What' Wrong With the Mighty Lord?
: Empirical Study on the Decline of *Lineage 2*

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Abstract

The purpose of this article is to take empirical tests for presumed causes of *Linege 2*'s declining trend. Using time usage data of *Lineage 2(L2)*, *Kart Riders(Kart)* and *World of Worldcraft(WoW)* collected from PC-bangs, we take statistical tests on the rivalry hypothesis among games. Results show that there is no consistent evidence that *L2*'s falling down is caused by the success of Kart or *WoW*. Instead, it is clearly identified that the trend of RMT had a respectable impacts on *L2* in comparison to *L1*. All the test result implies that in-game factors such as RMT played a more decisive role in *L2*'s decline than external factors like tougher competition.

Keyword: *Lineage 2*, *World of Warcaraft*, *Kart Rider*, VAR(Vector autoregression), Granger causality, Impulse response function, Real-money trading

*** It's review version. See next page for the use of this article.**

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The latest day of modifying the paper is on its cover. If you are to quote this article in any way, contact the author. Also, you cannot distribute the copy of the article without permission of author. Thanks to Park, Sang Woo for helpful comment. Special thanks to Yu, Hyun Joo of ItemPF for valuable data on item price of *L1* and *L2*. All faults of this article belong to author. Any comment will be welcomed.

1 *Linage 2*, the Falling Lord?

Doubtlessly, NC Soft's smash hit massively multi-user online role-playing game(MMORPG) *Lineage 2*(*L2*) is the one of the most successful games in Korea. *L2* launched its beta testing service in Jul. 2003, the number of subscribing players had hit 150,000 just in Korea by Oct. 2003. Though *L2* enjoyed unprecedent steep growth curve, its durability fell a little short of expectations of many players and experts. They had been so sure that the life-cycle of *L2* would be much longer than recently observed trend. This assertion came from the comparison with *Lineage 1*(*L1*). *L1* started in 1998, but it still contribute much to the NC Soft's revenue until now.[1] At first, many gamers saw that *L1* could be substituted for by *L2*. *L1* gamers would move to richer and more beautiful world of *L2* eventually. Everyone thought that *L2* were the one and only legitimate successor of *L1*. But, reality revealed that its younger brother has been aging much faster than the elder. What's wrong with *L2*? Fig. 1. shows that the succession went wrong after Nov. 2004(in Fig1 period C). *L2* had gained steady dominance over *L1* after Jun. 2004(period B), but this dominance ended suddenly during falls and recoveries in both of *Lineage* brothers.[2] By and large, about three factors are believed to play in the decline of *L2*.

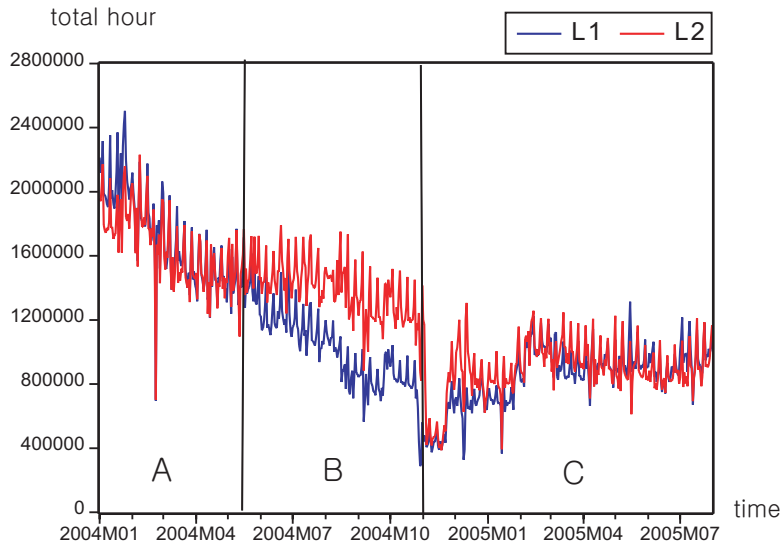
First assertion is that more competitive environment of *L2* might shorten its life-cycle.(Kim (2005)) *L1* could get most of MMORPG users when it came out, and for a considerable time it had enjoyed nearly monopolistic position in the market. But, *L2* had no chance of having such an advantage. This assertion is not wrong in the broader scene. But, this view does not explain why *L2* was getting cold much faster than *L1*. In a sense, competition around *L1* might be fiercer than *L1*, for *L1* is 2D-graphic based old-fashioned game. Considering huge rush of MMORPG in Korea after *L1*, competitive condition for *L2* is not so severe than *L1*. Moreover, the launch of *L2* had won a spectacular success, which might be bigger than its elder. Moreover, *L2* had leveraged an powerful reputation from the elder. We can not definitely judge that tougher competitive condition brings *L2* faster declining trend.

