




“Market coupling: an empirical study of the Sino-Korean game industry”

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MARKET COUPLING: AN EMPIRICAL STUDY OF THE SINO-KOREAN GAME INDUSTRY

Abstract

This study aims to examine the relationship between the Korean and Chinese game industries, and more broadly, the Chinese stock market. Chinese firms are the most important partners and investors in the Korean game industry, which has emerged as a significant component of a thriving Korean economy. The paper examines the impact of growth in the Chinese game industry on the Korean market and the correlation and cointegration between the stock returns of nineteen Korean game companies, the Chinese stock market, and Chinese game companies. A portfolio constructed from Korean game companies listed on the KOSPI and KOSDAQ is analyzed. Variation in the Shanghai Composite Index is shown to significantly influence the performance of Korean game companies. Further, the Korean game industry is sensitive to changes in the stock price of leading Chinese game publishers. The Korean game industry returns more closely mirror the returns of the Chinese stock markets rather than the Korean markets, evidence of the influence of China. As growth and returns in the Korean game industry are closely related to the performance of the Chinese market, future performance is subject to political and economic changes in China.

Keywords

stock market coupling, Korean game industry, stock
performance, cointegration, ROE, market indexes

JEL Classification

G10, G19

INTRODUCTION

After the 1997 Asian financial crisis, the source of Korean economic growth shifted from labor and capital intensive manufacturing businesses to information-technology (IT) value-added businesses. South Korea experienced an IT venture boom in the early 2000s, part of the global dot-com bubble. Korean IT infrastructure is well developed, including fast, inexpensive internet connections. In this environment, the Korean online game industry has emerged as a meaningful part of the economic transformation. In the last two decades, world game markets substantially grew along with the evolution in PCs, internet, and smartphones. The Korean game industry has played an important role in contributing to GDP growth. Additionally, Chinese firms represent the biggest partners of the Korean game industry and the largest investors. Given this close relationship, possibly, if a systemic risk event occurs in the Korean game industry, it could possibly impact the Chinese game market and vice versa.

Moreover, the Korean game industry is highly associated with the Chinese game industry, not only due to geographic proximity but also because of similar game environments. Unlike the U.S. and European game industries, which began with PC and console games (e.g., xBox and PlayStation), the Korean and Chinese game industries have experienced considerable development through mobile games. Both

Chinese and Korean game industries are mobile game-oriented markets, while the U.S. and Europe can be viewed as console game-oriented markets. Similarity in popularity of games and method of delivery exist between the Korean game industry and the Chinese market, while greater differences exist when compared to Western countries¹.

Given the consistencies between the two game industries, we examine whether the stock prices of Korean game companies are affected by changes in the Chinese stock market performance. To investigate whether Korean game companies' stocks are coupled with the Chinese stock market, stochastic trends of Korean game stocks and the Chinese market are examined using a cointegration test following Granger and Newbold (1974) and Engle and Granger (1987).

This study aims to clarify the inter-relation of changes in stock prices in the Sino-Korean game industry by defining the co-movement between the Chinese and Korean game industries. To identify the relationship between the Korean and Chinese game industries, an analysis of returns for an equally weighted portfolio of nineteen Korean game companies is utilized. Portfolio stocks were selected from game companies listed on KOSPI and KOSDAQ, and comparative analysis included the KOSPI, KOSDAQ, Shanghai, and Shenzhen indexes. It is found that the variation in the Shanghai Composite Index price significantly influences the returns for the Korean game company portfolio. Further, the paper examines the influence of stock price movements of the leading Chinese game companies: 1) Tencent, the Chinese game publisher with the largest market value, and 2) NetEase, the Chinese game publisher with the largest market value in Korea.

The rest of the paper proceeds as follows. Section 1 contains the literature review and formulation of the hypotheses. In section 2, the data and methods are presented, and the results and discussion of findings are presented in section 3. The final section concludes the paper.

1. LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

The South Korean economy is heavily comprised of service industry companies, which contribute to the largest component of GDP. The Korean Statistical Information Service annual index identifies that approximately 60% of South Korean GDP is derived from the services industry (59.2% in 2016, 58.3% in 2017, and 59.1% in 2018). More recently, the game industry in South Korea (hereafter referred to as Korea) has played an increasingly important role in the economy (Choi & Lee, 2015). The IT industry represents 11% of the Korean GDP. Moreover, export of game industry products accounts for 56.8% of the IT industry. The gaming industry plays a significant role in the large-

ly services economy². In 2017, the Korean Trade Statistics Promotion Institute identified China as the largest trading partner in both imports and exports. Arslanalp, Liao, Piao, and Seneviratne (2016) analyze the correlation between China and other Asian countries connected through international trade to identify the economic relationship. They find that the influence of China on Korean capital markets, as well those of other Asian countries, is gradually increasing. Given the close economic relationship between China and Korea, this study examines the co-movement between the Chinese and Korean game market, and the impact of the growth in the Chinese game industry³.

Liberalization of China has contributed to the Chinese economy experiencing consistent growth, and the role of China in the world economy has greatly expanded. Following the 2008 financial

1 For the sake of brevity further discussion of the Western vs. Sino-Korean game industries was removed but is available upon request.

