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## Conference Paper

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# **An Event Study of the First Telecommunications Spectrum Auction in Korea and “the Winner’s Curse”**

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## **Abstract**

The first telecommunications spectrum auction in Korea is attention worthy due to the fierce competition for only the 1.8GHz spectrum band and the winning bidder was suspected of overpaying for acquiring the spectrum license. This study empirically investigates the existence of a “winner’s curse” in the Korean spectrum auction by using standard event study methodology. The results showed that both the winner and the loser experienced significant positive return on the completion day of the auction. It implies that there is no winner’s curse and the losing firm may actually increase its competitive advantage by acquiring the second-best spectrum though failing to achieve its initial objective. Therefore, these results suggest that regulators may need to consider bringing positive short-term wealth benefits for all bidders by designing the spectrum auction appropriately such as performing multi-band auctions.

**Keyword:** spectrum auction; winner’s curse; event study; 4G spectrum

## **1. Introduction**

As the demand for and value of spectrum resources has significantly increased (Hwang & Yoon, 2009), it is particularly important to use limited spectrum resources as efficiently as possible due to scarcity (Freyens & Yerokhin, 2011). In addition to various efforts to achieve efficient spectrum management, including spectrum sharing (Hwang & Yoon, 2009) and spectrum usage rights (Webb, 2009), the use of auctions has become increasingly widespread (Mackley, 2008) as the most commonly used mechanism to assign spectrum in national telecommunications markets (Madden, Saglam, & Morey, 2011). Auctioning the spectrum has been regarded as a faster, more transparent, and less costly way of spectrum assignment than administrative “beauty contests” processes (Kwon, Lee, & Oh, 2010). The Korean regulator, the Korean Communications Commission (KCC), assigned three national spectrum licenses by auctions for the first time in August 2011, and expects to assign additional spectrum via this approach according to the national spectrum strategy, the “Mobile Gwanggaeto Plan” (KCC, 2012).

One interesting result of the first auction is that two of three Korean mobile operators

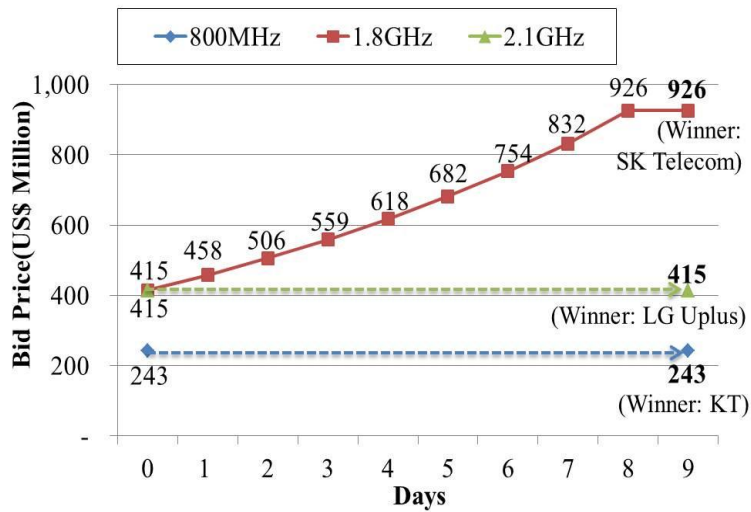
focused on bidding for the single 1.8GHz spectrum band license, with the winning bid circa \$926 million, more than two times than the reserve price, prompting suggestions that the winning company overpaid possibly resulting in a price increase of mobile communication services in Korea. Also, previous studies pointed out that the auction system might relax the price competition between mobile operators and reduce investments in telecommunication infrastructure (Gruber, 2007; Kwon et al., 2010). In particular, several studies tried to investigate whether the winning companies overpaid, in other words, experienced a “winner’s curse” in the spectrum auctions, based on European 3G auctions cases (Basili & Fronini, 2003; Cable, Henley, & Holland, 2002; Mackley, 2008). Because the existence of a winner’s curse in an auction indicates that the government needs to rectify the auction design, it is necessary to examine whether the winning bidder overpaid in Korea’s first auction.

The purpose of this paper is to empirically investigate the existence of a winner’s curse in the first spectrum auction in Korea by using standard event study methodology. This study may be the first attempt to examine the spectrum auction results in terms of a winner’s curse in Korea. Although previous literature examined the existence of a winner’s curse in European 3G auctions, by using event study approach (Cable et al., 2002; Mackley, 2008) or real option technique (Basili & Fontini, 2003), these might not be useful in the Korean case because the results were limited to 3G auctions in countries such as the United Kingdom and Germany. Concerning auction revenue, national spectrum auction outcomes are still influenced by country-specific factors including national mobile market and economic conditions (Madden et al., 2011). However, our results may provide a better understanding of the appropriate value of the 1.8GHz spectrum band in Korea concerning policy implications.

