1 demonstrates that Amazon is consistently increasing this flow, thereby its main business is securing ample cash.

Free cash flow is the value measured by deducting capital expenditures necessary for business expansion (included in investment cash flow) from operating cash flow. This is money reserved in the company after paying due payments as debt repayment, redemption of bonds, and dividend to shareholders. This is called free cash flow as this is the money that companies can use freely.

**Table 4** and **Fig. 7** demonstrates trend in cash flow in Amazon by decomposing into net operating cash flow, net investment cash flow, and net financing cash flow, together with free cash flow. Aiming at market leader status and raising shareholder value, Amazon has been paying special attention to free cash flow and reports the trend in this flow at the beginning of the company's quarterly report by defining it as follows:

*Free cash flow is cash flow from operations reduced by "Purchases of property and equipment, including internal-use software and website development, net," which is included in cash flow from investing activities.*

One of the noting characteristics of the Amazon is that it has consistently communicated its intention to create free cash flow since its inception. In his 2004 Letter to stakeholders, Jeff Bezos, founder of Amazon, explained that "Free cash flow for 2004 of US\$ 477 mil. is net cash provided by operating activities of US\$ 566 mil. less purchases of fixed assets, including capitalized internal-use software and website development costs, of US\$ 89 mil." [15].

Table 4. Trend in cash flow in Amazon (2012-2018) – US\$ bil.

	2012	2013	2014	2015	2016	2017	2018
Net income before extraordinary	-0.04	0.27	-0.24	0.60	2.37	3.03	10.07
Depreciation, depletion & amortization	2.16	3.25	4.19	5.65	7.48	11.48	15.34
Deferred taxes & investment tax credit	-	-	-0.32	0.08	-0.25	-0.03	0.44
Other funds	0.54	1.19	2.24	3.15	3.68	4.13	5.91
Changes in working capital	1.52	0.77	0.97	2.56	3.92	-0.24	-1.04
<b>Net operating cash flow</b>	<b>4.18</b>	<b>5.48</b>	<b>6.84</b>	<b>12.04</b>	<b>17.20</b>	<b>18.37</b>	<b>30.72</b>
Capital expenditures*	-3.79	-3.44	-4.89	-4.59	-6.74	-10.06	-11.32
Net assets from acquisitions	-0.75	-0.31	-0.98	-0.80	-0.12	-13.97	-2.19
Purchase/sale of investments	0.94	-0.52	0.81	-1.07	-3.02	-3.05	1.14
<b>Net investment cash flow</b>	<b>-3.60</b>	<b>-4.28</b>	<b>-5.07</b>	<b>-6.45</b>	<b>-9.88</b>	<b>-27.08</b>	<b>-12.37</b>
Issuance/Reduction of debt. net	2.79	-0.62	4.42	-3.88	-3.74	9.93	-7.69
Other funds	-0.53	0.08	0.01	0.12	0.83	-	-
<b>Net financing cash flow</b>	<b>2.26</b>	<b>-0.54</b>	<b>4.43</b>	<b>-3.76</b>	<b>-2.91</b>	<b>9.93</b>	<b>-7.69</b>
<b>Free cash flow (Net OCF – Cap. exp.)</b>	<b>0.40</b>	<b>2.03</b>	<b>1.95</b>	<b>7.45</b>	<b>10.47</b>	<b>8.31</b>	<b>19.40</b>

\* Purchases of property and equipment, net of proceeds from property and equipment incentives.  
Source: [12, 13].