2 Report of statistical survey on content industry for 2018.

3 For instance, Reuter news published on January 15, 2019 identified over 1.5% of the increase in the KOSPI Index is related to the expectation of economic growth in China. This is an example of China's influence on the Korean capital market (<https://www.reuters.com/article/southkorea-markets-close/south-korean-stocks-jump-on-china-stimulus-hopes-idUSZZN2YHL00>).

crisis, the Chinese economy has emerged as the world's second-largest. Several studies have analyzed the co-movement between the Chinese and international stock markets. Factors including Chinese investment status, economic policies, monetary policies, and market accessibility have been identified as influential both in China and abroad.

A prolific body of research examines the co-movement of international capital markets. Events such as Black Monday in October 1987 motivate the co-movement of markets as a research theme. Eun and Shim (1989) find that U.S. stock markets have consistently strongly impacted the price movements of foreign markets. Additionally, Theodossiou and Lee (1993) identify the statistically significant spillover between the U.S. stock markets and foreign markets for both mean and volatility values. Koutmos and Booth (1995) identify that investors must consider domestic as well as foreign stock market movements. Further, they find that both price and volatility information spillover occurs and that the spillover effect is greater after October 1987. Andersen, Bollerslev, Diebold, and Vega (2007) identify that foreign stock markets are sensitive to the release of the U.S. macroeconomic news, and those market movements are related even after controlling for the release of macroeconomic news. Further, Ahmad, Bhanumurthy, and Sehgal (2014) study the Eurozone crisis period to ascertain whether a contagion effect occurred among the stock markets of Eurozone and non-Eurozone countries. They find significant contagion effects for both EU and non-EU countries to varying degrees. Shu, He, Wang, and Dong (2015) analyzed the influence of Chinese capital markets on the Asia-Pacific region, as well as the relative impact of the U.S. markets. The study shows that Chinese capital markets have an increasingly greater influence on stock and foreign exchange markets of the Asia-Pacific regions. Conversely, the Chinese bond market remains isolated from the Asia-Pacific and the U.S. Finally, Fang and Bessler (2018) examine the influence of China on other Asian markets in the period following the 2015 Chinese stock market crash. They find empirical evidence that the Chinese market crash is associated with negative results in the stock markets of the neighboring Asian countries.

A small number of studies have focused on the correlation between the Korean capital market and the Chinese market. These studies primarily propose a significant co-movement phenomenon between the two markets. J. Chung and T. Chung (2010) find a strong co-movement relationship between Korean and Chinese stock markets. They document that market changes are quickly integrated, and information is rapidly passed from one market to the other. Kim (2013) documents that the effect of the Chinese market movements on Korean stock index volatility has increased since the 2008 financial crisis, as has both the U.S. and Japanese influence. Finally, Kim and Shin (2018) present a predictive model study of the KOSPI, the Korean Composite Stock Index, and find that the changes in the Shanghai Composite index significantly influenced the KOSPI.

There is a close relationship between the Korean game industry and the Chinese market. Several major Korean game publishers have marketed their games globally, with success in China, i.e., NCSoft and Nexon. Ryu et al. (2016) chronicle the success of the Korean game company Smilegate in China with the online game offering Cross Fire. Their success has served as an example for Korean game companies and has sparked an increased focus on the Chinese market. Korean game publishers that had previously focused primarily on the domestic market have begun to focus more on the Chinese market, recognizing the importance of this market for continued success. The growth of Korean games in the Chinese market mirrors the expansion of Chinese games in Korea. Firms have targeted strategic mutual growth through the development of diverse products benefiting both countries' economies. Growth in the Chinese IT industry and expansion in Chinese online ventures have added to the volume of imports of games manufactured in China. Imports have steadily expanded in Korea as the popularity of Chinese games has grown considerably in the Korean market. The Sino-Korean game industries are closely related, and the game industry environments become increasingly similar (KOCCA, 2018). The high degree of industrial exchange, specifically trade relationships, motivates the examination of the correlation between the game firms in the stock markets of both countries (Arslanalp et al., 2016).

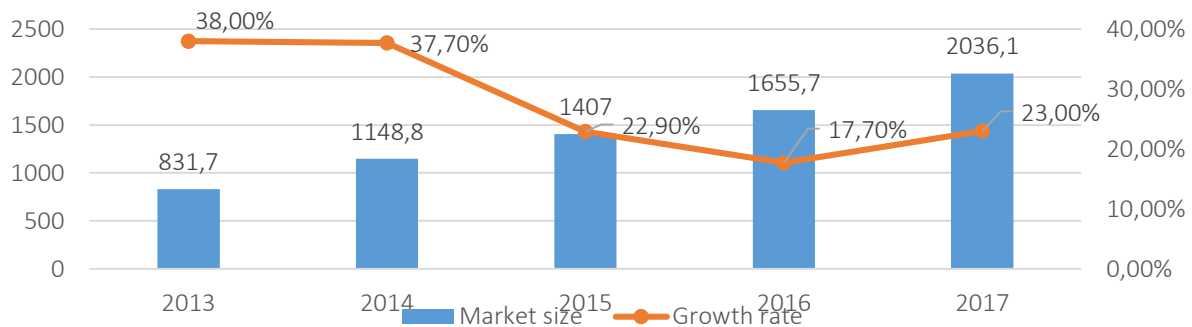


Figure 1. Market size of the Chinese game industry (unit: hundred million Yuan)

1.1. Korean and Chinese game industries

The Korea Creative Content Agency (2018) presents a summary of the growth in the global game industry. The global game industry experienced a higher growth rate than the average global economic growth rate, while its absolute economic scale has reached over 1% of the global economy. The estimated market size for all global mobile games in 2017 corresponds to 74 trillion Won (equivalent to US\$ 61.7 billion), while the estimated market size for Chinese games is 28 trillion Won (equivalent to US\$ 23.3 billion) or 38% of total revenue. Chinese game publishers control a larger market share than the combined share controlled by Japan and the U.S.

