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The Determinants of Cartel Duration in Korea

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Abstract This paper analyzes a database of Korean Fair Trade Commission anti-cartel cases from 1989 through 2013 to explain determinants of reported cartel duration. These are all formal (rather than tacit) cartels, with start and end dates as determined by the KFTC; furthermore, our analysis does not address the question of frequency of cartel attempts. Nevertheless, we find that the expected fine imposed, normalized by number of firms and cartel duration, seems to be viewed *ex ante* as a cost of collusion—limiting duration—while foreign company involvement in cartels generally has promoted greater cartel stability (though perhaps less so in recent years). We also find that a larger number of participating firms generally limits cartel stability, though the statistical significance of this finding is not completely robust to specification choices. While not our primary focus, leniency/amnesty programs have generally expected effects on cartel stability.

Keywords Cartel stability · Cartel duration · Korea Fair Trade Commission · Antitrust policy · Competition policy

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1 Introduction

There is a long empirical literature in Industrial Organization, dating at least back to the 1970s, examining determinants of cartel stability. However these studies have all been based on data derived from US and European antitrust enforcement actions. In Feinberg and Park (2015), a database of horizontal conspiracy antitrust cases in South Korea was examined to analyze the impact of these enforcement actions on prices and profit margins. In this paper, we take a different approach and explore the determinants of cartel duration as revealed in these cases. We believe this to be among the first of such studies for a newly-developed economy (or new adopter of antitrust enforcement).

Previous work in this area goes back to Hay and Kelley (1974) for the US, Dick (1996) for US export cartels, Marquez (1994), Suslow (2005), Zimmerman and Connor (2005), and Levenstein and Suslow (2011) for international cartels, and De (2010) for European cartels. With the growth of antitrust enforcement agencies around the world, the ability to study cartel activity in other countries is now feasible. Recently Choi and Hahn (2014) have analyzed the role of the recent strengthening of the antitrust leniency/amnesty program in Korea on cartel stability; we utilize similar data, but our focus here is somewhat broader.

It must be acknowledged in this analysis, as in previous work in this area, that we are analyzing formal cartel agreements that have been uncovered by the antitrust authority—in this case the Korean Fair Trade Commission—and rely on their estimates of when cartels were formed and ended. Excluded, therefore, are tacitly collusive agreements and formal agreements that never came to light. And, of course, the end-dates of these cartels are not necessarily the "natural" ones suggested by theory, but rather those truncated by government investigations and enforcement. Furthermore, while stability of cartel efforts can be examined, explaining the determinants of the frequency of cartel formation is beyond the scope of our analysis.

2 Previous Literature

Theory yields some predictions for when collusive arrangements are likely to be more durable, but many of these are ambiguous in explaining formal cartel agreements; factors leading to less stability in tacit collusion may reinforce the need of members to form and attempt to stick with formal cartels. For example, work from Stigler (1964) on notes that the number of firms should matter, with less likelihood of longevity as the number of firms increases; however, with a very small number of firms tacit collusion may be feasible, with no need for formal collusion.[1]

[1] There is of course theoretical work on stability of cartel formation which focuses on numbers of firms within and outside the coalition. For example, Salant et al. (1983) suggests that a merger/coalition of at least 80 % the (symmetric) firms in the market is required for it to be profitable (hence stable); Catilina and Feinberg (2006) show that stability can be enhanced (such that a smaller share of the market can make a stable coalition) if some other facilitating factor (in their case a research joint venture) exists. But, that literature tends to assume that any number of fully-colluding firms can create a stable cartel.

And, as the number of firms increases (up to a point) formal cartels may become *more* durable (since the alternative option of tacitly colluding gets less feasible) though eventually formal cartels are likely to become less manageable with additional members; this suggests that the relationship between number of cartel members and its stability may be nonlinear.

Other determinants of cartel duration include indicators of cartel profitability as well as expected costs associated with engaging in illegal activity (including antitrust fines). Changes in enforcement policy may both disrupt existing cartels and change the incentives to form new ones. It has also been noted that the presence of a "ringleader" can facilitate cartel stability;[2] in particular, the participation of one or more foreign companies (and in the Korean case, a chaebol[3] member) may play this role. Similarly, cartels involving local geographic markets may be more durable than national cartels as it may be easier (less costly) to monitor member behavior to limit defections.