Secondly, Shrinking tendency of MMORPG users may be one of factors in play. This assertion is somewhat similar to the first, but it focuses on

[1] *L1*'s total revenue for five years since the launch amounts to five hundred million USD, which is recorded just in Korea.

[2] Some events or changes were attributable to this sudden dropping down. Much anticipating advent of *WoW* might be decisive. Some game experts, however, pointed out that banning on simultaneous running of multiple clients were the hidden factor.

Figure 1: The usage trend of *L1* and *L2*



another aspect. Actually, most of big budget MMORPGs since 2003 didn't achieve juicy successes that older ones had enjoyed. A new winner in the market was the casual online game. Especially, *Kart Rider*(*Kart*) developed by Nexon is the most impressive one. *Kart* quickly stole the throne of national videogame from the long-lived *Starcraft*. Some game analysts were so in rush that their conclusion was the end of golden age of MMORPG. It is clearly right that the growth of casual games was unexpected and surprising one. But, it is neither certain nor proved that casual games had really eroded the share of the MMORPG away. Is there any statistically consistent proof for this? Might two events happen independently? Rising of casual games does not always means a harsh trimming of MMORPGs.

Third argument is that design features or in-game motives for playing *L2* bring the premature aging upon itself. Media on videogames often commented this sort of view that such a failure as shallow degree of emersion in *L2*, the collapsed balance of in-game economy incurred its short life-cycle. Some had pointed real-money trading (RMT) issues that returns on selling items in *L2* were falling more sharply than *L1*. the declining trend of *L2* would result from those in-game disruptions.

Three assertions above share some parts of reality. No empirical works, however, have ever been done. First of all, as detail data on subscription

condition have been among top and deep secret of game companies, empirical analysis is hardly to be done. Recently, a Korean research firm, Gametrics[3], has been collecting and announcing various kind of time usage data on each game from their franchisee PC-bangs.[4] Data gathered by Gametrics do not suffer any critical problem for statistical tests. Data have been collected in the error-minimizing computerized way, which make them fairly credible than others. The number of sample is large enough to make statistical tests stable and robust. Even though data do not contain the trend of many other players in their homes, these are best and most reliable numbers which can be relied on by now.

The focus of research in this article is a just simple one. Does rivalry among online games really exist? In a word, did *Kart* or *World of Warcraft*(*WoW*) do any real harm to *L2*? As previously seen, consequences of tougher competition seems to be obvious, but statistical tests for common wisdom often tell entirely another story. Moreover, this tests would shed some lights on narrowing down the cause of fast-pacing decline of *L2* and identifying some of properties of Korean online game markets.

2 Data and Basic Statistics

Gametrics has been collecting data from its franchisee PC-bangs on a daily basis. As the number of sampling units(PC-bangs) is different, Gametrics announces MV index of its own for normalization. But, we'll use total time usage instead of this normalized MV index, because MV index do not measure overall popularity or scale of each game.

Selected games for analysis are *L2*, *Kart*, and *WoW*. Previously mentioned, *Kart* is the most successful casual game so far. Some of game experts see the downturn of *L2* came from a boom in casual games like *Kart*. Another seemingly fatal blow to L2 was *WoW*. The launch of *WoW* attracted so much attention not just for its excellent game contents. The game was expected to be the toughest challenge for *L2* in Korea's MMORPG market.[5]

Basic statistics for three games are at Tab. 1. Variables are obtained from Gametrics database from Jan. 1st 2004 to Jul. 31th 2005.

[3]http://www.gametrics.com

[4]The PC-bang is a representative playground for online players. As Korea is one of best broad-banded countries in the world, you might think that places like PC-bang would be much less needed than others. The PC-bang, however, is not only places for connecting games with more speed, but also cozy dedicated heavens for players.

[5]Blizzards, the developer of *WoW*, is one of the most influential developers among Korean gamers.

Table 1: Basic statistics for time usage(hour)

Statistics	L2		Kart		WoW
	T[a]	S[b]	T	S	T
Mean	1,216,734	910,219.3	1,268,907	1,651,955	704,790.9
Median	1,203,917	896,000	1,339,118	1,600,913	681,054.5
Maximum	2,230,753	1,306,817	2,860,164	2,860,164	1,180,403
Minimum	387,630	387,630	37,434	499,008	62,100
Std. Dev.	373,355.2	153,579.2	676,343.4	447,890.9	170,673.6
# of Obs.	578	258	383	258	258

[a] Calculated for total observation range of each game
[b] Calculated only for sample observation range(WoW)

For total and sample period, Kart has highest mean and median. But, As expected, *L2* and WoW which are classified as MMORPG have much less volatility. Standard deviation of *Kart* is larger than the other two.

