System Dynamics Report of Telecom Industry in China

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Abstract: This article analyzes mobile carriers' competition strategies by using balanced scorecard and system dynamics. We use four indexes to evaluate the situations of 2 main Chinese telecom carriers like Internal Business Index, Financial index, Market & Customer Index, as well as Innovation and Learning index. According to these four indexes and system methodology, a system dynamics model is provided, which has 4 subsystems and 80 variables. Taking the government influences into consideration as well as companies' strategies and the corresponding system simulations, we try to use system dynamics as a new enterprise computing analyzing method and give competition suggestions to the two mobile carriers.

1 Introduction

At present, Chinese telecom enterprises are facing the biggest challenges. 3G (the third generation of mobile communication technology) time is coming. Information technology is changing our world everyday. People concern how to combine internet with mobile technology. As the two mobile carriers in China, A is the dominant carrier while B is the challenger. How could B operate well in the next step? What are the results if A reacts? What should the government do next?

System dynamics is a traditional simulation tool. It's broadly used in analyzing environment, social problems and so on [1, 5]. Balanced scorecard was proposed by Kaplan and Norton and further developed by Berkman [3, 4, 6] based on managerial

experiences of many superior companies. Developed in the early 1990s, this valuation methodology converts an organization's value drivers—such as customer service, innovation, operational efficiency, compensation [2] and financial performance—into a series of defined metrics.

Different from previous work, we resolve the problems by combining system dynamics with balanced scorecard and econometrics [7]. Searching the Securities and Derivatives Markets Quarterly Report of these 2 carriers of Hong Kong Exchanges Cooperate every half year, we extract data from 1999 to the first half of 2005 [8] and use a special software Vensim-PLE5.4c to establish a system dynamic model to simulate the operation situation of 2 carriers in China.

2   System Dynamic Model for One Mobile Carrier

This model (**Fig.1**) contains 4 subsystems according to the balanced scorecard. Considering the policy environment as surroundings, we evaluate indexes referring to EFE and IFE method [10]. The global telecommunication market environment is not considered.
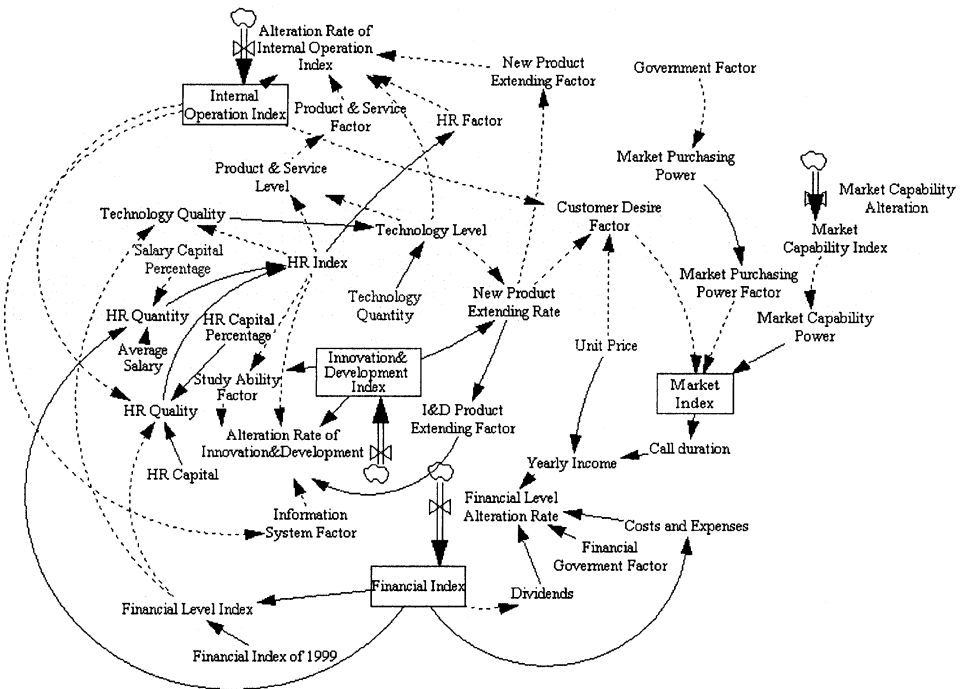