The remainder of the article is organized as follows: The first section reviews the first spectrum auction for 4G mobile services in Korea, focusing on the particular result of the 1.8GHz spectrum license. The possibility that the winning mobile operator overpaid for the spectrum license is also addressed. The second section suggests a developed hypothesis and describes the data and method used. The fourth section presents empirical results and discusses their implications. The final section offers a conclusion.

## **2. Overviews of the First Korean Spectrum Auction**

The Korean government commonly used “beauty contest” awards to assign wireless spectrum but, considering economic efficiency, it decided to introduce an auction system as a more efficient spectrum allocation method. The auction is a market-based management regime in terms of spectrum management policy and has been popular in many countries (Hwang & Yoon, 2009). The amendment of the “Radio Waves Act” was initiated in January 2011, with the first auction conducted in August 2011. It performed simultaneous multi-round ascending bid auctions (SMRA) for three national spectrum licenses: total 50MHz bandwidth of 800MHz and 1.8/2.1GHz spectrum bands.



Note: The auction began on August 17th, 2011 (Day 1) and concluded on August 29th, 2011 (Day 9) after 83 rounds.

**Figure 1.** The spectrum auction results in Korea

The auction progressed from August 17th to August 29th in 2011, as described in Figure 1. We believe that the auction is quite attention worthy because there was only a fierce competition between SK Telecom, the largest mobile operator, and KT, the second-ranked mobile service provider, for the 1.8GHz spectrum license (20MHz bandwidth). The 2.1GHz spectrum license (20MHz bandwidth) was acquired by the third biggest mobile operator LG Uplus at the reserve price without any competition because the other companies were not allowed to bid for it so as to avoid spectrum monopolization (KCC, 2012). Although the 800MHz spectrum has been the most attractive spectrum band in European countries, the spectrum license may have insufficient bandwidth (10MHz) for advanced mobile services such as long-term evolution (LTE). Therefore, the other two mobile operators focused on bidding for the 1.8GHz spectrum instead of the 800MHz spectrum. Finally, after 83 rounds, KT pulled out of the 1.8GHz spectrum bidding and SK Telecom acquired the desired spectrum license. KT won the 800MHz spectrum license instead.

Because the winning bid for the spectrum was about \$926 million, more than two times than the reserve price of \$415 million, there have been suggestions that the winning company overpaid. Moreover, the two bidders also officially commented that the winning bid might be overpriced<sup>1</sup>. Therefore, it is necessary to empirically investigate whether the winner, SK Telecom, overpaid for the 1.8GHz spectrum license in the auction, since this has not been addressed yet.

<sup>1</sup> See the article titled “1800MHz the star of Korean tri-band auction” (August, 2011), Retrieved May 29th, 2012 from <<https://www.policytracker.com/headlines/1800-mhz-the-star-of-korean-tri-band-auction/?searchterm=Korean.>>

### 3. Research Model: Event Study Method

To investigate whether the winner overpaid for the 1800MHz spectrum license in the first Korean spectrum auction, this study examines the short-term performance of the winning bidder using standard event study methodology. There have been numerous studies utilizing the power of the event study methodology in management research (Wilcox, Chang, & Grover, 2001), including previous studies related to spectrum license in telecommunications industry (Cable et al., 2002; Mackley, 2008). This approach provides researchers with a powerful tool to assess the linkages between managerial decisions and actions, and the resulting value created for the firm (Wilcox et al., 2001) by measuring the impact of a specific event on the firm's market value (Rhéaume & Bhabra, 2008). Therefore, this technique has been widely used to not only see if takeovers had a positive/negative effect on shareholder wealth (Akdoğan, 2009; Gerpott & Jakopin, 2007; Rieck & Doan, 2009; Trillas, 2002), but also to evaluate the economic effects of classes of phenomena that would otherwise be hard to measure (Mackinlay, 1997).

According to the event study method, under the assumption of investor rationality and semi-strong market efficiency, the impact of an unanticipated event is expected to be fully and instantaneously incorporated into a firm's market value. Controlling for other contemporaneous events, the change in market value of the firm from its expected value should provide an estimate of the new information value, measured in terms of abnormal returns. Therefore, in this study, any abnormal return will reflect a differential in the true valuation of the licenses and the fee paid by the firm (Mackley, 2008); positive abnormal returns indicate that the winning bidder obtained a bargain while negative ones indicate that it overpaid.