The Korea International Trade Association marketing report (2018)⁴ presents the size of the Chinese game market as of 2014, 111.4 billion Yuan (approx. 12.33 trillion Won). The Chinese gaming industry has shown steep growth, with growth in

market size from 10 trillion Won (US\$ 8.3 billion) in 2014 to over 20 trillion Won (US\$ 16.7 billion) in 2017. Although, growth rates have gradually declined since 2014, reaching a steady rate of 17.7% in 2016 and remaining relatively stable thereafter, as shown in Figure 1. The Chinese game market is estimated at 235.1 billion Yuan in 2018.

In 2012, online games accounted for 74.9% of the entire Chinese game market, but, in the succeeding years, this dominance has declined, with a market share of 50% as of 2016. The decline in the market share of online games may be attributed to the growing popularity of mobile games, as shown in Figure 2. From 2015 to 2016, the mobile game market grew by 59% and is now established as a key component of the Chinese game industry. In 2017, the mobile game market size was 122.1 billion Yuan, and increased to 145 billion Yuan in 2018. It is projected that the mobile game market will represent approximately 62% of the online game market (Korea Creative Contents Agency, 2018).

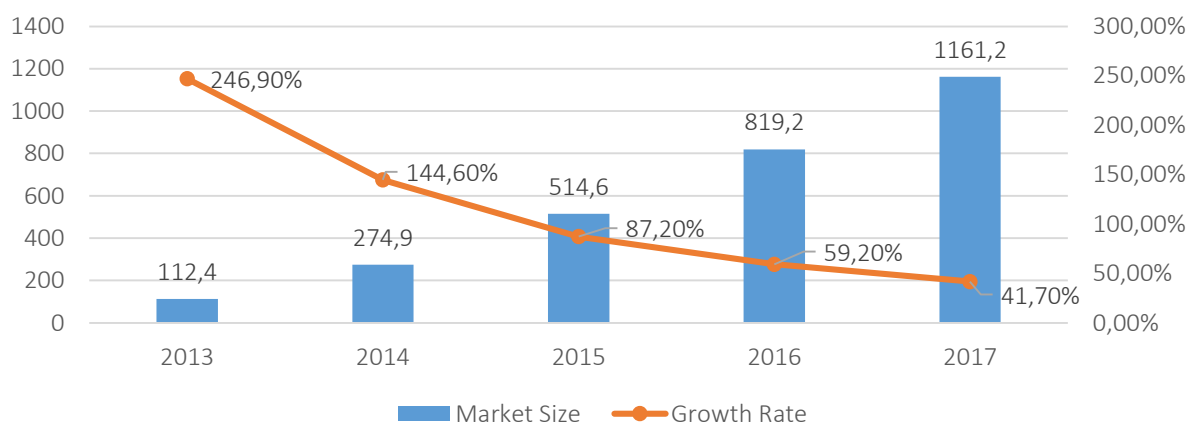


Figure 2. Market size of the Chinese mobile game industry (unit: hundred million Yuan)

⁴ Utilizing the Chinese game industry analysis results of the Game Publishing Committee of China, China New Game Research and International Data Corporation.

Table 1. Chinese game companies ranked by total sales

Rank	Company name	Aggregate market value (hundred million yuan)	Game sales (hundred million Yuan)	Website
1	TENCENT	33000	978	www.qq.com
2	NetEase	3024	360	www.163.com
3	PERFECT WORLD	455	57	www.wanmei.com
4	SHANDA GAMES	—	38 (In 2016)	www.sdo.com
5	SANQI MUTUAL ENTERTAINMENT	584	32	www.37.com
6	YOOZOO	200	32	www.youzu.com
7	SEASUN ENTERTAINMENT	—	31	www.xishanju.com
8	GIANT NETWORK	547	29	www.ga-me.com
9	WONIU	—	20	www.woniu.com
10	YINGXIONG	129	10	www.yingxiong.com

Table 2. 2018 rank of PC games in China

Rank	Game name	Publisher	Developer
1	Dungeon & Fighter	Tencent	Neople
2	League of Legend	Tencent	Riot Games
3	Fantasy Westward Journey	NetEase	NetEase
4	JX3 (jx3.xoyo.com)	Kingsoft	Kingsoft
5	Hearth Stone	NetEase	Blizzard
6	Blade & Soul	Tencent	NCsoft
7	World of Warcraft	NetEase	Blizzard
8	PATH of EXILE	Tencent	Grinding Gear Games
9	QQ SPEED 3	Tencent	Tencent
10	Cross Fire	Tencent	Smilegate
11	Maple Story	Tencent	Nexon

In 2017, ten of the top fifteen companies in the Chinese game market, in terms of sales, were publicly listed companies. Sales for the ten publicly listed companies exceeded 98.7 billion Yuan, accounting for 77% of total sales for the top 15 companies. The top three game companies comprised approximately 45.5% of total market share, exhibiting significant dominance of the industry. In the third quarter of 2017, two companies, Tencent and NetEase, represented 70% of the entire market share. As demonstrated in Table 1, Tencent and NetEase are the most dominant game firms in the Chinese market. They have successful products in multiple categories and platforms, including portal, messenger, and mobile applications (Korea International Trade Association, 2018).