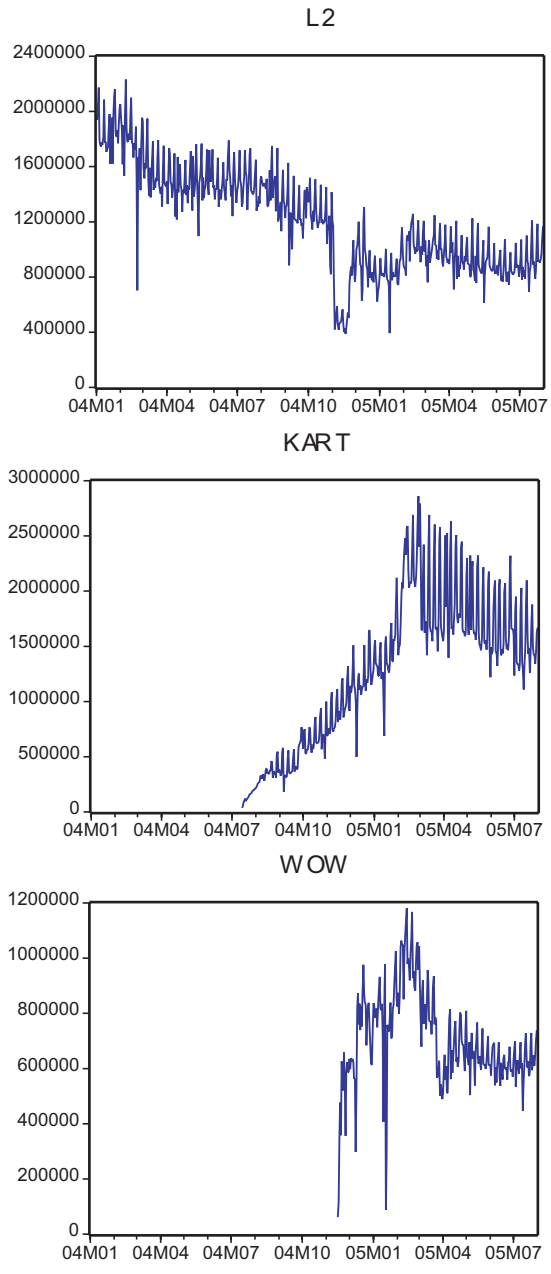
Fig. 2 shows the time trend of each game for total range of each variable. The trend of WoW was going up steeply during open beta service. But, usage trend is not seriously slowed down after the official launch in which players should pay monthly fee. The trend of *Kart* shows its huge success directly. Patterns of WoW and *L2* are relatively stable. The usage of L2 had dropped down suddenly around Nov. 2004.[6] The trend was back on the track again quickly after Jan. 2005. Judging from data, L2 had probably hit the peak before Jan. 2004. So, the trend of *L2* as a whole is already falling down for our total observation period. Thus, whether two competitors really have speeded up the falling trend of L2 or not is one of our crucial points in analysis.

3 Empirical Methodology

The methodology is Vector autoregression(VAR). Though VAR has been criticized for its weak theoretical foundations, it is really useful to analyze time series data. Also, Granger causality tests using VAR fits well for our

[6]What caused this abrupt drop down was somewhat unclear. Firstly, shock of WoW might have been one of a reason. Another more interesting explanation was NC soft's change of policy. About Nov. 2004, NC Soft banned strictly running multiple clients in one PC. Many players and traders at the time harnessed this trick for their needs.

Figure 2: time trends of each series



purpose. The procedure of statistical test consists of two steps.[7]

First, for building VAR equations, the unit root of individual variable should be check. If any variable follows unit root process, we should check co-integrating relation among them. With co-integration, we can not use unrestricted VAR estimation directly, but error correction model(ECM). If no co-integration exists, modified variables that are free from integrating process fit for VAR estimation. Next, based on previous pre-tests, VAR equations are to be set up. With these equations estimated, we'll look at causalities among variables using Granger causality test. Impulse response functions(IRF) are useful in finding how a shock from one variable could affect others through the time. Equations in our analysis have many lagged terms, which we can not tell definite signs of causalities. With IRF analysis, we can track down dynamic changes of each variables.

4 Empirical Results

In this section, empirical results on relation between three games will be reported in following order. At first, two pre-tests are reviewed shortly. Next, results of VAR estimation are presented(Sims (1980)). With this, causal relationship between variables are to be established by the method of Granger causality(block exogeneity) analysis. Finally, using IRF analysis, the dynamic effect of a change in a game to the others will be examined.

For this analysis, three data in focus are transformed into appropriate forms for better specification.[8] First, every three series are divided by *L1* daily total usage.[9] Second, natural logarithm is taken to each series.

Unit Root Tests

Unit root tests are first steps before estimation. If each variable has no integrating process, we are to estimate VAR equations directly. If not, we should transform variables to eliminate integrating process.