To examine the stock market reaction to auction related announcements, we used the market model, which is the most commonly used model in event studies (Rieck & Doan, 2009). The market model is a statistical method that relates the return of any given security to the return of the market index. Relying on the Korea Composite Stock Price Index (KOSPI), we used the model as the market benchmark in the model specified in Equation (1)

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it} \quad (1)$$

where  $R_{it}$  = the realized return of the share of the bidder at time  $t$ ,  $R_{mt}$  = the realized return on KOSPI at time  $t$ ,  $\varepsilon_{it}$  = the error term,  $\alpha_i$  = intercept, and  $\beta_i$  = parameter of the regression equation.

Abnormal returns (ARs) are then calculated from the difference between actual return and predicted return using the market model approach, as described in Equation (2).

$$AR_{it} = R_{it} - (\alpha_i + \beta_i R_{mt}) = \varepsilon_{it} \quad (2)$$

The returns during the event period are accumulated to calculate the cumulative abnormal returns (CARs) for the stock, as showed in Equation (3). CARs are also a good

indicator because they capture the total firm-specific stock movement for an entire period when the market might be responding to new information (Nam, Yang, Park, Oh, & Park, 2005 ; Park, Yang, Nam, & Ha, 2002).

$$CAR(t_0, t_1) = \sum_{t=t_0}^{t_1} AR_{it} \quad (3)$$

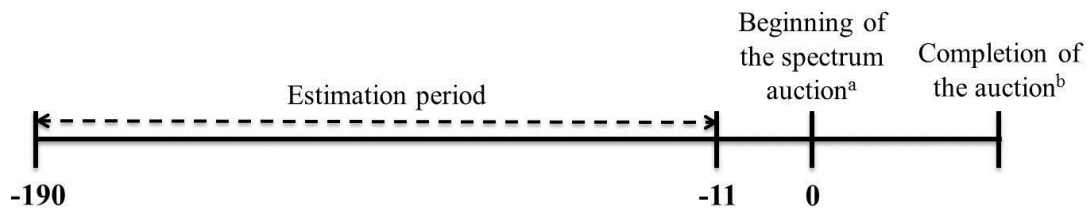
An appropriate test can be used to determine whether such measured wealth effects differ significantly from zero (Park et al., 2002). For this purpose, a t-statistic was used to assess the statistical significance of CAR and constructed as described in Equation (4).

$$T = CAR(t_0, t_1)/SD(t_0, t_1) \quad (4)$$

$SD(t_0, t_1)$  is the estimate of the standard deviation adjusted for the auto covariance of returns, which was used by previous studies (Nam et al., 2005), as described in Equation (5).

$$SD(t_0, t_1) = \sqrt{(t_1 - t_0 + 1)VAR(AR_t) + 2(t_1 - t_0)COVAR(AR_t, AR_{t-1})} \quad (5)$$

In this study, to estimate parameters in the market model, the estimation window of 190 trading days to 11 days prior to the first date of the spectrum auction was used. We then examined two event windows according to the subsequent events related to the auction. First, on August 17th 2011, the first spectrum auction was started in Korea. While LG Uplus won the 2.1GHz spectrum in an uncontested auction, the other two firms, who had not been allowed to bid for the 2.1GHz spectrum, began to fight for the remaining ones, particularly the 1.8GHz spectrum license. Second, on August 29th 2011, the auction ended after KT pulled out of the 1.8GHz bidding. SK Telecom won the desired spectrum paying about 925 million dollars while KT won the 800MHz spectrum instead. The timeline in Figure 2 illustrates the estimation period and each relevant event data.



Note: a. Beginning of the spectrum auction (August 17th, 2011)  
b. Completion of the auction (August 29th, 2011)

**Figure 2.** Estimation period and event dates

To examine the shareholder wealth consequences of the spectrum auction, we utilized the KISVALUE database, one of the most reliable databases in Korea, for the stock price information and financial information.

## 4. Empirical Findings

### 4.1. Results

We focused on the short-term shareholder wealth effects associated with the two auction related announcements; the results of the event study for the bidders are reported in Table 1 and Figure 2. First, both the bidders experienced positive shareholder wealth creation around the beginning of the spectrum auction (August 17th, 2011). They commonly had a significantly positive AR on the preceding day, AR(-1), day of, AR(0), and following day, AR(1), at the start of the auction. Over the three days, both firms cumulatively earned positive returns of more than 12.0%. It indicates that the spectrum auction should be interpreted as “good news” to the marketplace because both the bidders expected to increase their competitive advantage by acquiring the attracted 1.8GHz spectrum license.

