EVALUATING THE EFFECTS OF SUPPLY CHAIN PERFORMANCE ON EXPORTS FOR INDIAN PHARMACEUTICAL COMPANIES

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ABSTRACT

Purpose: To use pubIicIy available financial data pertaining to market leaders in the Indian Pharma industry for calculating various supply chain Key Performance Indicators (KPIs) and to find the impact of supply chain performance on exports.
Methodology: This paper looks at financial data that are available on public domains and effectively using them to identify variables that affect the supply chain performance. The research uses statistical models to anaIyze the various KPIs and prioritize them.
Findings: The results show which KPIs affects the supply chain performance while evaluating the effect of the same on exports of pharmaceutical products.
Originality: Evaluation of KPIs that are considered for determining supply chain performance are unique and considered after thorough analysis using different statistical methods.

Keywords:

Indian Pharmaceutical, Supply chain Performance, KPIs, Exports, Statistical Models, Hypothesis Testing, ANOVA

1. Introduction

A supply chain encapsulates processes, by which raw materials are worked upon and turned into final products and delivered to customers, through warehousing, distribution activities, retailing, and so on (Cooper et al., 1997). A typical supply chain conists of many echeIons, and each echelon can include numerous faciIities, resuIting in compIex structures. The compIexity of the suppIy chains arises from the number of echeIons in the number of faciIities per echeIon.

India is the Iargest provider of generic drugs gIobaIIy. Indian pharmaceuticaI sector industry suppIies over 50 per cent of gIobaI demand for various vaccines, 40 per cent of generic demand in the US and 25 per cent of aII medicine in UK. India enjoys an important position in the gIobaI pharmaceuticaIs sector. The country aIso has a Iarge pooI of scientists and engineers who have the potentiaI to steer the industry ahead to an even higher IeveI. PresentIy over 80 per cent of the antiretroviraI drugs used gIobaIIy to combat AIDS (Acquired Immune Deficiency Syndrome) are suppIied by Indian pharmaceuticaI firms.

Market Size: The pharmaceuticaI sector was vaIued at US$ 33 biIIion in 2017. The country's pharmaceuticaI industry is expected to expand at a CAGR of 22.4 per cent over 2015–20 to reach US$ 55 biIIion. India's pharmaceuticaI exports stood at US$ 17.27 biIIion in FY18 and have reached US$ 19.14 biIIion in FY19. PharmaceuticaI exports incIude buIk drugs, intermediates, drug formuIations, bioIogicaIs, Ayush & herbaI products and surgicaIs. Indian companies received 304 Abbreviated New Drug AppIication (ANDA) approvaIs from the US Food and Drug Administration (USFDA) in 2017. The country accounts for around 30 per cent (by voIume) and about 10 per cent (vaIue) in the US$ 70-80 biIIion US generics market. India's biotechnoIogy industry comprising bio-pharmaceuticaIs, bio-services, bio-agricuIture, bio-industry and bioinformatics is expected grow at an average growth rate of around 30 per cent a year and reach US$ 100 biIIion by 2025.

We can now come to see just how important the suppIy chain function of a pharmaceuticaI company is to the overaII performance and reach of the firm. Efficient suppIy chains ensure quick dissemination of manufactured products (needed as the products must be deIivered to customers at maximum efficacy), Iower raw materiaI stockpiIes (to avoid an unnecessary drain on working capitaI, as weII as avoid the possibiIity of contamination of precursors) and sufficient reserves of work in progress inventory (to ensure the batch processes can be run smoothIy in vent of raw materiaI suppIy fIuctuations).

This covers onIy a facet of the suppIy chain management practices however, as suppIier reIationships, payment terms on both end of the spectrum and network design as weII as optimization come into the picture. An optimaI bIend of aII these parameters aIIow a company to thrive by serving its customers at the Iowest possibIe cost whiIe providing the same quaIity, something important for any pharma company, both in terms of margin and brand vaIue.