Geopolitical tension between the Chinese and Korean governments has had repercussions for the Korean game industry⁵. Despite the restric-

tions on Korean game publishing in China, several Korean games have experienced success in the Chinese market. In particular, **Dungeon & Fighter** and **Cross Fire**, both Korean developed games, have seen continued success and rank among the most popular PC games in China. Table 2 lists the Nielsen Company's survey, from February 2018, of the most popular PC games in China. Games listed in bold were either developed in Korea or with intellectual property originating from Korean game companies.

Table 3 reports the rank of mobile games in China during the same period. Korean games are highlighted in bold and rank prominently on the list. Tencent, the largest Chinese company, develops and publishes many of the games, but their dominance does not preclude contributions from Korean game companies. Korean game content has found acceptance by Chinese gamers who do not object to the origin of the material.

5 The Chinese government imposed a ban on publishing Korean games as a measure of economic retaliation after the deployment of THAAD in Korea (<https://www.gamesindustry.biz/articles/2017-03-09-china-will-ban-new-korean-games-from-being-published-report>).

Table 3. 2018 Rank of mobile games in China

Rank	Game name	Publisher	Developer
1	Penta Storm	Tencent	Tencent
2	Onmyoji	NetEase	NetEase
3	Blade & Soul Mobile	Tencent	NCsoft
4	Ragnarok Online	Xindong	Xindong
5	Demi-Gods and Semi-Devils	Tencent	ChangYou
6	Fate Grand Order	Bilibili	DELIGHTWorks
7	Clash Royale	Kunlun	Supercell
8	Clash of Clans	Supercell Oy	Supercell
9	QQ SPEED 3	Snail Games	Snail Games
10	Cross Fire Mobile	Tencent	Smilegate, Tencent

Tencent has sought to participate in the success of the Korean game industry by investing in Korean game companies. The annual financial statements of Tencent show that the company earns more than 1 trillion Won a year from Cross Fire, a product by Korean game company Smile Gate. Dungeon & Fighter, a product of Korean game company Neople, represents a significant source of sales for Tencent. Lee (2018) provides details regarding the Chinese mobile game market. Lee (2018) identifies that Tencent became the second-largest stockholder in Bluehole, a Korean game developer, with an investment of more than 600 billion Won. Tencent had begun distributing Battle Ground, developed by Bluehole, towards the end of 2017. They have garnered success in both PC and mobile versions of the game. Tencent has a history of investment in the Korean game industry with the establishment of Tencent Korea in 2011. In 2014, they partnered with Daum Communications to create Kakao, a Korean internet company, with an investment of 72 billion Won. Finally, Tencent invested approximately 500 million dollars in Netmarble, Korea's largest mobile game company. League of Legend, a product of Riot Games, which is wholly owned by Tencent, has been excelling in the Korean game market with a focus on internet café distribution since late 2013. Similarly, NetEase has had an important influence on the Korean game market. They have pursued a strategy of consistently publishing Korean games in China through NetEase Korea. They distribute Herowarz, developed by the Korean game company A-Storm, to Chinese players (Kim, 2016). Ji (2018) explains that Tencent holds share values of 3.6 trillion Won in seven Korean game companies. Given the high degree of associations between the Chinese and Korean game markets, we expect that Korean game com-

panies will be influenced by the political and economic conditions of China.

1.2. Research hypotheses

Given the previously discussed connections between Chinese and Korean game industries, the following research hypotheses are developed and examined:

H1: The performance of Korean game stocks will be cointegrated with the Chinese stock market performance.

H2: The stock price performance of Tencent and NetEase, the dominant firms in the Chinese game industry, will be positively correlated with the performance of Korean game companies.

By testing these hypotheses, the study attempts to identify whether the variation in the Chinese stock market and specific game industry market leaders significantly affect the performance of the Korean game industry.

2. DATA AND METHODOLOGY

2.1. Research data

To examine the research hypotheses, various datasets are used. First, annual financial statements and monthly stock data of game companies listed on the Korean stock market were collected from January 2000 to December 2017. The study includes nineteen game firms with a Korean Standard Industry Classification Code (KSIC)

of 5821, which corresponds to game software development and supply. Second, the financial statement and Korean stock data were collected from KIS-Line. Last, to understand the relationship between the Chinese stock market and variation in the stock price of Korean game companies, Shanghai Composite Index and Shenzhen Composite Index price data were collected from Bloomberg over the same period.