Unit Test results are summarized in Tab. 2. ADF(Augmented Dick-Fuller) tests show that one variable($\Delta log(Kart^*)$) has unit root process of

[7] See Greene (2003) for a simple introduction to VAR model

[8] This transformation of data is implemented for specification issue, eliminating auto-correlation and heteroscadasticity in residuals. Estimation results, however, do not fundamentally differ among alternative specifications. So, we choose statistically fitting model without a full account.

[9] In economics, macroeconomic data are transformed into real ones by dividing price index. By dividing *L1* usage data, similar treatment could be achieved.

Table 2: Unit root test

Variable	ADF-t[a]	Prob.	Order of integration[b]
$log(Kart^*)$[c]	-2.526191	0.1104	I(1)
$\Delta log(Kart^*)$	-8.349515	0.0000	I(0)
$log(WoW)$	-3.049098	0.0319	I(0)
$\Delta log(WoW^*)$	-18.55215	0.0000	I(0)
$log(L2)$	-3.827581	0.0030	I(0)
$\Delta log(L2^*)$	-18.60911	0.0000	I(0)

[a] Lag length is chosen according to Schwarz info criterion.
[b] For 10% rejection region
[c] Asterisk(*) means each variable divided by total usage time of *L1* of each day.

I(1).[10] According to Tab. 2, daily data of *Kart* are non-stationary for their levels. The order of integration of each variable is also provided along with ADF statistics. One is I(1) process, and two are I(0). As only one variable is integrating process, issue of co-integration process can be safely ruled out. Unrestricted VAR estimation with 1st difference terms of each variable would do well.

VAR Estimation

VAR equations are following forms.[11]

$$g_t = A_1 g_{t-1} + A_2 g_{t-2} + \cdots + A_p g_{t-p} + BX_t + \epsilon_t$$

g'_{t-i} : $[\Delta log(L2^*)_{t-i}, \Delta log(Kart^*)_{t-i}, \Delta log(WoW^*)_{t-i}]$, for $i = 0, 1, \ldots, p$

X_t : a vector of constant and exogenous variables

ϵ_t : a vector of innovations

[10] ADF tests for each series are achieved assuming the presence of a unit root or non-stationary variable in the null hypothesis(H0) and stationary variable in the alternative hypothesis(H1).

[11] This specification is called as VARX model which exogenous variables are included in equations.

A_is and B are coefficient vectors that are to be estimated. ϵ_t is contemporaneously correlated but are uncorrelated with their own lagged values and uncorrelated with all of the right-hand side variables.

A critical issue for model specification is lag length choice. Generally, lag length can be determined by alternative criteria such as LR, FPE, AIC, SIC, etc. The best fitting model is the one that maximizes the LR or minimizes the FPE, AIC, SIC, or HQ criteria. Alternative criteria imply different tradeoffs between fit and loss of degree of freedom. Eight lag length is chosen, because it fits best in LR, FPE, AIC criteria. Moreover, eight days appear to be not so bad to observe changing choices of players. Two exogenous variables are included. One is constant, the other is weekend dummy.[12]

As the result of estimation is somewhat cumbersome, it was reported at the appendix. With this result, Granger causality tests and impulse response analysis are to be implemented.

Granger Causality Tests

Granger causality test is a technique to find statistical causalities in time series data. The Granger (1969) approach of whether X causes Y is to see how much of the current Y can be explained by past values of X and then to see whether adding lagged values of X can improve the explanation. Y is said to be Granger-caused by X if X helps in the prediction of Y, or equivalently if the coefficients on the lagged X's are statistically significant.[13]

Test statistics is χ^2-Wald statistics for the joint significance of each of the other lagged endogenous variables in each equation. H0 is that lagged endogenous variables has not caused dependent variable. The result of tests is summarized in Tab. 3. If excluded variable has not statistically significant predictability on dependent variable, we can not reject H0, so there presumes to be no causality between two variables. According to results, the only statistically significant effect is *Kart* on *L2*. Is this rivalry confirmed? As seeing next subsection, the sign and the magnitude of this effect appear not to be consistent with rivalry between two games. Except this one case, three games seemingly in rival relationship do not compete to each other. As *Kart* and *WoW* have been on more vigor early stage than *L2*, non-rivalry among

[12] In weekend, time usage tends to be up-rising for all games. With weekend dummy variable, Two differences in a week(from Friday to Saturday, and from Sunday to Monday) are set to be 1, all the rest are 0.

[13] It is important to note that the statement "X Granger causes Y" does not imply that Y is the effect or the result of X. Granger causality measures precedence and information content but does not by itself indicate causality in the more common use of the term.