One of the earliest empirical investigations of characteristics associated with price-fixing rings was Hay and Kelley (1974).[4] In a purely descriptive study, they examined US criminal (horizontal) price-fixing cases which were won or settled by the US Department of Justice for the 10 years 1963–1972. They first, however, discussed various factors likely to affect incentives by firms to engage in collusive activities (and presumably to affect the duration of these activities); these include fewness of numbers, concentration of market shares, product homogeneity, demand inelasticity, lumpiness (infrequency) of orders, high fixed costs, sealed bidding, and industry social structure. Hay and Kelley find that almost 80 % of the conspiracies involved 10 or fewer firms, and that where larger numbers of firms were found trade associations were generally employed to aid in coordination (in 7 of 8 cases with more than 15 firms). They also found that cartels were more likely to occur and last longer where concentration is high and the product is homogeneous.

Marquez (1994) estimates the determinants of the duration of 52 international cartels covering a very wide period from the late 1880s through the early 1980s, using maximum likelihood techniques; the only statistically significant factor is the Herfindahl index, which (as expected) increased duration. In a more sophisticated study of 81 recent (active after 1990, ending by 2007) international cartels, Levenstein and Suslow (2011) estimate a proportional hazard model—attempting to distinguish between factors leading to "natural" cartel collapse and those related to cartel death via antitrust investigation (though one might argue about the extent to which an "amnesty application" represents "natural death" as they claim vs. "death

[2] Davies and De (2013) examine 89 European cartels and find ringleaders played a role in 19 of them; they seemed more prevalent in cartels that otherwise would be relatively unstable—with large numbers of firms and size asymmetries.

[3] A chaebol is a large family-controlled business conglomerate. They are differentiated from usual conglomerates in that the members of a family control its affiliated companies but we define a chaebol member as a company in a large business group whether or not it is family-controlled. The KFTC announces every year a list of conglomerates for which cross-shareholdings among the member companies are prohibited. In 2014, for example, the list included 63 business groups which have 26.6 subsidiaries and 35 trillion KRW (about $35 billion) in assets on average.

[4] Posner (1970) was an earlier broad look at historical antitrust enforcement trends in the US.

by antitrust"). The unit of observation in their study is "cartel-year pair" during which "a cartel is colluding and is at risk for breakup."

Levenstein and Suslow find empirical support for the theoretical argument of Harrington and Chang (2009) that enhanced antitrust enforcement (via amnesty programs and/or vigorous claims of international jurisdiction) will lead to collapse of the weakest cartels, resulting in observation of longer-lasting cartels immediately after the policy change.[5] Somewhat surprisingly, they find trade association involvement to hasten collapse (reduce duration) via "antitrust death," perhaps due to providing more visible evidence of collaborative efforts, but to promote stability in the sample of cartels dying "naturally"—through its help in promoting internal communication among members. They fail to find significant impacts of numbers of firms, concentration of the industry, buyer concentration, or macroeconomic factors. What do seem to matter are internal mechanisms of the cartel (such as market allocation, punishment and compensation procedures).

The most recent work examining cartel duration and/or stability has focused on the effects of the increasingly popular amnesty/leniency policies for those cartel members who first self-report to the antitrust authorities. Miller (2009) develops a theoretical model of cartel behavior, and then tests this on US data for 1985–2005. His interest is in the impact of a strengthened leniency program (in 1993) on rates of cartel formation and detection, applying a Poisson regression approach to explain cartel "discoveries" by the Antitrust Division. Miller finds that (as predicted by his model) the enforcement innovation leads to an immediate increase in cartel discoveries (enhanced detection) followed by a longer-term decline (consistent with enhanced deterrence).

Choi and Hahn (2014) examine the same issue for Korea, estimating a hazard model on 619 cartels discovered between 1981 and 2012. Their results on the impact of leniency policy are similar in nature to previous findings, with a short-run effect reducing the hazard rate or increasing cartel duration, but a long-run increase in the rate of cartel dissolution and a reduction in duration. Our study looks at similar issues though we focus as well on other determinants of cartel success.

3 Data

We obtain information on cartels formed between 1989 and 2012 from publicly available decision reports published by the Korea Fair Trade Commission (KFTC). The reports contain the basic facts and case summaries including the start and end dates of collusion, the participating firms, the nature of the collusive agreements or meetings, and the fines imposed by the KFTC. The KFTC determines the start and end dates corresponding to the periods during which the firms engage in collusive activities, in order to compute fines commensurate with collusive profits.