2.2. Cointegration test

To avoid spurious regression results and investigate the cointegration between the Korean and Chinese game industry, cointegration tests are performed as defined by Granger and Newbold (1974) and Engle and Granger (1987). Let x_t and y_t denote non-stationary $I(1)$ time-series variables, which are captured by the stationary first difference, the integrated order of one. x_t and y_t are cointegrated if there is a linear combination of them such that:

$$e_t = y_t - \beta_1 - \beta_2 x_t \sim I(0). \quad (1)$$

Thus, x_t and y_t are cointegrated if there is a linear combination of them that is stationary, $I(0)$. Cointegration implies that x_t and y_t show similar stochastic trends. Since the difference is stationary, they do not diverge greatly from each other over time. The test for stationarity of the residual is based on the following equation:

$$\Delta \hat{e}_t = \gamma \hat{e}_{t-1} + a_1 \Delta_t \hat{e}_{t-1} + v_t, \quad (2)$$

where $\Delta \hat{e}_t = \hat{e}_t - \hat{e}_{t-1}$. To test for cointegration, a two-step estimation is used. First, the linear square estimation is used to regress y_t on x_t . Next, the residuals for stationarity are tested using the Augmented Dickey-Fuller (ADF) test. The rejection of the null hypothesis indicates the residuals are stationary, $I(0)$, and the series are cointegrated. To examine whether the portfolio of Korean game industry stocks is cointegrated with the Chinese stock market, the cointegration test is run using the Engle-Granger method.

2.3. Linear relationship

To examine the relationship between the Chinese stock market and the Korean game industry, the following regression model is utilized:

$$ROE_t = \beta_0 + \beta_1 CIndex_t + \varepsilon_t, \quad (3)$$

where ROE_t represents an average of the Korean firm's return on equity at time t , $CIndex_t$ represents the annualized Shanghai stock market index returns at time t . The regression is intended to identify the effect of Chinese market conditions on the operating income of Korean game firms. Specifically, annualized compounding index returns observed each year are used. Further, one assumes that the composite index returns observed 6 months prior to each firm's fiscal year end affect the average ROE of Korean game companies. Using the above equation, the change in Korean companies ROE is investigated with respect to the change of the annualized market index returns. If one observes $\partial ROE / \partial CIndex > 0$, this indicates that better Chinese market conditions are associated with greater profitability for Korean game companies. Conversely, $\partial ROE / \partial CIndex < 0$ indicates that poorer Chinese market conditions are associated with lower profitability for Korean game firms.

2.4. Sharpe ratio

The Sharpe ratio, as suggested by Sharpe (1966, 1994), is used to compare Korean and Chinese stock portfolios constructed from stocks in each country's game industries. The Sharpe ratio is specified as follows:

$$SR = \frac{R_p - R_f}{\sigma_p},$$

where R_p is a rate of return of a portfolio, R_f is risk-free rate, and σ_p is standard deviation of the portfolio's excess return. The larger a portfolio's Sharpe ratio, the greater its risk-adjusted-performance, the equation measures the risk-reward compensation.

3. EMPIRICAL RESULTS AND DISCUSSION

3.1. Correlation analysis between the Korean game industry and the Chinese stock market

Table 4 presents the descriptive statistics for stock markets and Korean game companies, including

average, standard deviation, and Sharpe ratio for monthly share returns. The data for the full sample period from January 2000 to December 2017 are displayed in Panel A. The column labeled Kgame represents an equally weighted portfolio of nineteen Korean game companies. The average return for the KOSPI, Shanghai, and Shenzhen indices is 0.071%, 0.762%, and 1.227%, respectively, while the average return for Korean game companies' portfolio is -0.401%. The standard deviation of Korean game companies' portfolio is 73.767% higher than the KOSPI and KOSDAQ indexes, exhibiting greater risk than the overall Korean markets. The Sharpe ratio for the Korean companies' portfolio is far lower than Korean and Chinese market portfolios, indicating poorer risk-adjusted returns for Korean game companies relative to the market portfolios.

A possible explanation for the lower returns on the Korean game companies' portfolio may be the inclusion of 2000–2008 returns, which corresponds to the incubation period of the Korean game market. As shown in Panel B, Korean markets experienced poorer performance in the 2000 to 2008 period compared to the period 2009–2017 displayed in Panel C. In the Panel C sub-period, the average return for the Korean game companies portfolio (2.272%) is significantly higher than the market indices (KOSPI: 1.124%, KOSDAQ: 1.243%, Shanghai: 0.863%, Shenzhen: 1.565%). The standard deviation of the Korean game companies' portfolio is greater than the market indices, indicating that the Korean game industry presents higher risks to investors. However, the Korean game companies' portfolio presents the highest risk-adjusted

return value of 0.235. The Korean game companies' portfolio represents an investment with relatively high risk-adjusted compensation after 2008.

Figure 3 displays the cumulative returns for the market indices and the Korean game companies' portfolio. The graph enables us to distinguish between the bear and bull market periods. The Korean game companies experienced decreased stock returns in the incubation period leading up to 2008 financial crisis. Beginning in 2009, the stock returns for the Korean game companies rose, as economies started recovering from the financial crisis.

Figure 3 displays the patterns regarding the relationship between Korean game companies and market indices. The Korean game companies' portfolio experiences a more rapid increase in returns than the KOSPI and KOSDAQ after 2008. The gains in the Korean game companies' portfolio mirror that of the Chinese stock market indices. The visual evidence indicates a high probability of correlation between the Korean game market growth and the economic recovery in China.