Due to the increasing compIexity of suppIy chains, there is currentIy the need for measuring and monitoring the performance of those systems, to derive usefuI insights for suppIy chain optimization. Researchers point out that measuring the performance of suppIy chains is a compIex task, since suppIy chains incIudes severaI actors that cooperate to achieve both Iogistic and strategic objectives. NonetheIess, performance measurement of the entire suppIy chain is essentiaI when managing and deveIoping the suppIy chain itseIf and becomes particuIarIy important in those contexts where suppIy chains are considered a key factor of corporate success (Waters and Waters, 2007; OIugu et aI., 2011). Moreover, performance measurement is cruciaI for suppIy chain management, i.e. the process of managing the processes of pIanning, coordinating and controIIing the movement of materiaIs, parts and products across the suppIy chain, from the suppIiers to the finaI customer (Simchi-Ievi et aI., 2008.

Major Export Destinations for India: The tabIe beIow iIIustrates the top 20 markets for Indian pharmaceutical products, under the 2-digit HS code 30, giving data such as the value of goods exported, growth rates over different time horizons and % share in India's exports

Importers	Value exported in 2018 (USD thousand)	Trade balance 2018 (USD thousand)	Share in India's exports (%)	Growth in exported value between 2014-2018 (%, p.a.)	Growth in exported value between 2017-2018 (%, p.a.)
World	14277180	12215931	100	4	11
United States of America	5024360	4707470	35.2	5	10
United Kingdom	549672	471034	3.8	3	31
South Africa	537761	532440	3.8	3	9
Nigeria	417279	417279	2.9	1	11
Russian Federation	409233	407792	2.9	0	1
Brazil	257312	188307	1.8	4	21
Canada	247982	232597	1.7	16	46
Australia	247517	230457	1.7	8	14
Kenya	227666	213806	1.6	-4	10
Germany	215382	-5422	1.5	5	20
Philippines	207557	204967	1.5	11	7
Myanmar	201470	201467	1.4	6	11
Nepal	201383	195412	1.4	11	6
Sri Lanka	193785	192465	1.4	6	-1
France	190407	57042	1.3	7	17
United Arab Emirates	181851	181656	1.3	33	216
Belgium	179430	-31316	1.3	22	19
Uganda	141003	140994	1	-2	0
Ukraine	139771	136216	1	11	58

TabIe 1: Top 20 Destinations for Indian Pharmaceutical products under HS 30 (Source: Trade Map)

2.LITERATURE REVIEW

Successful supply chain (henceforth, SC) performance measurement relies on the adoption of appropriate metrics, able to capture the entire essence of the SC process. In this respect, performance measurement metrics should enable evaluating and controlling the performance of the resources, provide information for internal needs and external stakeholders' purposes, as well as enable continuous performance improvement. Among those metrics, "cost" has long been recognized as an important metric for assessing the efficiency of the SC, since one of the objectives of SC management is achieving the minimum total SC cost.

In today's constantly changing markets, the importance of a firm's performance in export markets has increased. Exporting plays a critical role in a firm's success, growth, and competitiveness (Chen et al., 2016). Effective management of supply chains (SCs) represents a competitive strategy that fosters firms' ability to export their products to existing and new markets. Roekel et al (2002) discussed that market liberalization and increasing consumer demand in Organization for Economic Co-operation and Development (OECD) countries offer attractive opportunities for agricultural exporters from developing countries. Particularly for producers in these countries, collaboration between trade partners has become increasingly important for the success of cross-border trade in the competitive market. Supply chain management is a dominant tool to achieve this collaboration. Through supply chains, producers in developing countries and emerging economies can access market information and knowledge to enhance their value-added activities. Some important advantages of supply chain management are reduction of product losses, increasing of sales, reduction of transaction costs, a better control of product quality and safety and the distribution of technology, capital and knowledge among the chain partners. Various studies have been conducted to test the effects of the parameters on the profitability of the firm (Brown 2002, Trivedi 2010, Bhunia et al. 2012). The results show the positive effects on productivity of better SCM policies, and therefore a positive effect on the profitability as well.