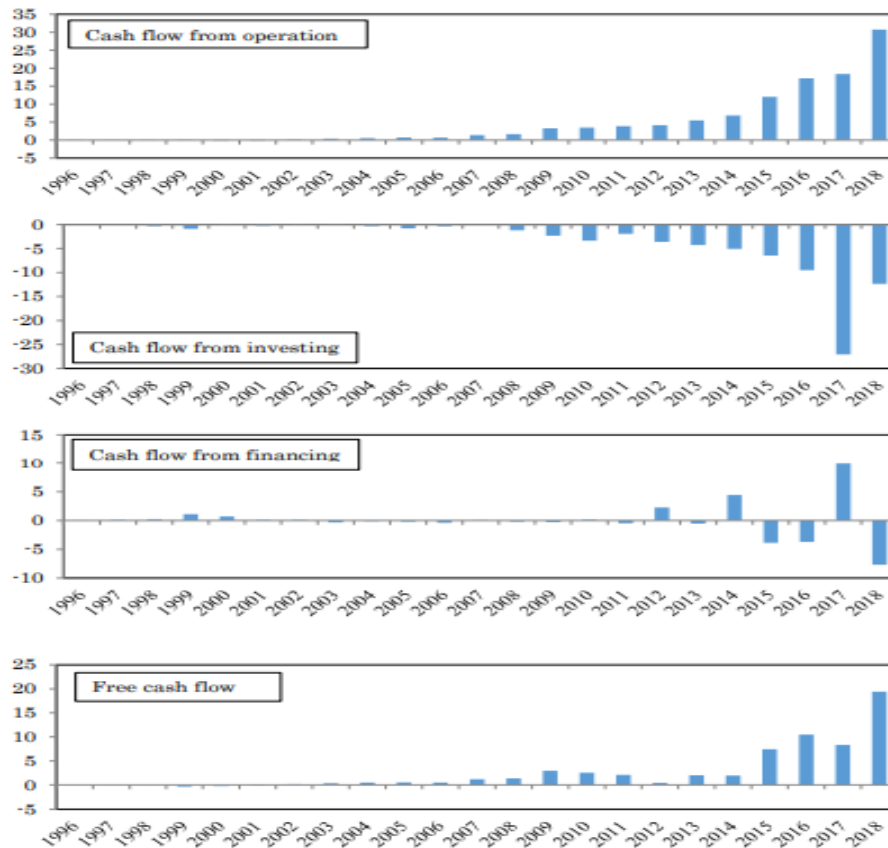


Figure 7. Trend in Amazon’s cash flow (1996-2018) – US\$ bil. Source: [16].

Fig. 8 illustrates trend in Amazon’s free cash flow over a period from 1996 to 2018.



Free cash flow is cash flow from operations reduced by capital expenditures, which is included in investment cash flow and illustrated in pink color.

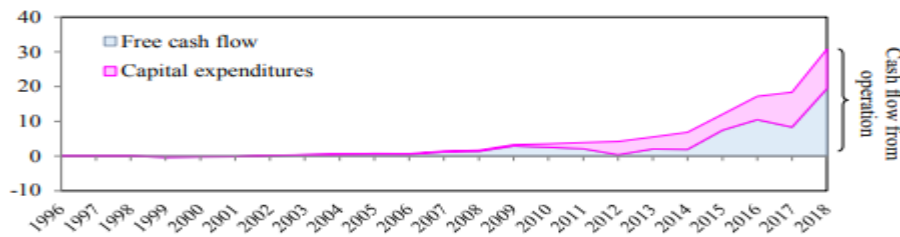


Figure 8. Trend in Amazon’s free cash flow (1996-2018) – US\$ bil.

In his 2004 Letter to stakeholders (Bezos, 2005), Bezos reminded that Amazon’s financial focus is on long-term growth in free cash per share by stressing that “*Our ultimate financial measure, and the one we most want to drive over the long-term, is free cash flow per share.*” In order to accomplish this focus, he stressed that “*Amazon’s free cash flow is driven primarily by increasing operating profit and efficiently managing both working capital and capital expenditures. We work to increase operating profit by focusing on improving all aspects of the customer experience to grow sales and by maintaining a lean cost structure.*”

As stressed by Bezos, Amazon’s financial focus is on long-term growth in free cash per share for addressing to its targeting direction as R&D-driven company. **Fig. 9** illustrates trend in Amazon’s free cash per share over a period from 1996 to 2018 which corresponds to significant R&D inducement as demonstrated in **Table 5**.

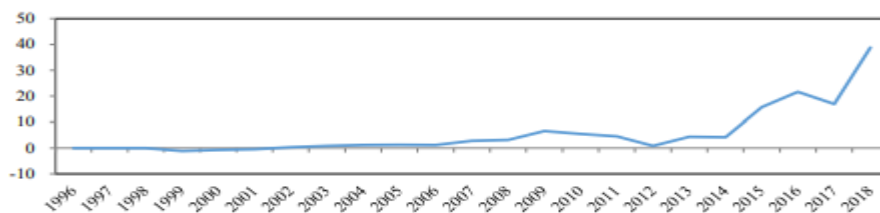


Figure. 9. Trend in Amazon’s free cash flow per share (1996-2018) – US\$.

Table 5. Correlation between free cash flow per share and R&D in Amazon (2002-2018).

$$\ln RD = 5.92 + 1.25 \ln FCF/Share + 2.67D \quad \text{adj. } R^2 \quad 0.848 \quad DW \quad 1.15$$

(24.27)(9.50)                      (3.78)

*RD*: R&D investment; *FCF/Share*: Free cash flow per share; *D*: dummy variable (2012 = 1, Other = 0). The figures in parentheses indicate t-statistics: all are significant at the 1% level.

While free cash flow (similarly, cash flow per share) continued to increase in proportion to operating cash flow until 2009, it decreased from 2010 to 2012. Contrary to sustainable growth in operating cash flow, free cash flow showed significant decrease in 2012. At that time, Amazon was investing most of the operating cash flow earned in its main business for the future. The amount was unimaginably huge for retail business. For example, in 2012, when net income decreased, investment cash flow was US\$ 3.8 bil. It was significantly higher than the previous year, as it was US\$ 1.8 bil. Active investment continued since then, with US\$ 10.1 and 11.3 bil. in 2017 and 2018, respectively.

Such an ample free cash flow played a function of fuel that endorsed Amazon an ambitious endeavor to risky challenge and enabled active R&D investment leading to world top R&D firm

as reviewed earlier. With an understanding that R&D should be completed through successive work without interruption and, therefore, free cash flow that fuels such R&D should be functioned without interruption, **Fig. 10** illustrates correlation between cumulative free cash flow and cumulative R&D investment in Amazon over a period from 2002 to 2018 which is statistically significant as demonstrated in **Table 6** and supports the analysis of Table 5.