Table 3: Granger Causality/Block Exogeneity Wald Tests

Dependent variable: $\Delta(log(L2^*))$

Excluded	Chi-sq	df	Prob.
$\Delta(log(Kart^*))$	15.35337	8	0.0526
$\Delta(log(WoW^*))$	6.192560	8	0.6257
All	21.88830	16	0.1468

Dependent variable: $\Delta(log(Kart^*))$

Excluded	Chi-sq	df	Prob.
$\Delta(log(L2^*))$	6.200248	8	0.6248
$\Delta(log(WoW^*))$	8.720225	8	0.3664
All	14.73893	16	0.5438

Dependent variable: $\Delta(log(WoW^*))$

Excluded	Chi-sq	df	Prob.
$\Delta(log(L2^*))$	6.162749	8	0.6290
$\Delta(log(Kart^*))$	7.562822	8	0.4773
All	14.31919	16	0.5749

them is even more surprising. Despite limited range of data collected, this could be interpreted that rivalry of online games is not so intense as one might think.

Impulse Response Analysis

Analysis with impulse response function(IRF) is useful in that the result of VAR estimation are not easily interpretable. With IRF, effects among variables can be identified in time progressive manner. A shock to a variable not only directly affects the variable but is also transmitted to all of the other endogenous variables through the dynamic (lag) structure of the VAR. Impulse response functions trace the effect of a one-time shock to one of the innovations on current and future values of endogenous variables.[14]

[14]Really important issue is the choice of decomposition method of residuals because this defines the pattern of impulses. Many criticisms on the a-thoretic of VAR model are