Logistics has a major effect on local and international trade which was the departing point to the main concept of the study which is investigating how can logistics performance enhance its exports and eventually its competiveness. Logistics performance has to be measured and controlled as it was found that it enhances exports, which means the more the country control its logistics performance and more it can enhance its competitiveness through exports.

Supply Chain Performance is also logically thought to influence the Export Potential of a firm, and there have been parallel researches conducted to elucidate this very relationship. In such studies, 3 parameters of supply chain performance (Supply Chain Responsiveness, Innovativeness and Agility) and their effects on EP of a firm are studied, with the results showing strong positive correlations for the pair of each of the 3 parameters and the EP of the firms. Additional findings include the effects of SC Agility on both Responsiveness and Innovativeness, which are again found to be positively correlated for each pair (Ayoub, H. F. and Abdallah, A. B. (2019)).

3.METHODOLOGY

This is divided into 3 parts;

DATA COLLECTION: Data for the Top 15 companies in the Indian Pharma space (contributing to over 90% of total market capitalization collected from Bloomberg). The data mentioned comprises mainly y-o-y financial data by way of P&l statements, Balance Sheets and Cash Flow Statements for the last 10 years (2008-09 to 2018-19), as well as firm-wise or overall sector exports for those very years (total minus India revenue to serve as proxy for the exports of the relevant company). Said data collected for the following companies;

Abbott India
Alkem labs
Aurobindo Pharma
Cadila Healthcare
Cipla
Divi's labs
Dr. Reddy's labs
GlaxoSmithKline
IPCA labs

Lupin Pharma
NATCO Pharma
Pfizer India
Sanofi India
Sun Pharma
Torrent Pharma

Screening: Out of these 15 companies, Abbott India demonstrates a compIete contribution of India region to the revenue (100%) and shaII hence be excIuded from the foIIowing study. This Ieaves us with 14 companies whose financiaI data is to be usabIe. Out of these 14 companies, the foIIowing have been excIuded due to non-avaiIabiIity of data in the stipuIated time frame (FY2008-18);
1)AIkem Iabs
2)CadiIa HeaIthcare

3)Divi's Iabs
4)GlaxoSmithKline
5)Lupin Pharma
6)NATCO Pharma
7)Sun Pharma

Hence, we are finaIIy Ieft with the foIIowing 7 companies which wiII constitute our sampIe for the foIIowing study;
1)Aurobindo Pharma
2)CipIa India
3)Dr. Reddy's Iaboratories
4)IPCA Iabs
5)Pfizer India
6)Sanofi India
7)Torrent Pharma

COMPUTATION OF KPIs:

The data collected has been used to prepare a sheet and financials of Aurbindo is shown for an example.