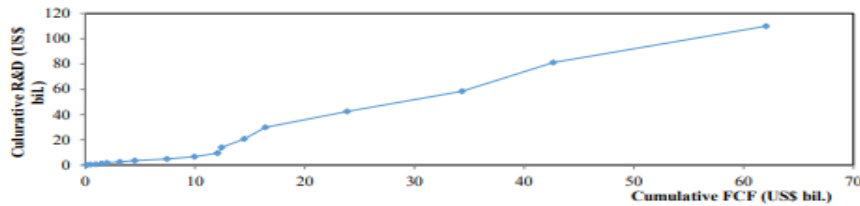


Figure 10. Correlation between cumulative free cash flow and cumulative R&D investment in Amazon (2002-2018) – US\$ bil.

Table 6. Correlation between Cumulative Free Cash Flow and Cumulative R&D Investment in Amazon (2002-2018).

$$lnc\_RD = 0.59 + 0.96D_1lnc\_FCF + 2.53D_2lnc\_FCF + 1.00D_3lnc\_FCF - 0.81D_1 - 4.33D_2$$

(1.85\*) (43.50)                      (2.88)                      (10.92)                      (-2.52)                      (-1.88\*)

adj. R<sup>2</sup> 0.998    DW 1.74

*c\_RD* cumulative R&D investment; *c\_FCF*: cumulative of free cash flow; *D*: dummy variable (*D*<sub>1</sub>: 2002-2011 = 1, others = 0; *D*<sub>2</sub>: 2012, 2013 = 1, others = 0; *D*<sub>3</sub>: 2014-2018 = 1, others = 0).

The figures in parentheses indicate t-statistics: all are significant at the 1% level except \* 5%.

### 2.3 Amazon’s Financing Dynamism

Based on the analyses in the preceding sections, **Fig. 11** summarizes Amazon’s financing dynamism in 2018. Bezos stressed repeatedly that “Amazon’s financial focus is on long-term growth in free cash flow per share,” and that “Amazon’s free cash flow is driven primarily by increasing operating profit (operating income, net income) and efficiently managing both working capital and capital expenditures. We work to increase operating profit by focusing on improving all aspects of the customer experience to grow sales and by maintaining a lean cost structure” [11].

Fig. 11 demonstrates a virtuous cycle between increases in free cash flow and R&D by optimizing free cash management and maximizing funding through thorough improvement of business growth, lean cost structure construction, and cash conversion cycle (CCC) advancement.

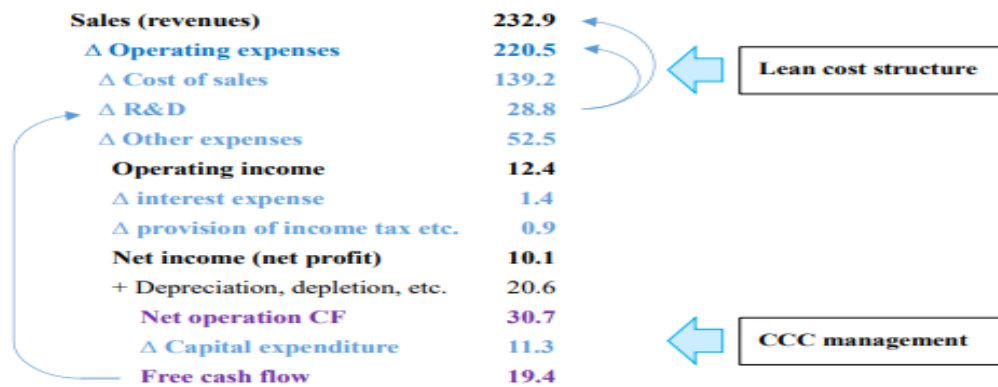


Figure 11. Amazon’s financing dynamism toward R&D-driven company (2018) – US\$ bil.

### 3. DYNAMISM ENABLING NOTING R&D INVESTMENT

#### 3.1. Cash Conversion Cycle

##### (1) Strengths with "Payment before Goods Sell"

As a world leading R&D-driven company, in order to secure R&D fund successively without interruption, Amazon highly depends on net cash flow, rather on net income (net profit) as reviewed earlier. This can be enabled by generating enough cash flow by collecting payments from customers promptly and then pays its vendors with relatively longer payment terms based on its sophisticated cash conversion cycle (CCC) management [17, 18, 19].

CCC is the timespan between disbursing and collecting cash by calculating the following period:  
 $CCC = \text{Days inventory outstanding} + \text{Days sales outstanding} - \text{Days payables outstanding}$ .

12 days of CCC of the world's largest retail Walmart Stores indicates that it takes 12 days to collect the cash by selling inventories and new products. Typical CCC in the retail industry is 10 to 20 days as demonstrated in **Fig. 12**. Due fund for this period should be provided by the company's own efforts.

Contrary to such a burden, Amazon demonstrates negative CCC as -20 to -30 days as also demonstrated in Fig. 13. This implies that the product in the distribution chain is already cashed 20 to 30 days before it is sold. Such a significant negative CCC is the source enabling Amazon to develop huge investments and new businesses thereby one after another.

##### (2) "Deal Deposit" that Can be Operated without Interest

While the inside the black-box of Amazon's negative CCC scheme has been unveiled, it can definitely be attributed to its unique marketplace function. Marketplace is a mechanism that allows non-Amazon vendors to sell their goods and services. In this marketplace, payments from customers are collectively received by Amazon. The sales are returned to the vendors a few weeks later after deducting a few percent of the commission.