[5] In that model, weak cartels dissolve via ***defection*** rather than ***detection*** by the authorities, so that the sample of surviving cartels—subject to detection by the antitrust enforcers—yields longer average durations.

Table 1 List of variables

Variable	Description
Duration	Number of months from start and end dates of cartel
Bid-rigging	Dummy for bid-rigging case
Fine	Fine imposed by the KFTC for each cartel firm (million KRW)
Other normalized fine per firm	Normalized per firm fine of other cartel cases over the past 36 months (based on end time)
End97	Dummy for cases that ended between April 1997 and March 2005
End05	Dummy for cases that ended after April 2005
Beg97	Dummy for cases that started between April 1997 and March 2005
Beg05	Dummy for cases that started after April 2005
Leniency received (%)	Percentage of cases over the past 36 months (based on end time) receiving leniency
Number of firms	Number of participating firms
Local	Dummy indicating firms operate in local markets (vs. nationwide market)
Foreign	Dummy indicating at least one participant is a foreign company
Chaebol	Dummy indicating at least one participant is affiliated with a Chaebol
Growth rate (%)	Real GDP growth rate of each industry 3 years prior to end date of each cartel (Source: Bank of Korea)
Industry index	Industry codes in the Korean Standard Industrial Classification

However, cartel durations defined based on the start and end dates specified by the KFTC may be underestimated if the firms had agreed to collude prior to *observed* collusive activities. The decision report provides the date of the first-agreement meeting for some cartels, but this information is not available for other cartels. Being aware of the potential measurement error in duration measure, we construct two measures of cartel duration. The first measure is defined as the difference between the start date and the end date specified by the KFTC for the purpose of computing fines. The second measure of cartel duration is based on the start date defined as either the first-agreement meeting or the date specified by the KFTC, whichever is earlier. We use the former in our analysis throughout as a baseline, and consider results based on the alternative measure of duration as a robustness check.

Tables 1 and 2 present a list of variables and descriptive statistics, respectively, on 388 price-fixing and bid-rigging cases that started between 1989 and 2012 with positive duration (several were deleted where their start date and end dates were reported to be the same, and—as noted below—short-duration bid-rigging cases were also dropped); the KFTC's decisions in these cases were made between 1994 and 2013.[6] The variables include the year in which the cartel started, the number of months it was active, whether the case involved bid-rigging, the total fine imposed

[6] We also dropped the seven cases for which prosecution was called for but no fines were imposed by the KFTC. These cases are suspected to be incorrectly documented because the decision to prosecute by the KFTC is typically made for the highest-impact cartels.

Table 2 Summary statistics (n = 388)

	Mean	Median	Std	Min	Max
Duration (months)	25.06	14	28.96	1	177
Bid-rigging	0.25	0	0.43	0	1
Fine (million KRW)	10,951.6	268.5	46,001.1	0	668,604
End97	0.45	0	0.50	0	1
End05	0.46	0	0.50	0	1
Beg97	0.59	1	0.49	0	1
Beg05	0.27	0	0.45	0	1
Leniency received (%)	0.05	0	0.08	0	0.33
Number of firms	6.38	5	5.67	2	67
Local	0.37	0	0.48	0	1
Foreign	0.10	0	0.30	0	1
Chaebol	0.23	0	0.42	0	1
Growth rate (%)	5.93	4.09	6.37	−8.01	31.75

ex post by the KFTC, the number of firms involved in the case, whether the cartel was local or national in scope, and whether chaebol or foreign participation was involved. To proxy demand growth facing the cartel, we include a measure of recent (3-years prior to end-date of the cartel) revenue growth in the broader industry.[7]

We see much variability in cartel stability with durations ranging from 1 month to almost 15 years (but a median duration of 14 months), and subsequent fines ranging from zero to approximately $600 million. Foreign firms were participants in 10 % of the cases, chaebols in about 46 % of the cases. More than one-third of the cases were local in nature, and 25 % involved big-rigging conspiracies (lasting at least 3 months). The number of cartel participants varied between two and 67 (with a median value of five firms).