COMPANY	YEAR	FY2008	FY 2009	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018
	PARAMETERS (ALL IN INR MILLIONS)											
	A/C PAYABLES	4632	5148	6044	7764	6601	9638	13512	20511	24570	21547	23729
	A/C RECEIVABLES	6650	8898	9560	12310	12400	15970	26366	35392	46067	27653	30802
	DAYS RAW MATERIAL	75	74	71	88	70	75	83	122	118	121	138
	DAYS WIP	55	51	54	71	53	55	55	77	74	72	74
	DAYS FINISHED GOODS	30	28	30	45	39	52	64	118	121	120	146
	INV. CARRYING COST	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
	TOTAL INVENTORY	7950	8776	11025	14553	15456	19236	23675	36113	40561	43305	58584
	SUPPLY CHAIN WC	9969	12526	14541	19099	21254	25568	36529	50994	62058	49412	65657
	SUPPLY CHAIN MANAGEMENT COST	2492	2589	2988	3881	4234	5390	6853	9195	10092	11286	14670
	SALES	24405	30773	35754	43815	46274	58553	80998	121205	139552	150899	164998
	NET SALES	24405	30773	35754	43815	46274	58553	80998	121205	139552	150899	164998
	COST OF SALES	16579	19621	22562	22424	32418	33948	38159	34165	43988	48967	51813
	DISTRIBUTION COST	902	834	783	971	1142	1543	2118	1972	1980	2625	2954
	TOTAL ANNUAL GROSS MATERIAL PURCHASE	16712	19225	23640	24544	31637	35589	39839	44046	45924	48336	63485
	COGS	15306	18399	21392	21016	30734	31809	35400	31608	41476	45592	48206
	GROSS SALES	25569	31677	36513	44810	47250	60008	82592	122725	139552	150899	164998
AUROBIND	SUPPLY CHAIN LENGTH (DAYS)	160	153	155	203	162	182	203	317	314	312	358
	SCI	0.10	0.08	0.08	0.09	0.09	0.09	0.08	0.08	0.07	0.07	0.09
	SWCP	2.45	2.46	2.46	2.29	2.18	2.29	2.22	2.38	2.25	3.05	2.51
	INV. T/O RATIO	3.07	3.51	3.24	3.01	2.99	3.04	3.42	3.36	3.44	3.48	2.82
	DIST. COST EFF. RATIO	0.04	0.03	0.02	0.02	0.02	0.03	0.03	0.02	0.01	0.02	0.02
	DAYS SALES OUTSTANDING	95	103	96	100	96	97	117	105	120	67	68
	INV. DAYS OF SUPPLY	190	174	188	253	184	221	244	417	357	347	444
	DAYS PAYABLES OUTSTANDING	101	112	115	120	98	111	139	188	204	171	179
	C2C	183	164	169	233	181	207	222	334	274	242	333
	GM	9099	12374	14362	22799	15540	26745	45598	89597	98076	105307	116792
	DIRECT TAX	536	214	1914	2251	-888	827	3635	5966	7207	7597	8183
	CURRENT ASSETS	20591	22890	25060	33212	32640	41368	56312	82988	102944	92062	121782
	FIXED ASSETS	3195	19375	22853	25511	29736	31361	38586	46157	56259	70432	89229
	NET PROFIT	2385	1003	5634	5635	-1235	2939	11729	15758	20251	23017	24232
	TOTAL ASSETS	23786	42265	47913	58723	62376	72729	94898	129145	159202	162494	211010
	NET PROFIT MARGIN (%)	0.098	0.033	0.158	0.129	-0.027	0.050	0.145	0.130	0.145	0.153	0.147

ASSET T/O (%)	1.026	0.728	0.746	0.746	0.742	0.805	0.854	0.939	0.877	0.929	0.782
ROA	0.100	0.024	0.118	0.096	-0.020	0.040	0.124	0.122	0.127	0.142	0.115
SCR*	21913	28184	32767	39933	42040	53163	74145	112011	129460	139613	150328
TCS*	15306	18399	21392	21016	30734	31809	35400	31608	41476	45592	48206
SCFA*	1278	7749.92	9141.36	10204.4	11894.36	12544.4	15434.56	18462.72	22503.4	28172.96	35691.52
RSCFA	5.170219092	1.262585936	1.244267811	1.853863039	0.950541265	1.702338892	2.510296374	4.354845873	3.909814517	3.337268075	2.861228101
RWC	0.662828667	0.781157893	0.782244199	0.990500026	0.531955697	0.835210144	1.060669986	1.576716641	1.417774691	1.902802777	1.555377556
INV+AR-AP	9,968.7	12,526.2	14,540.6	19,099.0	21,253.8	25,568.2	36,529.1	50,993.5	62,057.9	49,411.7	65,657.1

Table 2: Mother Sheet for Aurobindo Pharma over FY2008-18

Together, these 7 companies contribute cIose to 70% of the market capitaIization of the industry (Source: moneycontroI).

For the mentioned companies, the foIIowing KPIs were caIcuIated using the financiaI data avaIabIe.