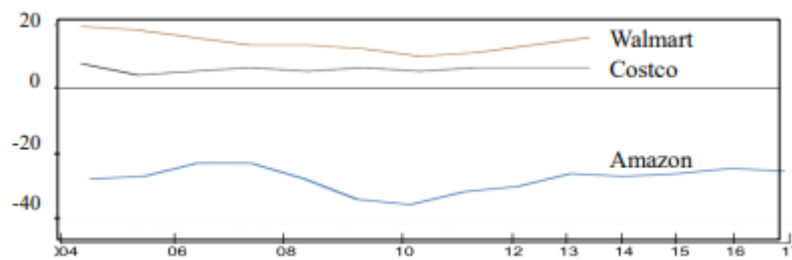


Figure 12. Cash conversion cycle in Walmart, Costco and Amazon (2004-2017) – In days. Sources: [6, 20].

The point is that the entire sales in the marketplace are deposited to Amazon first and then returned to the vendors certain days later. This temporary deposit is called “deal deposit.” Amazon's negative CCC can largely be attributed to this deposit magic. Amazon incorporates some specific function in its marketplace enabling to practice this magic.

#### 3.2. Unique Function in Amazon's Marketplace

CCC management is a management strategy for attaining shorter receivables (days of outstanding of inventory and sales) and longer days of payables. This management is deployed by leveraging such functions of marketplace as pricing dynamism together with systems promoting customers purchase by enabling them to review goods and services that satisfying such requirements as speed of delivery and fulfilment options.

Amazon, which is based on R&D as a culture, has been promoting companywide experimentation to cause customers obsessed with making purchase decisions. This has enabled Amazon to deploy an architecture for participation that makes the most of digital technologies by harnessing the power of users (Tou et al., 2019a, 2019c). Such user-driven innovation enabled Amazon to offer lower prices of goods and services, which satisfied customers leading to a virtuous cycle between them. However, Amazon’s pricing strategies are much more complex in that it does not always offer the lowest prices but changes millions of prices daily as illustrated in **Fig. 13** [20].

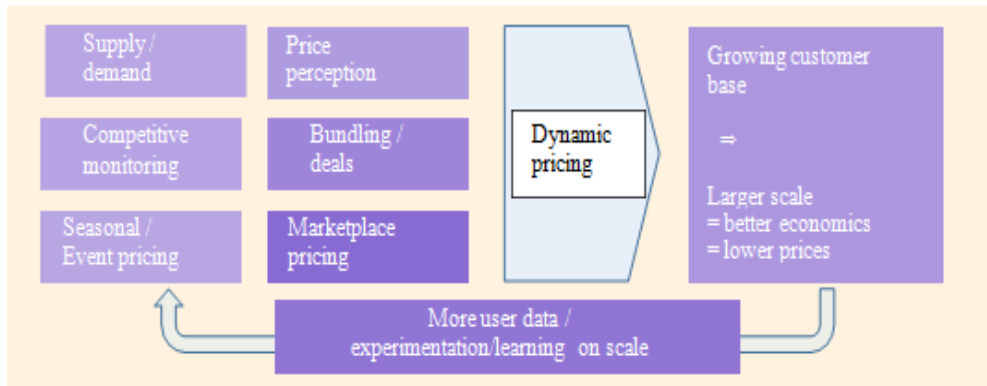


Figure 13. Amazon’s virtuous cycle of pricing leading to data network externality. Original source: [20].

Through such pricing strategy that enables to learn users reaction to (i) supply-demand relation, (ii) competitors’ prices, (iii) seasonal effects, (iv) perception among consumers, (v) discounts effect, and (vi) feedback to algorithmic pricing, Amazon has been enjoying the effect of data network externality. This effect increases exponentially as interaction with users increases leading to gaining overwhelming power in the CCC game in its marketplace. This power can be considered one of the significant sources of Amazon’s high dependence on cash flow.

**Fig. 14** and **Table 7** demonstrate this hypothetical view by analyzing the correlation between sales increase (which represents interaction increase) and corresponding exponential increase (which represents network externality effect) in operating CF in Amazon over the period from 2002 to 2018.

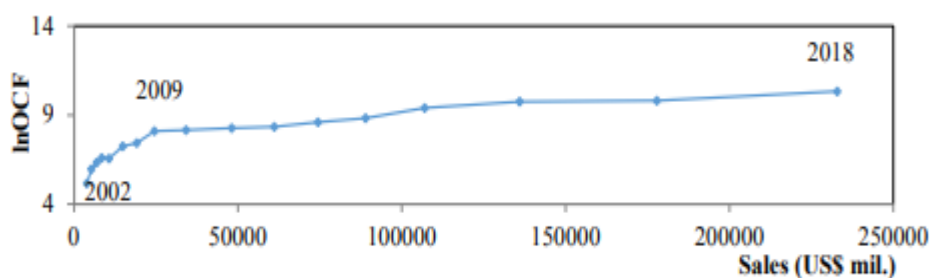


Figure 14. Correlation between sales and logistic value of operating CF in Amazon (2002-2018).