On the other hand, both firms experienced significant shareholder wealth loss before the completion of the auction. Over the three preceding days, they earned statistically significant negative returns of more than -7.0%. The results imply that, while the auction was under way, the competition between the bidders became fierce thus uncertainty existed concerning spectrum acquisition.

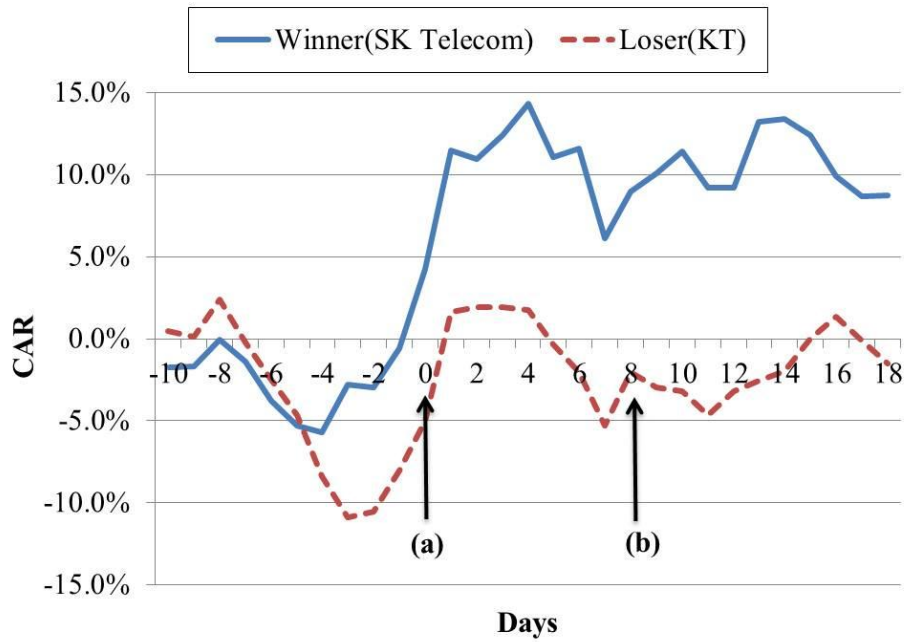
However, at the completion day (August 29th, 2011), the winning bidder, SK Telecom experienced positive shareholder wealth creation; the firm earned statistically significant positive returns of about 2.8%. Therefore, this result may indicate that there is no winner’s curse in the spectrum auction and that the winner acquired the attractive spectrum at an appropriate price. Moreover, the loser, KT also had a significantly positive return of about 3.2% on the auction completion day. This might mean that the second-best spectrum acquired by the firm also contributed to its competitive advantage anyway, even though it was not the best option that the operator really wanted. However, as shown in Figure 3, while the auction was underway, the loser seemed to experience insignificant shareholder wealth creation compared to the winner; the winner clearly generated positive shareholder values via the auction.

**Table 1.** Event study results for the bidders in the spectrum auction in Korea

Event day and window	Winner (SK Telecom)	Loser (KT)
Panel A: Beginning of the spectrum auction		
AR(-3)	2.90% ***	-2.50% **
AR(-2)	-0.17%	0.37%
AR(-1)	2.38% **	2.49% **
AR(0)	4.84% ***	3.02% ***
AR(1)	7.19% ***	6.62% ***
AR(2)	-0.49%	0.31%
AR(3)	1.47%	-0.01%
CAR(-3,0)	9.96% ***	3.38%
CAR(-1,0)	7.23% ***	5.51% ***
CAR(0,1)	12.04% ***	9.64% ***
CAR(0,3)	13.01% ***	9.94% ***
CAR(-1,1)	14.42% ***	12.12% ***
CAR(-3,3)	18.13% ***	10.29% ***
Panel B: Completion of the auction		
AR(-3)	-3.27% ***	-2.13% **
AR(-2)	0.53% ***	-1.66% *
AR(-1)	-5.47% ***	-3.24% ***
AR(0)	2.83% **	3.21% ***
AR(1)	1.12%	-0.92%
AR(2)	1.32%	-0.24%
AR(3)	-2.19%	-1.44%
CAR(-3,0)	-5.39% **	-3.82% *
CAR(-1,0)	-2.65%	-0.03%
CAR(0,1)	3.94% **	2.29%
CAR(0,3)	3.07%	0.61%
CAR(-1,1)	-1.53%	-0.95%
CAR(-3,3)	-5.14%	-6.42% **

Note: AR stands for abnormal return and CAR stands for cumulative abnormal return of the winning bidder and losing bidders, SK and KT respectively; CAR(-3,0) is the abnormal return cumulated over the day of the auction announcement and the three preceding days; CAR(-1,0) is the abnormal return cumulated over the day of the auction announcement and the preceding day; CAR(0,1) is the abnormal return cumulated over the day of the auction announcement and the day after; CAR(0,3) is the abnormal return cumulated over the day of the auction announcement and the three days after; CAR(-1,1) is the abnormal return cumulated over the preceding day of the auction announcement and the day after; CAR(-3,3) is the abnormal return cumulated over the three preceding days of the auction announcement and the three days after; As is common, \*, \*\* and \*\*\* represent one-tailed statistical significance at 10%, 5% and 1% level, respectively.