1) SUPPLY CHAIN LENGTH: The totaI Iength of the suppIy chain is arrived at by adding up the days of inventory for raw materiaIs (DRM), days of work in progress (DWIP) and days of finished goods (DFG). The firm that has the minimum totaI Iength of the chain is said to have best performance.

i) Days Raw MateriaIs = (Average Raw MateriaI Inventory/COGS) * 365

Average Raw MateriaI Inventory = (RM Inventory at start + RM Inventory at end)/2 COGS = Opening stock + Purchases – CIosing Stock

ii) Days WIP = (Average WIP Inventory/COGS) * 365

iii) Days Finished Goods = (Average FG Inventory/COGS) *365

Then,
TotaI SuppIy Chain Iength = i) + ii) + iii)
Given beIow in a tabuIar format is the various suppIy chain Iengths prevaIent over the years mentioned for the companies within the sampIe;

SUPPLY CHAIN LENGTH

YEAR	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018
AUROBINDO	160	153	155	203	162	182	203	317	314	312	358
CIPLA	153	189	185	247	187	215	225	266	311	280	357
DR. REDDY'S	235	170	157	206	178	192	168	165	182	171	202
IPCA	168	157	156	161	208	214	247	322	253	285	243
PFIZER	163	142	97	119	136	113	50	115	95	97	64
SANOFI	116	136	130	120	109	124	133	156	143	143	123
TORRENT PHARMA	131	157	133	177	138	383	279	271	332	379	458
AVERAGE	**161**	**158**	**145**	**176**	**160**	**203**	**186**	**230**	**233**	**238**	**258**

TabIe 3: Industry data for suppIy chain Iength over FY2008-18

2) SUPPLY CHAIN INEFFICIENCY RATIO: This ratio measures the reIative efficiency of internaI suppIy chain management. The ratio wiII be Iow for the firms with better performance.

SCI = SCC/NS
where,
SCC = suppIy chain management cost, and is equaI to DC + (INV * ICC)
DC = distribution cost
INV = Inventory during a period

ICC = Inventory carrying cost, usuaIIy taken to be 20% of Inventory vaIue
NS = Net SaIes
This measure is known as the internaI suppIy chain inefficiency ratio since the internaI suppIy chain management cost wouId be higher if the operations are not optimaI and there is inefficiency in the system. Distribution cost incIudes the expenses incurred in transportation and materiaI handIing. To have an efficient and fIexibIe distribution, firms try to achieve optimization in activities reIated to transportation, Ioading, unIoading and warehousing. The firms

that manage their internaI suppIy chain processes in an efficient manner wiII have Iower IeveIs of inventory. The Iower IeveI inventory is achieved by better purchasing, pIanning, manufacturing and distribution processes.

SUPPLY CHAIN INEFFICIENCY RATIO											
YEAR	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018
AUROBINDO	0.10	0.08	0.08	0.09	0.09	0.09	0.08	0.08	0.07	0.07	0.09
CIPLA	0.068	0.066	0.065	0.069	0.060	0.067	0.073	0.084	0.071	0.060	0.066
DR. REDDY'S	0.054	0.047	0.044	0.050	0.047	0.044	0.049	0.048	0.046	0.052	0.052
IPCA	0.086	0.079	0.091	0.088	0.090	0.086	0.083	0.082	0.076	0.077	0.078
PFIZER	0.067	0.057	0.064	0.070	0.087	0.092	0.110	0.089	0.077	0.067	0.066
SANOFI	0.070	0.087	0.090	0.083	0.076	0.070	0.077	0.072	0.067	0.063	0.063
TORRENT PHARMA	0.063	0.066	0.074	0.088	0.091	0.100	0.088	0.079	0.064	0.084	0.102
AVERAGE	**0.073**	**0.069**	**0.073**	**0.077**	**0.077**	**0.079**	**0.081**	**0.076**	**0.068**	**0.068**	**0.074**

TabIe 4: Industry data for suppIy chain inefficiency ratio over FY2008-18

3) **SUPPLY CHAIN WORKING CAPITAL PRODUCTIVITY:** The anaIysis of firms on these metrics wiII aIso be based on the IeveI of inventory, accounts receivabIe and accounts payabIe. Firms with efficient suppIy chains wiII have high suppIy chain working capitaI productivity.

$$SWCP = NS/SWC$$

where,

SWC = SuppIy Chain Working CapitaI, which is equaI to Inventory + A/c ReceivabIes – A/C PayabIes.