Table 7. Effect of network externality in inducing operating CF in Amazon (2002-2018)

$$OCF = A e^{\lambda S} \quad \Rightarrow \quad \ln OCF = \ln A + \lambda_1 D_1 S + \lambda_2 D_2 S + dD_1$$

$$\ln OCF = 7.81 + 0.13 D_1 S + 0.01 D_2 S - 2.62 D_1 \quad \text{adj. } R^2 \text{ 0.969} \quad DW \text{ 1.29}$$

$$(51.59)(6.71) \quad (9.06) \quad (-9.96)$$

OCF: operating CF; S: sales;  $\lambda$ : learning coefficient; A: scale factor; D: dummy variables ( $D_1$ : 2002- 2008 = 1, others = 0;  $D_2$ : 2009-2018 = 1, others = 0)

The figures in parentheses indicate t-statistics: all are significant at the 1% level.

These analyses demonstrate operating CF increases exponentially corresponding to interaction increase. Sharp increase with high learning coefficient ( $\lambda$  in Table 7) changed to moderate increase after 2009. This suggests that Amazon has developed high level of operating CF dependent structure by 2009 as demonstrated in **Fig. 15** and support the above hypothetical view.

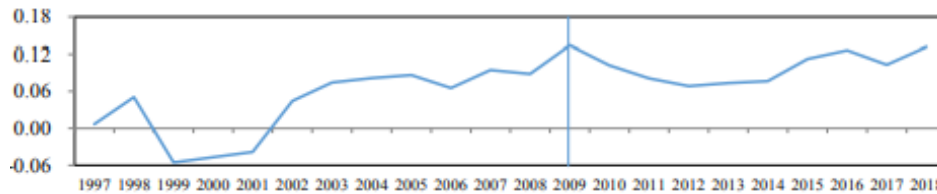


Figure 15. Dependence on operating CF per sales in Amazon (1997-2018). Source: [12, 13].

### 3.3 CCC's Role in Accelerating the Transformation of R&D

Amazon has been endeavoring to be an R&D-driven company since its inception in 1994. This culture has led to Amazon establishing its fundamental business principle.

Most of Amazon's profits come from its high-tech division which have been reinvested in its business and employees, not in dividends and buybacks. That strategy is reflected in spending on R&D activities, which has led to Amazon the world's top R&D firm over a short period of time. Notwithstanding such an increase in expenses for business activities generally described as R&D, Amazon insists on describing them as "technology and content." While the former focuses on business activities for "significant improvement," the latter encompasses those for "routine or periodic alterations."

Amazon has invested considerable resources in extremely innovative business areas such as AWS, Kindle, Alexa and Amazon Go for the former improvement. In parallel with such forefront innovation, it is endeavoring to absorb external innovation resources, particularly soft innovation resources [3, 4] from external markets and assimilate them into its business model, which transforms the latter business activities into the former during its R&D process.

Scheme of this unique R&D model is illustrated in **Fig. 16**.

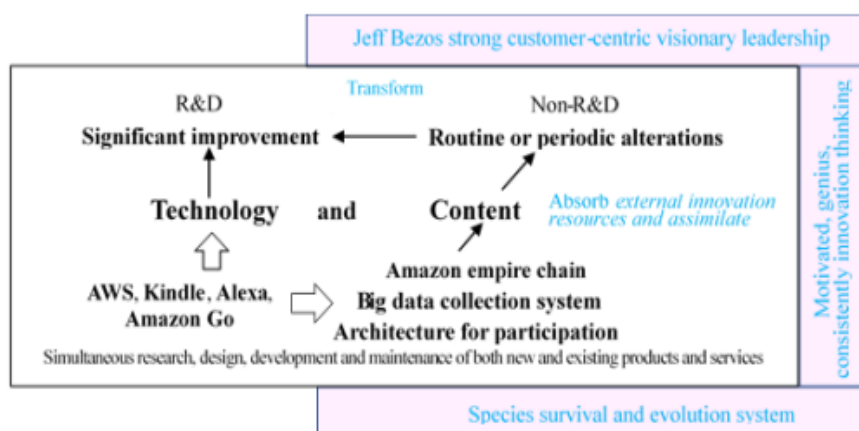


Figure 16. Scheme of Amazon's unique R&D model.

Such a world top R&D investment can be attributed to its ample free cash flow enabled by sophisticated CCC management. This management enabled Amazon to acquire ample funds that can be managed without interest for certain period as reviewed earlier leading to decrease in

average interest rate of operating funds. This decrease enabled Amazon to decrease prices of goods and services which induced interactions with customers as illustrated in **Fig. 17**.

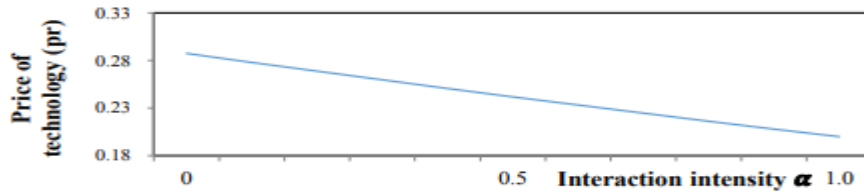


Figure 17. Correlation between interactions with customers and price decrease in Amazon..

$$\text{Marginal productivity of technology} = \frac{\partial S}{\partial T} = (1 + mr)(r + \rho) \approx p_r, \quad r = (1 - \alpha)r_0$$

where  $m$ : lead-time between R&D and commercialization,  $r$ : interest rate,  $\rho$ : rate of obsolescence of technology,  $p_r$ : relative price of technology,  $\alpha$ : interaction intensity ( $0 < \alpha < 1$ ),  $r_0$ : interest rate in the market ( $m = 3$  years,  $\rho = 0.2$ ,  $r_0 = 0.05$ : [4]).