Figure 3: Accumulated impulse responses

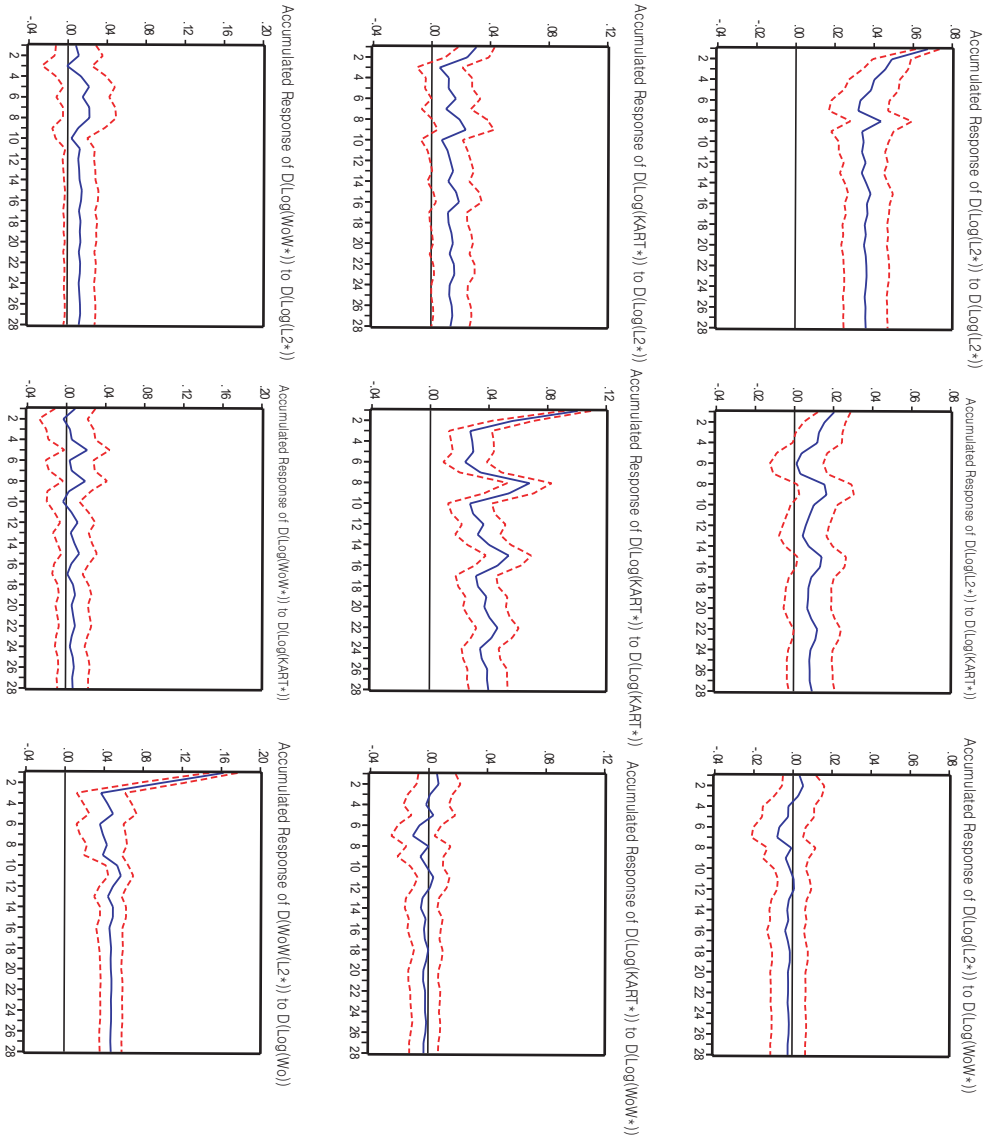


Fig. 3 shows accumulated changes of each variable to a shock in other variables during twenty eight days(one month). A shock is measured by Cholesky one standard diviation, the dash lines are ± twice of standard error. Some results are out of common expectations. Looking first at responses of *L2*, the effect of a shock in *Kart* turns out to be positive to *L2*. According to previous Granger causality test, the only statistically valid effect is *Kart* on *L2*. Contrary to expectations, however, there does not exists rivalry, but complementary. The effect of *WoW* on *L2* is in the line with the commonly held view. But, rivalry between *L2* and *WoW* is not easily established in that the effect of a shock in *L2* takes positive to *WoW*.

Table 4: Accumulated changes in usage for 28 days

Variable	Shock[a]	% Change
L2	L2	0.54%
	Kart	0.46%
	WoW	-0.66%
Kart	L2	0.44%
	Kart	0.40%
	WoW	-0.55%
WoW	L2	1.51%
	Kart	0.82%
	WoW	0.29%

[a] For 1% shock of each variable

Although Fig. 3 is good for the intuitive overview, more interpretable numbers are to be calculated. In Tab.4, numerical reposes of each games by different shocks are presented. the response of itself means network effect of each variable. *L2* has the strongest network effect, but this values do not varied much among games. *WoW* have negative effects on the usage

all about this decomposition method(Cooley & Leroy (1985)). Bernanke (1986) proposed Structural VAR model that modified decomposition method in line with assumed economic theory. If any theory were on hand, we could easily build SVAR model. But,we have no theory on choices of players among games. So, in this article,we'll just adopt frequently used decomposition method in empirical works of economics. Generalized Impulses as described by Pesaran & Shin (1988) constructs an orthogonal set of innovations that does not depend on the VAR ordering. The generalized impulse responses from an innovation to the i-th variable are derived by applying a variable specific Cholesky factor computed with the i-th variable at the top of the Cholesky ordering. It is known that Generalized method is more stable than adjusted Cholesky decomposition.

of *L2* by 0.66%. this value is not large enough to shake *L2* down. Also, *L2* quickly regained losses from WoW shock that happened at its open beta service(See Fig. 1). More interesting value is the effect of *L2* on *WoW*, positively 1.51% that are bigger than the effect of *Kart* on *WoW*. Also, this shows that decline of *L2* is not helpful to *WoW*. *WoW*'s upkeep of usage after official service launching could not resulted from falling down of *L2*.

IRF analysis shows that rivalry among games do not follow commonly held intuitions or expectations. But, one fact is clear that ups and downs of a game is not easily explained as the result of changing in competition.

5 The Effect of Real-money Trading: *L1* vs *L2*

If the rivalry among games does not cause *L2* to fall down, in-game factors are our next potential candidates. Examining these is not so easy as it seems, however. All detail changes in game design, various reactions of players should be scrutinized for all the critical period. This work is another big subject to be done by itself. In this section, we'll review one possible factor that might influence declining process of *L2*, real-money trading(RMT).

Data on RMT market are extremely hard to come by. In Korea, there are many mediators which specialize in matching demand and supply of item in many games. The ItemPF[15], one of leading mediating companies, provided valuable pieces of data. ItemPF has been posting weekly price indices for each game, which are calculated by the appropriate averaging rule across servers.[16] These data with usage data could be used to analyze effect of RMT to each game. As previously seen, *L1* shows much more stable trend during observation period. If there is any relationship between the price of item and usage of playing time, RMT might be one of possible actor playing a role in *L2*'s declining. At first, let's look at the change of ItemPF's price index for L1 and L2.

According to Fig. 4, both of two indices have the falling trend during observation period. *L2*, however, shows more steep declining trend. Same to usage data, *L2* has a more quick tendency to slide down. Previous statistical tests would be applied to understand relationship between price and usage in two brothers.[17]