To further examine this relationship, the level of correlation between the portfolios is calculated, and the results are shown in Table 5. Panel A shows the correlation analysis results for the entire sample period. The correlation between Chinese and Korean market indices is greater than 20%, while the correlation to the Korean game companies' portfolio is relatively low, less than 9%. Similar results are observed after 2008 in Panel B. Notably, the growth period in Panel C exhibits the correla-

Table 4. Descriptive statistics

Statistics	KOSPI	KOSDAQ	Kgame	Shanghai	Shenzhen
Panel A. Full sample period (Jan. 2000 – Dec. 2017)					
Average return	0.762	0.071	-0.401	0.830	1.227
Std. deviation	8.052	10.875	17.532	7.819	8.871
Sharpe ratio	0.095	0.006	-0.023	0.106	0.138
Panel B. Sub-period (Jan. 2000-Dec. 2008)					
Average return	0.400	-1.101	-3.074	0.797	0.889
Std. deviation	9.222	13.511	22.574	8.391	9.133
Sharpe ratio	0.043	-0.082	-0.136	0.095	0.097
Panel C. Sub-period (Jan. 2009-Dec. 2017)					
Average return	1.124	1.243	2.272	0.863	1.565
Std. deviation	6.706	7.232	9.675	7.240	8.631
Sharpe ratio	0.168	0.172	0.235	0.119	0.181

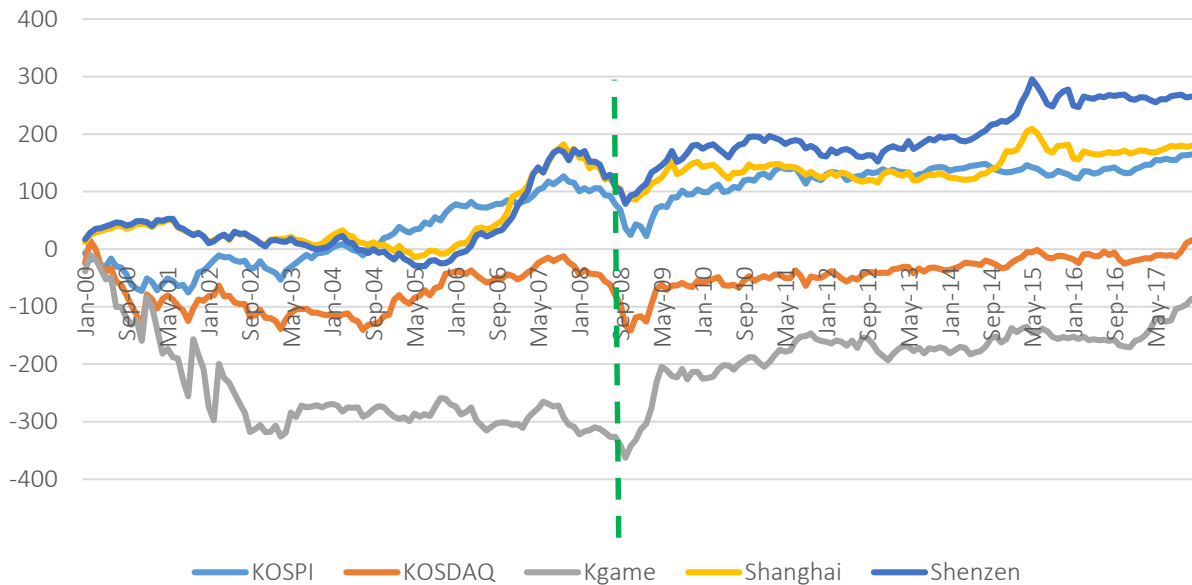


Figure 3. Cumulative returns for KOSPI, KOSDAQ, Shanghai index, Shenzhen index, and Korean game companies' portfolio

tions of 9% and 11% between the Chinese markets and the Korean game companies' portfolio.

The correlation results are contrary to the pattern identified in Figure 3, possibly because correlation analysis does not fully reflect the economic interrelationship among time series variables. To further examine whether a portfolio of Korean game company stocks is cointegrated with the Chinese stock market performance, the Engle-Granger cointegration test is run. The test results are presented in

Table 6. Panel A shows the cointegration values for the Shenzhen market index and the Korean game companies' portfolio and the Shanghai market index and the Korean game companies over the full sample period. Panels B and C display the results for two sub-periods. From the Engle-Granger cointegration test, all the coefficients of γ in Table 6 range from -0.82 to -1.34 , and the absolute values of all the t-statistics are greater than 2.00. The null hypothesis of no cointegration is rejected, with 95 percent confidence.

Table 5. Correlation coefficients

Stock Market Indexes	KOSPI	KOSDAQ	Kgame	Shanghai	Shenzhen
Panel A. Full sample period (Jan. 2000 – Dec. 2017)					
KOSPI	1.00				
KOSDAQ	0.78	1.00			
Kgame	0.33	0.56	1.00		
Shanghai	0.32	0.21	0.07	1.00	
Shenzhen	0.27	0.20	0.09	0.89	1.00
Panel B. Sub-period (Jan. 2000 – Dec. 2008)					
KOSPI	1.00				
KOSDAQ	0.82	1.00			
Kgame	0.30	0.47	1.00		
Shanghai (SSE)	0.40	0.32	0.09	1.00	
Shenzhen (SZSE)	0.31	0.30	0.11	0.86	1.00
Panel C. Sub-period (Jan. 2009 – Dec. 2017)					
KOSPI	1.00				
KOSDAQ	0.77	1.00			
Kgame	0.35	0.57	1.00		
Shanghai (SSE)	0.27	0.17	0.07	1.00	
Shenzhen (SZSE)	0.23	0.15	0.09	0.91	1.00