Induced interactions, in turn, further advanced CCC as reviewed earlier leading to constructing the **first virtuous cycle** as illustrated in the upper part of **Fig. 18**.

Since increased fund through this CCC advancement can be considered as “invisible fund” unexpectedly obtained from the balance of interest free deal, such fund can be utilized for risky investment as it could be excused even if the investment resulted in no return [21, 22]. Thus, induced interactions accelerated the transformation of R&D: transformation of activities in routine or periodic alterations into significant improvement endorsed and supported by free cash flow. This acceleration increased in qualified technology stock. Increased stock contributed to sales increase and also construction of lean cost structure as demonstrated in **Fig. 19**, both contributed to increase in operation profit. This increase contributed to increase in free cash flow, thus constructing the **second virtuous cycle**. Sales increase contributed to further advancement of CCC management leading to constructing the **third virtuous cycle**.

Thus, three folds virtuous cycles can be constructed in Amazon’s CCC management as demonstrated in Fig. 18.

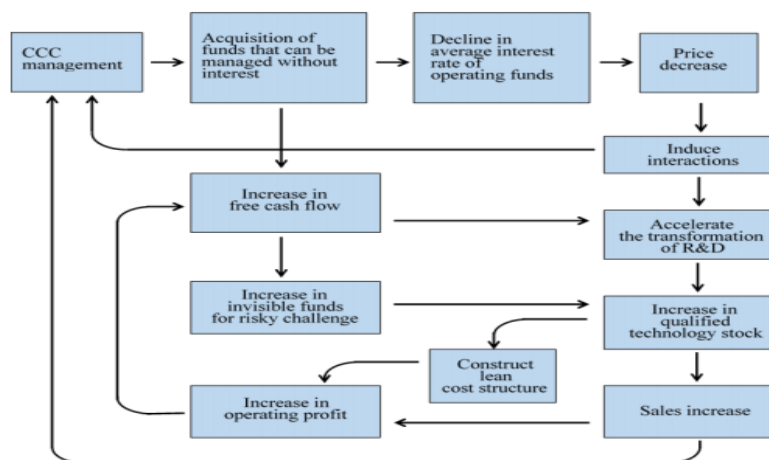


Figure 18. Dynamism of CCC in accelerating the transformation of R&D.

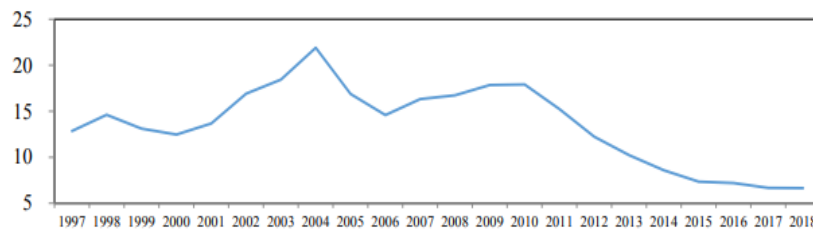


Figure 19. Dependence on non-R&D operating expenses per R&D in Amazon (1997-2018).

non-R&D operating expenses: Operating expenses – R&D.  
Source: [12, 13].

## 4. OPTIMAL COMBINATION OF ACQUISITION AND R&D

### 4.1. Exquisite Combination of Own Cash and Debt Financing

In addition to the foregoing noting cash flow management, it is also distinctive that Amazon uses different methods of financing for business acquisitions and investments taking into account the capital market conditions [23].

For example, Amazon acquired US\$ 16 bil. in debt financing for the acquisition of Whole Foods by US\$ 13.7 bil. in 2017. At that time, Amazon had over US\$ 21 bil. in cash on hand and was able to fully prepare the funds needed for the acquisition without issuing bonds. However, taking advantage of the low interest rate market environment, Amazon succeeded in raising cost and flexible funds. As Amazon continued to invest in R&D in parallel with the acquisition of Whole Foods, it was considered that its own cash should be devoted to R&D and the acquisition of Whole Foods could be covered by low interest rates as it was expected to generate cash flow.

Contrary to such financing decision to Whole Foods acquisition, Amazon utilized abundant cash generated through its CCC management as reviewed in the preceding section for investments to its new engine such as AWS and Amazon Prime. Such investments enabled Amazon holding broader financing possibilities. All financing strategy and R&D-driven business development strategy thereon has been deployed as a consolidated machine.

### 4.2. M&A Strategy

#### (1) General Trend in M&A

Amazon's M&A trend can be classified into three periods as summarized in Table 7.

Table 7. Trend in number of acquisitions by Amazon (1998-2018).