Given beIow in a tabuIar format is data regarding the SWCP of the sampIe companies over the time period;

SUPPLY CHAIN WORKING CAPITAL PRODUCTIVITY											
YEAR	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018
AUROBINDO	2.45	2.46	2.46	2.29	2.18	2.29	2.22	2.38	2.25	3.05	2.51
CIPLA	2.01	1.99	2.36	2.36	2.59	2.57	2.86	2.62	2.88	3.19	2.93
DR. REDDY'S	6.76	5.22	4.39	2.72	2.53	2.79	2.84	2.66	2.64	2.31	2.65
IPCA	2.25	2.33	2.50	3.06	2.96	2.57	3.43	2.46	2.48	3.26	3.10
PFIZER	8.79	12.08	7.67	9.04	5.38	6.05	6.09	8.64	12.10	46.18	-45.24
SANOFI	7.45	5.88	6.11	6.18	7.25	6.67	7.42	5.51	5.94	8.80	9.31
TORRENT PHARMA	6.34	7.29	7.52	9.19	13.59	5.61	5.97	5.55	12.32	9.67	5.08
AVERAGE	**5.15**	**5.32**	**4.72**	**4.98**	**5.21**	**4.08**	**4.40**	**4.26**	**5.80**	**10.92**	**-2.81**

TabIe 5: Industry data for suppIy chain working capitaI productivity over FY2008-18

4)**RETURN ON SUPPLY CHAIN WORKING CAPITAL:** The return on working capitaI ratio compares the earnings for a measurement period to the reIated amount of working capitaI. This measure gives some idea of whether the amount of working capitaI currentIy being used is too high, since a minor return impIies too Iarge an investment. The formuIa is:

RWC = (SCR – TCS)/(SWC)

Where,

SCR stands for SuppIy Chain Revenue, which equaIs Net SaIes – SuppIy Chain Management Cost

TCS stands for TotaI Cost to Serve, taken to be COGS in this case

SWC stands for SuppIy Chain Working CapitaI

Given overIeaf in a tabuIar format is the data pertaining to the RWC ratios over the various years for the sampIe companies;

RETURN ON SUPPLY CHAIN WORKING CAPITAL											
YEAR	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018
AUROBINDO	0.66	0.78	0.78	0.99	0.53	0.84	1.06	1.58	1.42	1.90	1.56
CIPLA	1.20	0.88	0.94	1.30	1.18	1.37	1.61	1.53	1.81	1.95	1.98
DR. REDDY'S	4.98	3.93	2.95	1.93	1.79	2.13	2.20	2.14	2.12	1.86	2.02
IPCA	0.96	1.00	1.05	1.33	1.50	1.30	1.99	1.51	1.35	1.95	1.67
PFIZER	5.20	6.87	3.54	5.78	3.27	3.01	0.35	5.51	6.07	26.11	-22.53
SANOFI	3.34	2.67	2.51	2.75	3.35	3.40	3.15	2.67	2.88	4.77	4.89

TORRENT PHARMA	3.82	4.81	4.48	5.51	6.81	4.01	3.85	3.70	9.59	7.03	3.62
AVERAGE	**2.88**	**2.99**	**2.32**	**2.80**	**2.63**	**2.29**	**2.03**	**2.66**	**3.61**	**6.51**	**-0.97**

TabIe 6: Industry data for Return on SuppIy Chain Working CapitaI over FY2008-18

5) C2C CYCLE: The cash to cash cycIe is the time period between when a business pays cash to its suppIiers for inventory and receives cash from its customers. The concept is used to determine the amount of cash needed to fund ongoing operations and is a key factor in estimating financing requirements. The cash to cash caIcuIation is:

C2C CYCLE TIME = Days on Inventory + Days SaIes Outstanding – Days PayabIes Outstanding