The KFTC initiated a leniency program in 1997 (similar in nature to earlier programs developed by antitrust enforcers in the US and EU), but it was strengthened considerably in 2005 as full immunity was given to the first informant; we examine whether leniency was involved in the case. However, the role of leniency policy is complicated (Harrington 2008; Hinloopen and Soetevent 2008; Brenner 2009; Miller 2009; Choi and Hahn 2014); it has been argued that the cartels most likely to be disrupted by the initial leniency program introduction are those which are inherently weak or unstable, hence the average duration of remaining cartels may rise. However, there may be different effects on the creation of new cartels. Ultimately, impact of leniency is an empirical question, and we investigate this issue below by looking at cartel durations both spanning and completely after the 2005 introduction of rigorous leniency rules by the KFTC.

[7] Industries are defined as 76 sectors, the 2-digit level in the KSIC (Korean Standard Industrial Classification) system; this is roughly comparable to the 3-digit level in the US NAICS system.

To capture the impact of the leniency program one may create a variable taking the value = 1 if any participating firm in a cartel case self-reports evidence of collusion to the KFTC under the program; however this measure seemed likely to be endogenous with respect to cartel duration (as well as being highly correlated with dummy variables discussed below indicating the timing of the cartel relative to adoption and strengthening of the leniency program). Another candidate is the percentage of recent cases involving leniency over the 3 years prior to the start date of the cartel. While this measure is not endogenous to the duration of a particular cartel it can be also highly correlated with the timing of the cartel. Neither of these variables is included in statistical analyses presented below. Instead we include (initially) End97 and End05 as binary variables indicating that a cartel ***ended*** after the adoption or revision of leniency policies, while, Beg97 and Beg05 take the value = 1 if a cartel ***started*** after the leniency program and its revision, respectively.

Dealing with bid-rigging cases also presents challenges. To the extent that firms come together for a one-time rigged bid, for which they are subsequently detected by the KFTC, the reported duration could be as low as a single month, yet if the volume of commerce at stake was considerable (as in a major construction project) this cartel could be as successful as a more traditional one lasting for many months. Our focus is on more enduring cartels (which would include bid-rigging rings which last for a while), and so we drop cases that appear to be one-time rigged bids with reported durations of less than 3 months—about half of all bid-rigging cases—and estimate the remaining cases together (with a bid-rigging dummy variable).

As noted above, the predicted effect of increasing the number of cartel participants on duration (or stability) is somewhat ambiguous when we are focusing on formal cartels. Clearly an increase in numbers makes *tacit* collusion more difficult, however that may imply that *up to a point* that increase will imply a greater need for (and perhaps more stability of) a formal cartel; beyond that point—even in a formal cartel—further increases may lessen cartel stability. For this reason, in preliminary specifications we include a squared term in firm numbers in explaining duration (however the squared term was generally not significant and these specifications are not reported here).[8]

In what follows we explain the duration of Korean cartels by the number of participants (and in some specifications the squared value), whether leniency was an option, the total fine applied by the KFTC normalized by number of firms and by duration (however as this would be clearly endogenous we use instead the normalized fine *applicable to other recent cartels* as an exogenous instrument), dummy variables for bid-rigging cases, chaebol participation, and foreign company involvement, along with industry fixed effects and the average real revenue growth rates for the broader industry over the past 3 years prior to the end year of the cartel. A dummy variable indicating a local market conspiracy is also included (however,

[8] Fonseca and Normann (2012), in experimental work, find that increased numbers imply lessened collusion—with or without communication between players—though the marginal effect was smaller for explicit cartels.