Year	Number	Cumulative number	Noteworthy acquisitions and trend
1998	5	5	Bookpages
1999	9	14	Alexa Internet
2000	0	14	Beyond book, US market
2001	2	16	
2002	0	16	
2003	0	16	
2004	1	17	
2005	4	21	Cautions against the effects of the net bubble bursting. Established a business culture to create by itself by shifting from M&A to R&D.
2006	2	23	
2007	2	25	
2008	5	30	
2009	5	35	
2010	6	41	Zappos
2011	5	46	Strengthened new infra - structure, digital contents toward fusing net and real. Established well complemented system between free cash flow and long-term debt.
2012	5	51	
2013	4	55	
2014	4	59	
2015	9	68	
2016	7	75	Twitch Interactive
2017	12	87	
2018	4	91	

Source: [12, 13].

The first period from 1998 to 2000 can be considered as the active acquisition period. During this period the acquisition aimed at beyond book and US market including Bookpages (1998, UK) and Alexa Internet (1999).

The second period from 2001 to 2008 can be considered cautious against M&A due primarily to the bursting of the net bubble. During this period strengthening of indigenous R&D base was focused.

The third period from 2009 to 2018 can be considered re-active acquisition with exquisite combination of own cash flow-driven R&D including Zappos (2009), Kiva Systems (2012), Twitch Interactive (2014) and Whole Foods Market (2017).

## (2). Typical M&A

### 1) Alexa Internet

Amazon acquired Alexa Internet in 1999 by US\$ 250 mil. This acquisition developed to Amazon's one of core business Amazon Echo (Alexa Voice Service) started from 2014.

### 2) Whole Foods

One of the biggest and most impressive acquisition was that of Whole Foods Market in June 2017 by US\$ 13.7 bil. Whole Foods is a high-end supermarket focusing on organic foods with 450 stores in the US. This acquisition was expected to Amazon's entry into real stores and sales. CNBC estimated that, Amazon's goodwill accounted for US\$ 9 bil. of the US\$ 13.7 bil. acquisition price. That means 70% of the price Amazon paid was for the future growth it expects to get from Whole Foods while a mere 30% was based on the value of Whole Foods current business and assets. Amazon's goodwill balance was US\$ 13.4 bil. as of the end of 2017.

## 4.3. Optimal Combination of Financial Resources in Inducing R&D

Fig. 20 illustrates trends in R&D, operating CF, long-term debt and number of acquisitions in Amazon over a period from 1998 to 2018.

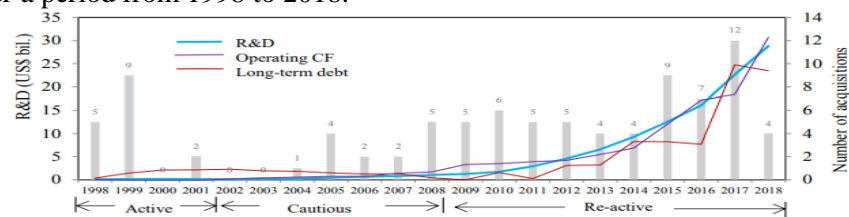


Figure 20. Trend in R&D, operating CF, long-term debt and number of acquisitions in Amazon (1998-2018).

Based on these observations, Table 8 demonstrates financial sources that induced Amazon's conspicuous R&D investment since its IPO in 1997.

Table 8. Financial sources inducing Amazon's R&D investment (1997-2018).

$$\ln R = 1.12 + 0.33D_2 \ln OCF + 0.72D_3 \ln OCF + 0.89D_1 \ln LTD - 1.04D_2 \ln LTD + 1.04D_3 \ln LTD$$

(1.79\*\*) (2.90\*) (7.71) (20.42) (-5.63) (3.80)

$$-2.46D_1 + 10.42D_2 - 0.79D_{31} \quad adj. R^2 \quad 0.996 \quad DW \quad 1.86$$

(-3.55) (5.53) (-6.42)

R: R&D investment; OCF: operating CF; LTD: long-term debt; D: dummy variables ( $D_1$ : 1997-2001 = 1, others = 0;  $D_2$ : 2002-2008 = 1, others = 0;  $D_3$ : 2009-2018 = 1, others = 0;  $D_{31}$ : 2009, 2010 = 1, others = 0).



The figures in parentheses indicate t-statistics: all are significant at the 1% level except \* 5% and \*\* 15%.

Based on this result, Amazon’s development trajectory focusing on R&D financing as an R&D-driven company can be summarized as **Table 9**.

Table 9. Amazon’s development trajectory focusing on R&D financing.

Period	1997-2001	2002-2008	2009-2018
Elasticity of financing resources to R&D			
Operating CF	-	0.33	0.72
Long-term debt	0.89	-1.04	0.17
Operating CF	No function	Start its function	Full-fledged function
M&A	Active	Cautious	Re-active
Development phase	Phase I Endeavor M&A by leveraging low interest rate market environment and raising fund with debt finance.	Phase II Develop business activities by fully utilizing the advantage of M&A and create CCC-oriented cash flow, thereby invest to R&D.	Phase III Increase cash flow, particularly free cash flow, through advancement of business and R&D thereby a virtuous cycle between them is constructed.