Table 6. Engle-Granger cointegration tests (Jan. 2000 – Dec. 2017)

Parameters	Coefficients	t-stat	p-value
Cointegration test model: $\Delta\hat{e}_t = \gamma\hat{e}_{t-1} + a_1\Delta_t\hat{e}_{t-1} + v_t$			
Panel A. Full sample period (Jan. 2009 – Dec. 2017)			
Cointegration with Shanghai market index			
γ	-1.16	-11.65	0.000
a_1	0.09	1.36	0.173
Cointegration with Shenzhen market index			
γ	-1.16	-11.72	0.000
a_1	0.09	1.43	0.153
Panel B. Sub-Period (Jan. 2000 – Dec. 2008)			
Cointegration with Shanghai market index			
γ	-1.33	-9.13	0.000
a_1	0.16	1.76	0.081
Cointegration with Shenzhen market index			
γ	-1.34	-9.15	0.000
a_1	0.17	1.77	0.079
Panel C. Sub-Period (Jan. 2009 – Dec. 2017)			
Cointegration with Shanghai market index			
γ	-0.82	-6.75	0.000
a_1	0.05	0.53	0.599
Cointegration with Shenzhen market index			
γ	-0.82	-6.76	0.000
a_1	0.06	0.58	0.565

Both the Shanghai and Shenzhen market indices are used to capture the Chinese stock market trends' impact on the returns of Korean game companies. The Shanghai composite index includes all stocks registered on the Shanghai market, while the Shenzhen composite index includes only the top 500 stocks registered on the Shenzhen market. Given the results, we conclude that Korean game company returns are cointegrated with fluctuations in the Chinese stock market, represented by the Shanghai composite index and the Shenzhen composite index.

Linear regression analysis is performed to examine the cointegration results further and test the research hypothesis that Korean game companies' stocks are impacted by the Chinese stock market return, proxied by the Shanghai composite index⁶. Linear regression results to capture the effect of fluctuation in the annual Shanghai composite index on the return on equity of the Korean game companies' portfolio are presented in Table 7 for

three periods: the full sample period from January 2000 to December 2017, the incubation period from January 2000 to December 2008, and the growth period from January 2009 to December 2017. Panel A and panel B show the coefficients for the Shanghai composite index of 0.14 and 0.23, respectively. However, all the *t*-statistics are less than 2.00, not statistically significant. In contrast, the regression coefficient for the Shanghai composite index for the growth period is 0.09. One percent increase in the annual return of the Shanghai composite index is associated with a 9% change in the capital returns of the Korean game company portfolio, significant at the 95% confidence level. The profitability of Korean game companies is found to be positively affected by the Chinese stock market movements, $\partial\text{ROE} / \partial\text{Changhai Index} > 0$.

Table 7. Regressions of ROE on annual SSE composite index return

Variables	Coefficients	t-stat	p-value
Panel A. Full sample period (Jan. 2000 – Dec. 2017)			
Intercept	4.80	2.59	0.01
Shanghai	0.14	1.62	0.13
R-square	0.04		
Panel B. Sub-period (Jan. 2000 – Dec. 2008)			
Intercept	8.94	3.48	0.01
Shanghai	0.23	0.83	0.45
R-square	0.09		
Panel C. Sub-period (Jan. 2009 – Dec. 2017)			
Intercept	1.66	0.93	0.43
Shanghai	0.07	2.15	0.01
R-square	0.02		

3.2. Co-movement between the Korean game industry and Chinese game market leaders

The influence of Chinese investors on the Korean game market has grown as Chinese game companies increase investment and share participation in Korean game companies. Of particular interest is the influence of two most dominant Chinese game companies, Tencent and NetEase, which control approximately 70% of the Chinese game market. Tencent trades on the Hong Kong stock market, and NetEase is listed on the NASDAQ. These differences introduce potential "noise" when attempting to understand the in-

6 Analysis results for linear regression of ROE on the Shenzhen composite index using full sample, and two subsample periods are not presented. Similar results were observed from an auxiliary test and are available upon request.