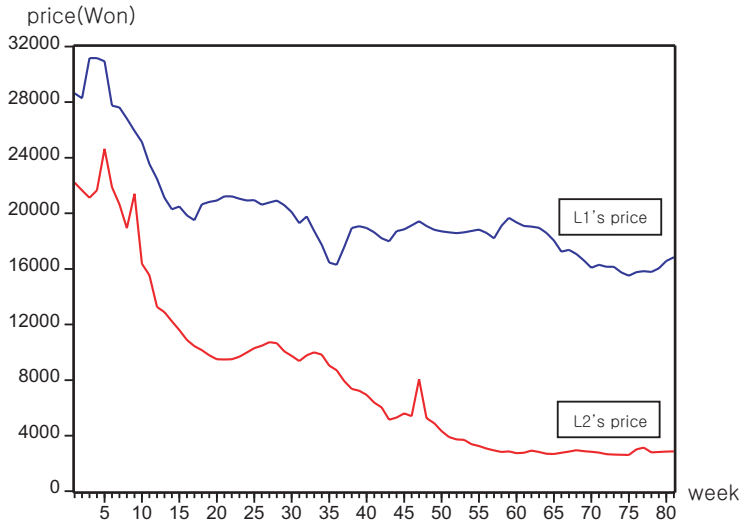
Firstly, the result of Granger causality tests are in Tab.5. According to

[15]http://trade.playforum.net

[16]It is somewhat similar to many stock market indices like KOSPI, DJIA, S&P 500, etc.

[17]I'm not dealing with statistical issues in estimation as full as section 4. The detail of analysis can be requested to author.

Figure 4: Weekly price trend of *L1* and *L2*(from Jan. 3th 2004 to Jul. 30th 2005)



results, *L1* shows no statistically significant causalities in any direction. It is not that RMT does not have any effect on usage, but that the response of RMT market in *L1* is so quick that it fades away before it does any real effect on usage. In contrast, *L2* shows significant causalities in both way. This shows that RMT could affect or be affected by time usage of *L2*. This can be more clearly seen by IRF analysis.

Fig. 5 and Fig. 6 are impulse responses of *L1* and *L2* for twelve weeks(three months). Differences in response are observable in a clear manner. Shocks are fade away more quickly in *L1* case. Price and time usage in *L2* case have fed back to each other. It is interesting to trace the effect of shock of one variable to the other.

An increase in usage of *L2* naturally gives downwards pressure on prices, the effect lasts for about five or six weeks. An increase in price of *L2* is more interesting to observe. At first, unexpected uprising in price give negative effect to usage. Cautiously, this might be interpretable as the result of selling out players' items to realize higher return. This negative effect lasts for two weeks. But, after this time point, price shock turns around to the positive until it almost goes away after five weeks. This also might be interpretable as the result of extending playing times to expect higher return. With IRF analysis, we can watch two opposite effects of price changes. In *L2*'s cases,

Figure 5: Impulse response of *L1* for 3 months

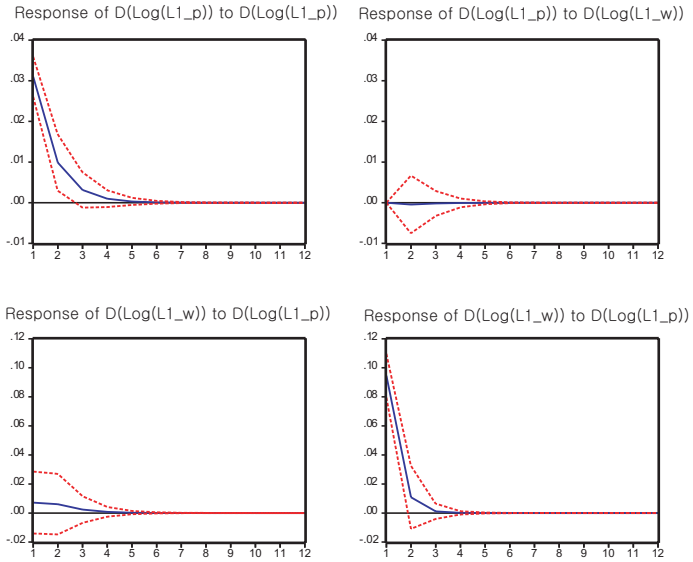


Figure 6: Impulse response of *L2* for 3 months

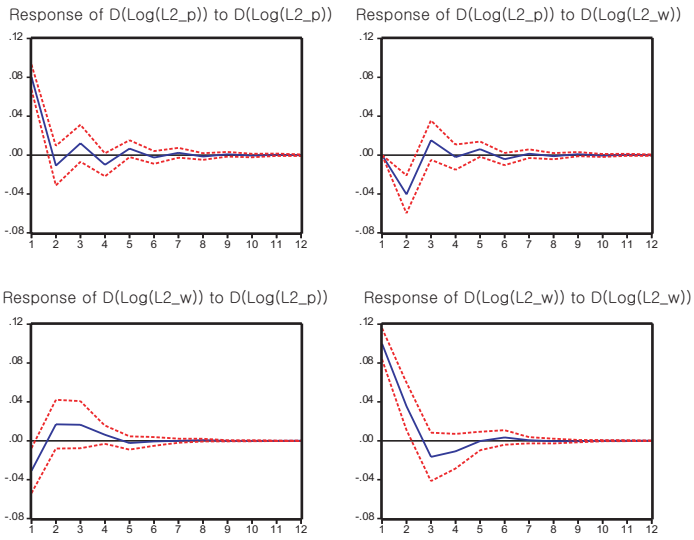


Table 5: Granger Causality/Block Exogeneity Wald Tests for *L1* and *L2*

Dependent variable: $\Delta(log(L1_w))$[a]			
Excluded	Chi-sq	df	Prob.
$\Delta(log(L1_p))$[b]	0.255912	1	0.6129