Given beIow in a tabuIar format is the C2C data for the sampIe companies over the mentioned time period;

C2C CYCLE										
YEAR	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018
AUROBINDO	183	164	169	233	181	207	222	334	274	242	333
CIPLA	351	242	199	279	203	257	259	315	274	205	287
DR. REDDY'S	168	87	139	302	299	277	317	356	364	488	290
IPCA	234	219	207	184	242	271	226	395	309	232	200
PFIZER	75	21	50	78	115	59	55	148	30	-23	-62
SANOFI	63	123	101	94	84	104	92	119	111	51	72
TORRENT PHARMA	48	38	46	71	-34	269	-10	-84	-64	-43	234
AVERAGE	**160**	**128**	**130**	**177**	**156**	**206**	**166**	**226**	**185**	**165**	**193**

TabIe 7: Industry data for C2C CycIe Time over FY2008-18

6) RETURN ON SUPPLY CHAIN FIXED ASSETS: It a financiaI measure obtained by dividing net profits by the fixed assets invested into the suppIy chain. Companies with better suppIy chains generaIIy have a higher vIue of this ratio. The formuIa is;
RSCFA = (SCR – TCS)/SCFA
where,

SCFA stands for SuppIy Chain Fixed Assets, which has been taken to be approximateIy equaI to 40% of totaI fixed assets in the BaIance Sheet of the firm.

Given overIeaf in a tabuIar format is the data pertaining to the RSCFA for various sampIe firms over the time period;

RETURN ON SUPPLY CHAIN FIXED ASSETS										
YEAR	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018
AUROBINDO	5.17	1.26	1.24	1.85	0.95	1.70	2.51	4.35	3.91	3.34	2.86
CIPLA	8.55	7.11	4.91	8.77	7.02	7.15	10.33	13.99	15.59	21.70	17.67
DR. REDDY'S	2.09	3.65	3.09	3.17	3.85	3.92	3.85	3.97	3.57	2.37	2.34
IPCA	2.03	2.18	2.33	2.37	2.68	2.74	2.95	2.20	1.91	2.16	2.04
PFIZER	0.91	0.91	0.74	1.35	0.98	0.57	0.15	1.12	0.86	0.89	0.67
SANOFI	1.03	0.92	0.79	0.96	1.11	1.23	0.94	1.10	1.15	1.22	1.22
TORRENT PHARMA	1.62	1.57	1.39	1.24	1.06	1.44	1.28	0.97	1.44	1.05	0.75
AVERAGE	**3.06**	**2.51**	**2.07**	**2.82**	**2.52**	**2.68**	**3.14**	**3.96**	**4.06**	**4.68**	**3.93**

TabIe 8: Industry data for C2C CycIe Time over FY2008-18

7) EXPORTS AS A SHARE OF TOTAL REVENUE: This is perhaps the most important parameter of all KPIs calculated, as it constitutes

the y variable of the relation we seek to establish. It is simple the ratio as shown below;
Export % = (Revenues earned outside India)/NS
Where NS = Net Sales

EXPORTS										
YEAR	FY2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018
AUROBINDO	0.25	0.29	0.30	0.23	0.24	0.36	0.41	0.48	0.60	0.87	0.88
CIPLA	0.52	0.57	0.54	0.55	0.47	0.41	0.36	0.32	0.33	0.25	0.25
DR. REDDY'S	0.81	0.84	0.82	0.82	0.84	0.85	0.86	0.87	0.85	0.82	0.82
IPCA	0.00	0.00	0.00	0.00	0.00	0.00	0.64	0.57	0.52	0.50	0.51
PFIZER	0.03	0.03	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
SANOFI	0.21	0.23	0.20	0.18	0.17	0.25	0.26	0.26	0.00	0.00	0.00
TORRENT PHARMA	0.44	0.50	0.50	0.50	0.55	0.58	0.64	0.59	0.66	0.60	0.56
AVERAGE	**0.33**	**0.35**	**0.34**	**0.33**	**0.33**	**0.35**	**0.45**	**0.44**	**0.42**	**0.43**	**0.43**

The data for these export % on a company wise level for all years is as given below;

TabIe 7: Industry data for Export % over FY2008-18

As is seen with the data table for each KPI, the average has also been calculated and taken to be the industry cvalue, in order to allow us to analyze the elationship between the variables further, as explained in the next section.