Table 8. Monthly performance of NetEase and Tencent

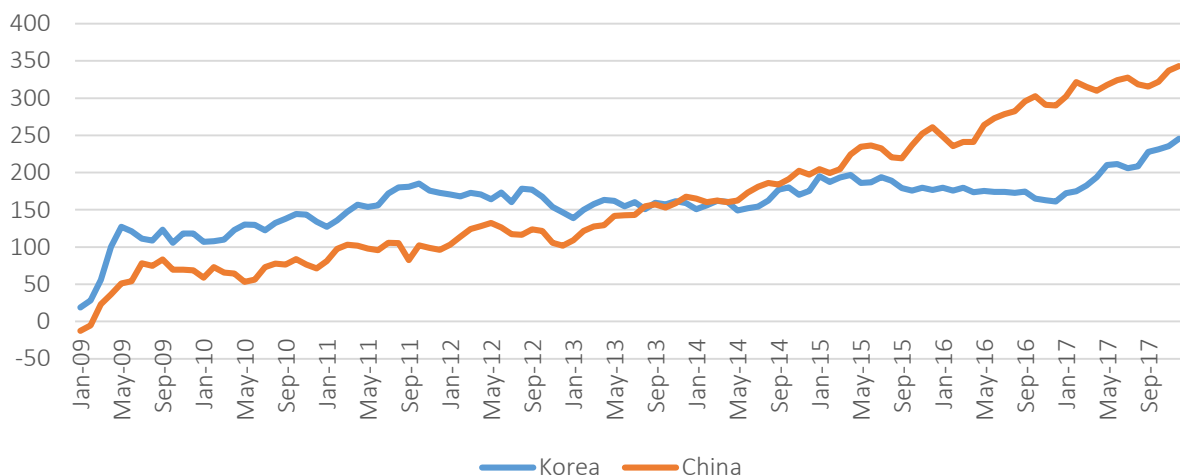
Statistics	NetEase	Tencent
Panel A. Full sample period (Jan. 2000 – Dec. 2017)		
Average	4.58	4.49
Std. deviation	17.38	11.23
Sharpe ratio	0.26	0.40
Correlation (Chinese vs. Korean game portfolios)	0.22	
Panel B. Sub-period (Jan. 2000 – Dec. 2008)		
Average	6.16	5.42
Std. deviation	23.57	14.44
Sharpe ratio	0.26	0.38
Correlation (Chinese vs. Korean game portfolios)	0.01	
Panel C. Sub-period (Jan. 2009 – Dec. 2017)		
Average	3.20	4.03
Std. deviation	10.38	9.30
Sharpe ratio	0.31	0.43
Correlation (Chinese vs. Korean game portfolios)	0.52	

fluence on Korean game companies' returns and complicate the analysis. Given the increased investment by these two firms in the Korean game market, the analysis of the relationship is necessary and important.

Table 8 shows the monthly stock returns, standard deviation, and Sharpe ratio for NetEase and Tencent over the period from January 2000 to December 2017. Panel A shows that the average returns for both companies are 4.58% and 4.49%, respectively, higher than the Korean game companies portfolio return over the same period. The standard deviation for the Chinese firms ranges from 17.38% to 11.23%, with the value for the Korean game companies' portfolio falling within this range. Finally, the Sharpe ratio of both companies is 0.26% and 0.00%, respectively, with Tencent exhibiting ap-

proximately a 1% difference in risk-adjusted return compared to NetEase. Similar results are shown in Panel B over the incubation period from January 2000 to December 2008.

An equally weighted portfolio of the Chinese game companies is computed and the same nineteen Korean game companies' portfolio is utilized to examine the relationship further. Figure 4 displays the cumulative stock returns of both portfolios over the growth period from January 2009 to December 2017. The Korean game companies' portfolio achieved better results than the Chinese game portfolio from January 2009 to November 2013. While the Korean game companies showed a gradual increase in stock returns beginning in December 2013, the Chinese game portfolio achieved a considerably steeper rise in

**Figure 4.** Cumulative returns for Korean and Chinese game industry portfolios

stock returns, outpacing the Korean game market. Though the slopes of the cumulative stock returns differ across the markets, the trend of the two markets is similar, with greater returns to

the Chinese game portfolio after December 2013. A correlation value 0.52, displayed in Table 8, indicates the two portfolios are linearly interrelated with each other.

CONCLUSION

This study presents a correlation analysis of the cumulative returns of nineteen Korean game companies listed on the Korean stock market and the Chinese stock markets from January 2000 to December 2017. Additionally, a linear regression analysis, including the Shanghai and Shenzhen composite indices, is presented, utilizing annual financial statement data and monthly stock data. The analysis results confirm that Korean game companies experienced a more rapid increase in returns than the general Korean economy over the examined period, proxied by the KOSPI and KOSDAQ composite indices. The Korean game company results more closely resemble the returns of the Chinese stock market. Growth in the Korean game market is closely related to Chinese economic performance, confirming research hypothesis 1. Contrary to expectations, the stock returns of the dominant Chinese game companies, Tencent and NetEase, are negligible indicators of the ascending-descending fluctuation in the returns of the Korean game industry, resulting in a rejection of research hypothesis 2. If the relationships and interconnectedness between the Korean and Chinese game industries persist, Tencent and NetEase will have the potential to be powerful influencers. Korean game companies would benefit from following the strategies of these companies and attempt to forecast how this will impact the current and future circumstances of the Sino-Korean game market. The impact of China on the Korean game industry is likely to increase if political actions are taken to increase content censorship in China. Actions such as establishing a department for overseas intellectual property protection by the Chinese government would limit the dispersion of Korean content in China. As the economic and political factors evolve, future examination of the correlation between the stock returns of Korean game companies and the Chinese economy will be necessary. Additionally, the examination of the impact of unlisted companies on the Korean game industry may play an important role in understanding the performance.

The Korean and Chinese game industries have developed close ties, while the U.S. and European markets continue to exhibit cultural and technical characteristics that make marketing Korean games challenging. Korean game companies are entwined with the Chinese game market, given the large size and importance of the market. Strong government intervention in China's game market could adversely impact the Korean game industry, and performance may be affected by China's economic and political issues. In the short run, there is unlikely to be any meaningful change, but Korean game companies are conscious of the situation and should work to reduce their reliance on China. The results have implications for other Korean industries, and possibly similarly developing industries in other Asian countries. Understanding how the performance of the Chinese markets could potentially impact a firm's performance may influence the strategies a firm chooses. Finally, investors and potential investors in Korean game firms must consider the economic and political expectations for China when estimating the expected returns.

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