Note: a. Beginning of the spectrum auction (August 17th, 2011)  
 b. Completion of the auction (August 29th, 2011)

**Figure 3.** The CARs trend of the bidders in the spectrum auction in Korea

#### 4.2. Discussions

We empirically investigated whether the winning bidder overpaid for the attracted spectrum license in the first auction in Korea, using the event study technique, and confirmed that the winner had a positive shareholder wealth creation, meaning that there is no winner's curse in the auction. One interesting result is that both the winner and the loser experienced a significant positive return on the completion day of the auction. In the case of the winner, its positive shareholder value creation might imply that the winning bid is less than the true value of the spectrum. On the other hand, a positive shareholder wealth creation of the loser may be an unexpected result because the competitor would be at a competitive disadvantage by failing to acquire the spectrum that it really wanted. However, in the auction, the loser had an alternative chance to obtain another spectrum license after pulling out of the desired one. It might imply that a firm may also increase its competitive advantage by acquiring the second-best spectrum even when failing to achieve the initial objective.

Therefore, the auction case in Korea implies that policy makers may be able to bring positive short-term wealth effects for all bidders by designing the spectrum auction appropriately. For example, in the case of 3G mobile license auctions in Europe, all the bidders had only one chance to obtain the licenses without any alternatives (Cable et al., 2002; Mackley, 2008), thus there existed excessive competition between the bidders, generating a winner's curse in some countries including Germany. On the other hand, in Korea, because the government put three different spectrum licenses up for the auction, the bidders were able to have a second-best option if failing to achieve their original objectives, a measure possibly

alleviating excessive competition in the auction. Therefore, the regulators need to consider performing multi-band auctions which would bring positive shareholder wealth effects for all bidders. The result of recent spectrum auctions for 4G mobile licenses in Europe might offer some evidence since the winning bid was significantly less than that of the 3G cases due to bidders having several alternatives<sup>2</sup>.

Our results also give some meaningful implications to mobile operators. First of all, we confirmed that the value of the 1.8GHz spectrum is higher than the winning bid, about \$925 million in Korea. Therefore, Korean mobile operators should make a subsequent spectrum plan based on the confirmed spectrum value. Further, bidders need to prepare alternative plans to cope with unexpected situations since second-best alternatives could still bring positive shareholder wealth creation.

## 5. Conclusion

The first spectrum auction in Korea is quite attention worthy because there was a fierce competition for only the 1.8GHz spectrum band and the winning bidder was suspected of overpaying for acquiring the spectrum license. We attempted to investigate the existence of a winner's curse in the auction, using event study methodology. We confirmed that both the winner and the loser experienced a significant positive return at the completion day of the auction. Our results indicate that the winning bid was less than the true value of the spectrum; in other words, there was no winner's curse in Korea's first auction. The results also imply that the losing firm increased its competitive advantage by acquiring the second-best spectrum even though it failed to achieve its initial objective. Therefore, we suggest that regulators need to consider bringing positive short-term wealth effects for all bidders by designing the spectrum auction appropriately, such as performing multi-band auctions. Mobile operators also need to prepare a second-best spectrum plan for their shareholder value creation.

Although we presented some meaningful implications, they are not without limitations. First of all, by limiting the focus of this study to the particular auction in Korea, the generality of the empirical results should be treated with caution. Therefore, a useful area of future research would be to extend the empirical analysis to recent spectrum auctions in other countries. Second, we focused on the existence of a winner's curse in the spectrum auction but did not fully explain which factors impacted the winning bid. Therefore, further research should examine the impact of auction design variables on 4G spectrum auction revenues, in terms of the winning bid price.

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<sup>2</sup> For example, see the article titled "Big three operators happy with low-cost German auction" (May, 2010), Retrieved May 29th, 2012 from <[https://www.policytracker.com/headlines/big-three-operators-happy-with-low-cost-german-auction/?searchterm=Germany auction](https://www.policytracker.com/headlines/big-three-operators-happy-with-low-cost-german-auction/?searchterm=Germany%20auction)>

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