Fig. 1. Flows and stocks diagram of one operator [9, 11, and 14]

Internal sub-system [Internal Operation Index (level variable), Alteration Rate of Internal Operation Index (rate variable)]. Human resource influences the core

technology, and the stronger enterprise's competing ability is the higher core tech level will be. To simplify the problems and diagram, we use 2 rates to show the output of these 2 enterprises. Human Resource Level is affected by HR Efficiency Level and HR Quantity Level. Core Technology Level is affected by Core Technology Efficiency Level. Staff Efficiency is determined by Financial Level, Standard HR Investment Ratio and HR Investment Ratio.

Financial sub-system [Financial Index (level variable), Financial Alteration Rate (rate variable)]. Financial Alteration Rate is the synthesized function of 'Income', 'Expense and Cost ', 'Revenue', 'Dividend', and 'Government Factor'. Income is the product of unit price (income per minute for the telecom companies) and the call duration. Call duration is the conditional function of the Market Level. Here Government Factor is the auxiliary variable.

Market sub-system [Market & Customer Index (level variable), Alteration Rate of Market & Customer (rate variable)]: Alteration Rate of Market & Customer is the synthesized function of 3 factors about Purchasing Power, Market Capability and Purchasing Desire.

Innovation and Development sub-system [Innovation and Development Index (level variable), Alteration Rate of Market & Customer (rate variable)]. Innovation and development ability indicates an enterprise's ability and potential.

3 Integrated System Dynamic Model for Two Mobile Carriers

This model is for the competition situation simulation of the 2 companies (**Fig. 2.**).
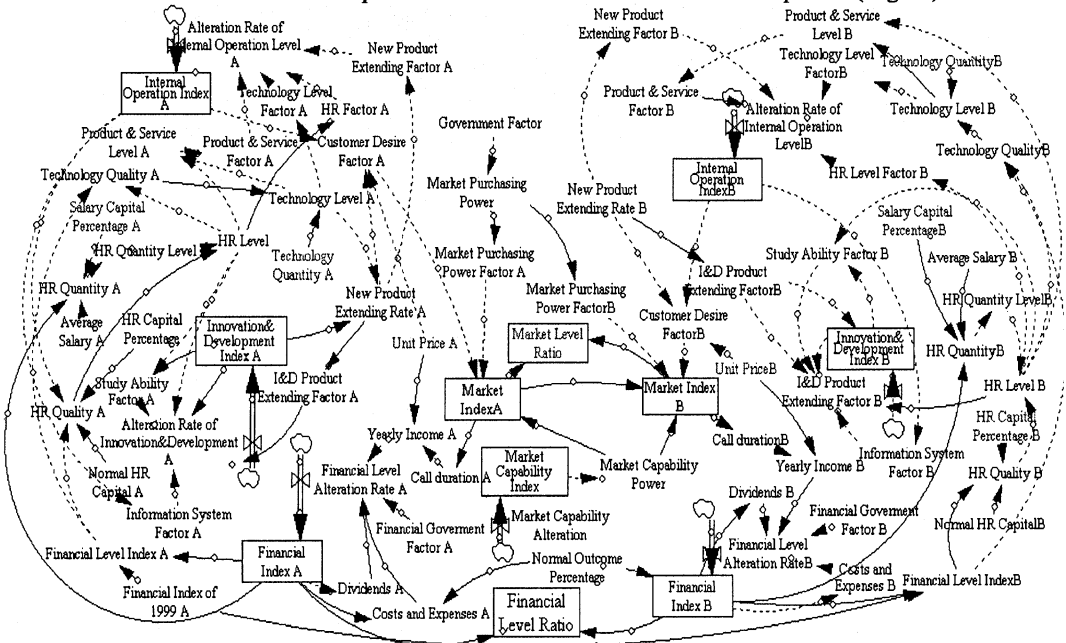
Fig. 2. The integrated system dynamic model

4 Equations for Stocks and Flows of The Integrated System Dynamic Model

Here we get the equations for the system simulation containing these 2 companies:

1. d(Internal Operation Level)/dt=Internal Operation Alteration Rate= f1(Core Technology Factor, Human Resource Factor, Product & Service Factor, New 2.Product Extending Factor) ; Internal Operation Level$|_{t=1999}$=4.3;
3. d(Financial Level)/dt=Financial Level Alteration Rate=f2(Income, Expense and Cost, Revenue, Dividend, Government Factor);

4. Financial Level$|_{t=1999}$=65,733;

5. d(Market&Customer Level)/dt=Alteration Rate of Market&Customer
=f3 (Purchasing Power Factor, Market Capability Factor, Purchasing Desire Factor);
6. Market&Customer Level$|_{t=1999}$=5.5
7. d(Innovation&Development Level)/dt=Innovation&Development Alteration Rate
= f4(Study Ability Factor * New Product Extending Factor* Information System Factor) +1)* Innovative&Develop Level;
8. Innovation & Development Level$|_{t=1999}$=1;
9. Financial Ratio= Financial Index A/ Financial Index B;
10. Market Index Ratio= Market Index A/ Market Index B;

As to the similarities between the systems of A and B we do not list the equations for B here.
The data sample is shown in Table1 in appendix.

OLS [12] parameter estimation;
CRY=u+β_1*FY;   (1)
CRL=u+β_1*FL;   (2)

Dependent Variable: Y				
Method: Least Squares				
Date: 01/02/06 Time: 14:57				
Sample(adjusted): 2000:2 2005:1				
Included observations: 10 after adjusting endpoints				

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2543.225	4694.145	0.541787	0.6027
X	0.266191	0.036661	10.73736	0.0000
R-squared	0.935113	Mean dependent var		50410.00
Adjusted R-squared	0.927002	S.D. dependent var		17208.21
S.E. of regression	4649.334	Akaike info criterion		19.90369
Sum squared resid	1.73E+08	Schwarz criterion		19.96421
Log likelihood	-97.51846	F-statistic		115.2913
Durbin-Watson stat	1.603004	Prob(F-statistic)		0.000005

Dependent Variable: LY				
Method: Least Squares				
Date: 01/02/06 Time: 15:07				
Sample(adjusted): 2000:2 2005:1				
Included observations: 9				
Excluded observations: 1 after adjusting endpoints				

| Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-4009.316	5854.328	-0.684846	0.5155
LX	0.399237	0.070324	5.677145	0.0008
R-squared	0.821565	Mean dependent var		26279.00
Adjusted R-squared	0.796074	S.D. dependent var		9220.582
S.E. of regression	4163.842	Akaike info criterion		19.69939
Sum squared resid	1.21E+08	Schwarz criterion		19.74322
Log likelihood	-86.64727	F-statistic		32.22997
Durbin-Watson stat	2.490722	Prob(F-statistic)		0.000753

Fig. 3. Eviews output of the costs analyses

To process the data reliably and accurately, we use software Eviews. Take the conditional function of Net Assets, Expenses & Costs for example: CRY=2543.225+0.285FY. F=115.2913, DW=1.518, r^2=0.935, interpret that only 6.5% could not be explained by sampling regression linearity with 93% of the total sum of squares of deviations qualifies. The sample regression line explains the sample point with a high goodness of fit (**Fig. 3**). It means the modeling may be in a fit format. Similarly, the correlation between Expenses& Costs level and net assets of Firm B: CRL=-4009.3+0.399FL. (Low goodness of fit indicates the superior firm has more choices and is much more dependent)

Equations: LS = -2826.122 + 0.994*LFI; YS = -13872.408 + 0.633*YFI

5 Simulation Results

5.1 Carrier B:

Because financial circumstance is the most important index for the operator and market is carriers' final goal, we pick graphs concentrating on these 2 sides. **Fig. 4** illustrates the financial ratio and **Fig. 5** describes the customer index's development in the next 5 years. (After B adopts the new strategy, keeping the total investment ratio at 1.2 and it improves the salary ratio and HR investment ratio to 1.25.)
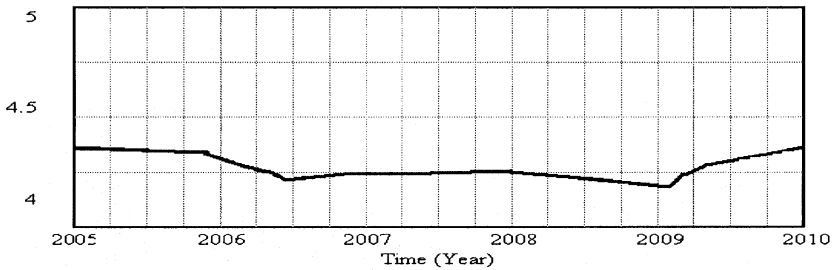
"M&CR" : final