Table 9 demonstrates distinct focus of financial resources for R&D-driven development depending on the three phases of development as follows:

#### Phase I (1997-2001)

Founded in 1994 as a book-based e-commerce company, focal efforts were devoted to establishing financial and own R&D bases towards beyond books and US market.

During this period, operating income was minus, the same as operating CF. Consequently, active M&A was endeavored largely depended on long-term debt.

#### Phase II (2002-2008)

Developed business activities by fully utilizing the fruits of the advancement of M&A leading to gaining operating income that enabled CCC-oriented cash flow creation, thereby intensive R&D was promoted. This accelerated R&D substitution for M&A leading to strengthening indigenous R&D base and decreasing long-term debt dependence.

#### Phase III (2009-2018)

Increased cash flow, particularly free cash flow, through advancement of business and construction of lean cost structure. This induced R&D significantly which contributed to further advancement of business and subsequent CCC management. Thus, a virtuous cycle between them was constructed which re-activated M&A.

On the basis of these phased efforts, three folds virtuous cycles, involving such financing structures as ample free cash flow creation and exquisite combination with debt financing, and also R&D transformation dynamism as transforming routine or periodic alterations into significant improvement during R&D process, was constructed.

## 5. CONCLUSION

In line with an increasing concern with respect to new concept of techno-management system in the digital economy as Amazon, based on its unique identical system, jumped up to the world R&D leader in 2017 and consequent skyrocketing increase in its market capitalization over a short period of time, this paper attempted to elucidate this dynamism.

Following the authors' own preceding analysis that identified Amazon's unique R&D inducing system that transforms routine or periodic alteration activities into significantly improving activities during its R&D process by assimilating external resources of innovation based on an empire chain, big data collection system, and also the architecture for participation, elucidation of the inside the black-box of its techno-management system that enabled to secure such a huge amount of R&D investment were attempted.

It was identified that Amazon succeeded in fusing unique R&D transformation system and sophisticated financing system centered on CCC-driven cash flow management that induced the following dynamism:

- (i) With strong user-driven innovation, Amazon has constructed overwhelming power to both customers and vendors in its marketplace.
- (ii) This power enabled to construct an extremely advanced CCC as negative 20 to 30 days.
- (iii) Advanced CCC decreased average interest rate of operating fund enabling Amazon to decrease prices of goods and services leading to inducing interactions with customers while increasing free cash flow.
- (iv) Induced interactions, in turn, further advanced CCC leading to constructing the first virtuous cycle.
- (v) Endorsed and supported by increased free cash flow, induced interactions accelerated the transformation of R&D leading to increasing qualified technology stock.
- (vi) Increased stock contributed to sales increase and also to construction of lean cost structure.
- (vii) Both contributed to increase in operating profit and subsequent increase in free cash flow, thus constructed the second virtuous cycle.
- (viii) Sales increase contributed to further advancement of CCC management leading to the third virtuous cycle.

Thus, three folds virtuous cycles have been constructed in Amazon's CCC management enabling its noting cash flow management.

In addition to this cash flow-based financing, Amazon uses also different method of financing for business acquisitions and investments for R&D, taking into account the capital market conditions, thereby deploying exquisite combination of own cash and debt financing.

All financing strategy and R&D-driven business development strategy thereon has been deployed as a sophisticated consolidated machine which has been constructed through three phases of development after IPO in 1997 consisting of:

(i) Phase I (1997-2001)

Focal efforts were devoted to establishing financial and R&D bases towards beyond books and US market through active M&A largely depended on long-term debt.

(ii) Phase II (2002-2008)

Developed business activities by fully utilizing fruits of the advancement of M&A leading to gaining operating income that enabled CCC-oriented cash flow creation, thereby R&D was promoted which accelerated R&D substitution for M&A leading to strengthening indigenous R&D base and decreasing long-term debt dependence.

(iii) Phase III (2009-2018)

Increased cash flow, particularly free cash flow through advancement of business and construction of lean cost structure which induced R&D significantly leading to contributing to further advancement of business and subsequent CCC management. Thus, a virtuous cycle between them was constructed which re-activated M&A.

Noteworthy is all functions as marketplace dynamism inducing CCC advancement, CCC-driven cash flow management, and R&D transformation from routine or periodic alteration into significant improvement during R&D process well-orchestrated as a consolidated sophisticated machine

These findings give rise to the following insightful suggestions supportive to transformation of R&D model in the digital economy:

- (i) Fusion between R&D transformation model in the digital economy and CCC-seeking advanced financing system should be promoted.
- (ii) Orchestration of institutional system endorsing R&D endeavor, market dynamism inducing CCC advancement, CCC-driven cash flow management, and R&D transformation strategy should be accelerated.
- (iii) Amazon's identical platform consisting of empire chain, big data collection system, and also the architecture for participation should be reviewed from the view point of above fusion and orchestration.

Future works should focus on the following points:

- (i) In-depth comparative analysis on the similar techno-financing system in global ICT leaders.
- (ii) Deployment of similar analysis in ICT leading nations.
- (iii) Development of analytical approach identifying the optimal orchestration on key governing functions.

## ACKNOWLEDGEMENTS

The research leading to these results is the part of a project: Platform Value Now: Value capturing in the fast emerging platform ecosystems, supported by the Strategic Research Council at the Academy of Finland [grant number 293446].

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