Dependent variable: $\Delta(log(L1_p))$			
Excluded	Chi-sq	df	Prob.
$\Delta(log(L1_w))$	0.015125	1	0.9021

Dependent variable: $\Delta(log(L2_w))$			
Excluded	Chi-sq	df	Prob.
$\Delta(log(L2_p))$	5.186647	2	0.0748

Dependent variable: $\Delta(log(L2_p))$			
Excluded	Chi-sq	df	Prob.
$\Delta(log(L2_w))$	20.48842	2	0.0000

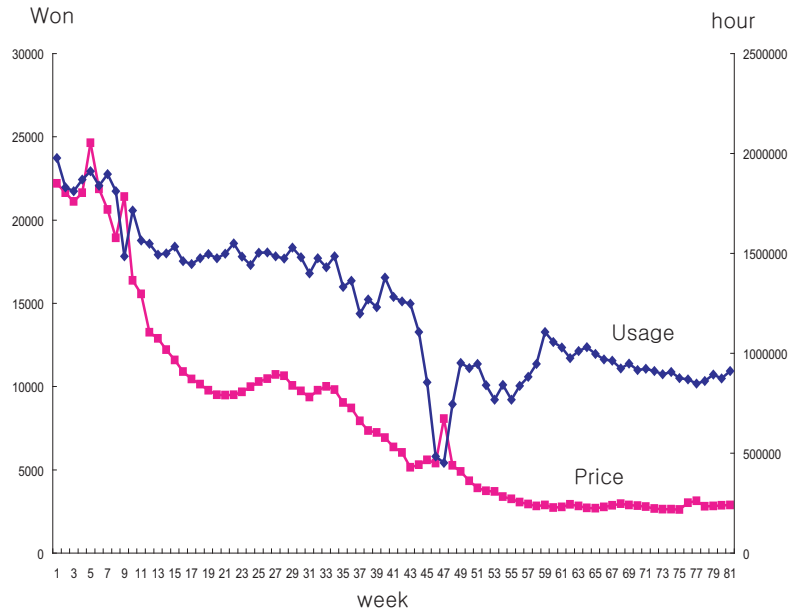
[a] Sub-script w means weekly usage data calculated from previous daily Gametrics data.
[b] Sub-script p means weekly price index provided by ItemPF.

the size of positive effect are a bit more large, so the increase in price has a positive effect on time usage.

Who is the culprit to let the lord fall down? If estimating demand and supply of RMT were possible, exact analytic cause could be identified. Our data only tell the some part of this hidden events. Guessing from above IRF analysis, the effect of price on usage in *L2* is slightly bigger than that of usage on price. So, judging from Fig. 7, It might be the case that dropping down of RMT return(price) had influenced more on declining time usage.[18]

[18]But, it is just a wild guess that are waiting for rigorous empirical works.

Figure 7: Price or time usage ?



6 Concluding Remarks

Conclusions of this article are summarized by following three findings. By empirically analyzing time usage data of Gametrics using VAR estimation,

1. presumed rivalry among *L2*, *Kart*, and *WoW* is not identifiable in a clear way,
2. directions of various effect among them also does not fit with common expectations,
3. in-game factors like RMT may caused *L2* to fall down beyond natural tendency.

This empirical analysis found that, contrary to some expectations, rivalry or tougher competition among online games may not play a crucial role in players' choices of games. Also, sources of decline in a game could be explained much better by analyzing factors within the game. It seems quiet natural conclusion, but many experts or game analysts often forget this basic point. This article is just a simple reminder of this starting line of analysis.

As previously mentioned, *L2*'s quickened aging has been like a difficult puzzle that cannot be solved easily. If not tougher competition, so what are forces that had rendered *L2*'s declining? In this article, we've examined one of possible factors, RMT market dynamics. Definitely, this must not be the one and only. Deeper and further analysis encompassing the specificities of game and players' experiences should be done to get to the bottom of the case.[19]

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[19] Many ordinary players have been already saying why and what. The interesting factor which was pointed out by them is that aggravating inflation might be one of main causes in *L2*'s depression. In *L1*, Gong Sung Jun, a kind of intensive warfare between two guilds, have been functioning as a strong device that could be utilized to drain excessive in-game resources out. But, *L2* had no comparable equivalence to this device of warfare or something. See Huhh & Park (2005) for more description on this account.

Appendix: VAR estimation result

Request to author for detail result of estimation.