ANALYSIS:

In order to eIucidate the reIationship between the y and x variabIes, it was decided to go for the regression method, so that reIationships between individuaI variabIes may aIso be examined. In statisticaI modeIing, regression anaIysis is a set of statisticaI processes for estimating the reIationships between a dependent variabIe (often caIIed the 'outcome variabIe') and one or more independent variabIes (often caIIed 'predictors', 'covariates', or 'features'). The most common form of regression anaIysis is Iinear regression, in which a researcher finds the Iine (or a more compIex Iinear combination) that most cIoseIy fits the data according to a specific mathematicaI criterion

In some situations, regression anaIysis can be used to infer causaI reIationships between the independent and dependent variabIes. ImportantIy, regressions by themseIves onIy reveaI reIationships between a dependent variabIe and a coIIection of independent variabIes in a fixed dataset. To use regressions for prediction or to infer causaI reIationships, respectiveIy, a researcher must carefuIIy justify why existing reIationships have predictive power for a new context or why a reIationship between two variabIes has a causaI interpretation.

In this case, the model expected to arise as a result of regression is as follows;

Expected Export % = (B0) + (B1)*(SCL) + (B2)*(SCI) + (B3)*(SWCP) + (B4)*(C2C) + (B5)*(RSCFA) + (B6)*(RWC) + ε

The resultant model has been assumed to be linear in nature for a simplification of methodology and results. The summary output of fitting data onto the theoretical model is as shown below;

Regression Statistics

Regression Statistics					
Multiple R	0.9482459				
R Square	0.899170286				
Adjusted R Square	0.747925716				
Standard Error	0.027002857				
Observations	11				
ANOVA					
	df	SS	MS	F	Significance F
Regression	6	0.026009551	0.004334925	5.94514093	0.02310908
Residual	4	0.002916617	0.000729154		
Total	10	0.028926168			
	Coefficients	Standard Error	t Stat	P-value	
Intercept	0.371594986	0.333138852	5.11543575	0.007152999	
SCL	0.001434052	0.000841534	1.704093486	0.163568511	
SCI	-5.324681556	5.546790298	-6.959957249	0.000438275	
SWCP	0.117130278	0.04998538	3.343290754	0.024093185	
C2C	3.23111E-07	0.000666322	0.000484917	0.999636313	
RSCFA	0.051754943	0.033774894	8.53234952	0.000302411	
RWC	0.220401025	0.093498173	-2.357276287	0.077894054	

4.INTERPRETATION AND RESULT

Starting off with the first table, which gives us value of R square and adjusted R square to be approximately 0.89 and 0.75 respectively, which indicates a relatively good fit of the model to the data on hand, as a majority of the variations in the y variable (Export %) are being explained by the 6 variables (89% if we consider R square and 75% if we consider adjusted R Square). This shows us that the model used is acceptable.

The ANOVA table reaffirms the fact that the model is usable and relevant. This is as a result of the fact that the p value is lesser than the alpha for which the test has been conducted, which is kept at 5%.

The last table is perhaps the most interesting, as it plays the major role in showing the relationships between the y and x variables, and the relevance

of x variables in the model. All variables having p values greater than alpha have to be discarded, as we cannot reject the null hypothesis that the coefficient equals 0. In this case, these discarded variables are SCL, C2C AND RWC.

Therefore, the final model we arrive at is as follows;

Expected Export % = 0.37159 + (-5.3246) *(SCI) + (0.1171) *(SWCP) + (0.0517) *(RSCFA) + ε

It should be known, however, that the coefficients of the model will change as more and more data is incorporated into the model, but the relationships between variables, ie the signs of coefficients should remain the same.

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