**Fig. 4.** Financial situation of carrier B in 2005~2010(FR- Financial Index Ratio)
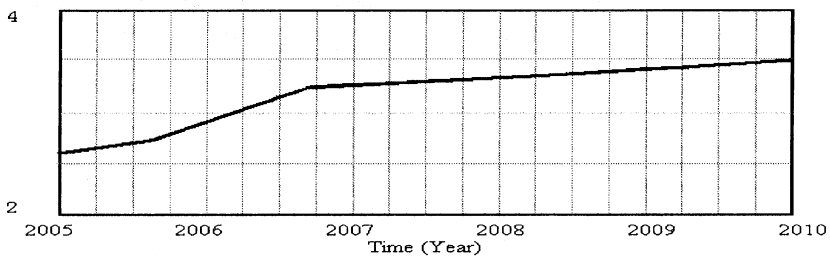
FR : final

Fig. 5. If carrier B takes the new strategic plan into application 2005~2010 (M&CR-Market and Customer Ratio)

From the graphs, we could see the slopes are positive, which means the distance between A and B is always growing and the speed is slowing down, with financial index increasing to 3.5 and M & CR to 4.35 at the end of 2010, (compare with FR 7.9 and M&CR 9.2 in 2010 if B do not adopt new strategic plans and the negative deposits lead to a negative circle). Originally A's net profit was 18 times of B's in 2005 and if B adopts the strategic amendment that would be delayed to 2010 or later. In the next 5 years it would experience several fluctuations; nevertheless the overall slope is going down but still larger than 1, indicating that B is still at the disadvantageous position. Here we could see the net asset ratio is much lower than that of net profit 2.26 in 2004. And that benefits B.

5.2   Carrier A

For carrier A, we compare carrier A's 2 situations whether A reacts after B changes its strategies or not. Market is the corporations' aim and also the factor we very concern.

"M&CR" : final
CPDR : final

(a)

"M&CR" : final
CPDR : final
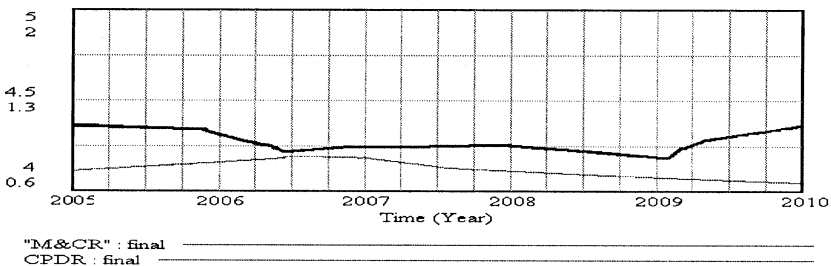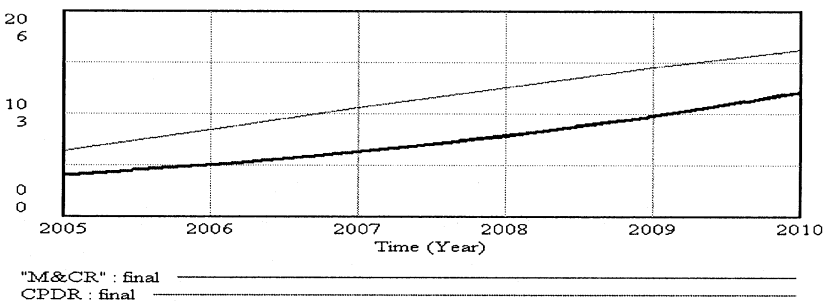
(b)

Fig. 6. Simulation for the next 5 years--A does noting (**Fig. 6** (a)), and A reacts immediately after B (**Fig. 6** (b)) when B works as in **Fig. 5** (M&CR is Market and Customer Ratio, CPDR is Customer Purchasing Desire Ratio)

We could see the financial ratio would keep on increasing from 4.35 to 12 in the next 5 years if A reacts immediately after B and the government does not interrupt with any anti-monopolization regulations. Among the top 500 companies, A ranks low in income but much higher in profit, which implies that the price of A is not very reasonable. So the structure of the price should be optimized and keep track with international level.

6   Conclusions and Limitations

Firstly carrier B could increase the investments and management efficiencies by improving human resource level and keep other level ratios to a certain degree simultaneously; To Concentrate investments in key areas including bonuses [16] and HR funds to maximize profits secondly; And to allege that they are aiming at becoming the second largest mobile carrier in China's Mobile Industry to distract competitions threats step by step [15].

Carrier A could firstly segment the market and emphasize differences. Second, it should develop products of lower price level and consider showing competition threats, improving the innovation and customer service investment, and finally individuating products to make them more different and remarkable so as to improve customers' desires.

For the government, encouraging efficient competitions, maximizing the competition capability and rationalizing resource distribution are rational suggestions. TD-SCDMA needs to be paid special attention to, with its own advantages in frequencies and standards [13].

We haven't made corresponding simulations on government side this time. Modify and making more specific simulations of enterprises' operation behaviors is part of the further work basing on the model.

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Appendix

Table1. Simulation data

Unit (million)	Carrier A						
Year	Income	Expenses and costs	Taxes& Interests	Net Profits	Dividends	Assets	Net Assets
First Half of 1999	16,940			4,004			
Second half of 1999	21,683			793			
1999	38,623			4,797			
							65,733
First Half of 2000	28,897	16,092	4,081	8,724			74,457
Second half of 2000	36,087	40,526	4,285	9,303			83,760
2000	64,984	56,618	8,366	18,027			83,760
First Half of 2001	48,864	28,146	6,909	13,809	2	13,811	97,571
Second half of 2001	51,467	30,467	6,794	14,206	2	14,208	111,779
2001	100,331	58,613	13,703	28,015	4	28,019	111,779
First Half of 2002	55,146	32,131	7,800	15,215	5,969	21,184	132,963
Second half of 2002	73,415	47,454	8,575	17,386	22,916	40,302	173,265
2002	128,561	79,585	16,375	32,601	28,885	61,486	173,265
First Half of 2003	76,675	49,858	9,355	17,462	-6,672	10,790	184,055
Second half of 2003	81,929	55,778	8,057	18,094	-3,346	14,748	198,803
2003	158,604	105,636	17,412	35,556	-10,018	25,538	198,803
First Half of 2004	86,420	58,232	9,359	18,829	-4,167	14,662	213,465
Second half of 2004	105,961	72,965	9,821	23,175	-3,236	19,939	233,404
2004	192,381	131,197	19,180	42,004	-7,403	34,601	233,404

Unit (million)	Carrier B						
Year	Income						
First Half of 1999	8,074						
Second half of 1999	9,376						
1999	17,450	Expenses and costs	Taxes& Interests	Net Profits	Dividends	Assets	Net Assets
First Half of 2000	10,505		360	270			
Second half of 2000	13,187			569			8,538
2000	23,692			839			8,538
First Half of 2001	13,619	10,223	111	171			
Second half of 2001	15,774	9,130	994	3,063			57,224
2001	29,393	19,353	1,105	3,234	45,452	48,686	57,224
First Half of 2002	17,991	10,576	851	2,192			
Second half of 2002	22,586	13,319	190	2,265			61,681
2002	40,577	23,895	1,041	4,457	0	4,457	61,681
First Half of 2003	31,967	15,125	729	2,137	115	2,252	63,933
Second half of 2003	35,669	19,134	991	2,461	259	2,720	66,653
2003	67,636	34,259	1,720	4,598	374	4,972	66,653
First Half of 2004	39,372	28,616	966	2,385	-1,256	1,129	67,782
Second half of 2004	39,960	35,669	922	1,822	36,327	38,149	105,931
2004	79,332	73,415	1,888	4,207	35,071	39,278	105,931
First Half of 2005	43,244	35,220	1,262	2,890	-6,628	-3,738	102,193