Table 3 Regressions of cartel duration

	All cartels				Duration after 2005			
	OLS		WLS		OLS		WLS	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Bid-rigging	−7.491**	−3.698	−7.898***	10.68	−9.280***	−2.383	−4.433**	−0.0323
	(3.017)	(2.998)	(2.044)	(7.498)	(3.194)	(4.527)	(1.758)	(2.829)
Normalized fines	−0.00165	−0.0165	−0.0516**	0.0513	−0.0870***	−0.219***	−0.143***	−0.269***
	(0.0231)	(0.0182)	(0.0206)	(0.0468)	(0.0243)	(0.0243)	(0.0114)	(0.0176)
End05	32.02***	47.35***	39.08***	56.08				
	(6.045)	(4.551)	(8.747)	(35.51)				
Beg05	−52.20***	−44.93***	−48.42***	−48.32	−3.551	5.534	1.175	2.623**
	(4.190)	(4.784)	(8.291)	(35.29)	(3.089)	(3.887)	(1.423)	(1.166)
Number of firms	−0.169	−0.214	0.0666	1.141***	−0.0615	−0.432	−0.135	−0.418**
	(0.153)	(0.143)	(0.145)	(0.229)	(0.220)	(0.345)	(0.116)	(0.180)
Local	−4.798	−5.947**	−2.999	11.82**	8.470**	3.647	3.451**	0.120
	(3.069)	(2.881)	(2.391)	(5.197)	(3.418)	(3.814)	(1.472)	(1.474)
Foreign	17.52***	18.66***	11.05	23.23	−0.139	2.486	−2.204	1.566
	(6.257)	(7.142)	(9.775)	(31.68)	(4.228)	(6.097)	(3.353)	(2.330)
Chaebol	−2.040	−0.542	0.347	−16.32***	−2.302	−0.614	−1.082	−4.087*
	(2.452)	(2.683)	(2.223)	(5.916)	(2.653)	(3.386)	(0.685)	(2.400)
Growth rate	−0.0693	−0.129	−0.145	0.884**	−0.0529	−0.196	−0.153	0.672**
	(0.200)	(0.208)	(0.124)	(0.403)	(0.458)	(0.699)	(0.357)	(0.334)
Constant	17.96	31.06*	11.02	−16.61	17.45	62.28***	37.66***	79.32***
	(19.80)	(18.18)	(31.58)	(120.2)	(11.29)	(11.12)	(8.912)	(8.130)

Table 3 continued

	All cartels				Duration after 2005			
	OLS		WLS		OLS		WLS	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Decision-year dummy	Yes	No	Yes	No	Yes	No	Yes	No
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	381	381	381	381	175	175	175	175
R^2	0.658	0.590	0.814	0.225	0.855	0.647	0.988	0.904

Robust standard errors in parentheses

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

given the relatively small geographic size of South Korea—about the size of Kentucky—the distinction between national and local cartels may be limited).

In order to control for general macroeconomic and political factors influencing cartel durations, we also include (in some specifications) decision-year dummy variables; the interpretation of these—and their interaction with the expected normalized fine variable discussed above—is complicated by the fact that fines (and enforcement generally) have increased over time (the simple correlation between decision year and the fine variable is +0.53). Furthermore some of this general enhancement of enforcement efforts over time is captured by the leniency variables (End05 and Beg05); for this reason, we present results both with and without the year dummies.

4 Econometric Specifications and Results

We first run linear regressions of cartel duration (in months) on its potential determinants as described above. Table 3 presents the estimates from regressions with industry fixed effects. The first two columns are based on OLS regressions, while the next two columns report the results from a weighted least squares estimation (results are presented both with and without year dummies, as discussed above).

As well documented in the literature on cartel stability, the estimation based only on discovered (or formal) cartels can be biased due to sample selection bias; successful long-lasting cartels (both tacit and formal) may not be the ones easily detected by enforcement authorities. To attempt to address the problem, we run weighted least squares regressions. The intuition for this approach is based on the theoretical framework of Harrington and Wei (2014), who explore the role of heterogeneity (particularly, in discovery and collapse probabilities) of cartels in regard to the directions of biases due to sample selection. The weighted least squares estimation takes into account such heterogeneity across cartels by specifying the variance of error terms which might reflect the sample selection process.[9] We present the results with squared residuals as weights. To test for heteroscedasticity in each regression, we use the Breusch–Pagan test and the test confirms that the null hypothesis (of homoscedasticity) is rejected at a 1 % significance level.

While the magnitudes of coefficients are generally similar between the OLS and WLS regressions, the WLS coefficients are more often statistically significant; the discussion below focuses on the WLS results. Over the full sample period—when year dummies are included—bid-rigging cartels tend to be about 8 months shorter

[9] Harrington and Wei acknowledge that their work is not able to give an exact solution to the sample selection problem, but they note that cartels with higher discovery (lower collapse) probabilities tend to have shorter (longer) duration and such cartels are more likely to be sampled (i.e. detected). We expect WLS, however, to improve the efficiency of our estimates.

on average than price-fixing cases, remembering that the very short-duration rigged auction cases (1 or 2 months duration) have been dropped from the sample.[10] Increases in expected fines seem to reduce cartel durations.

We include a dummy variable for cartels that have ended after the revision of the leniency program in 2005, End05, to capture the short-run effects of the leniency program on durations of detected cartels, relying on the intuition of Harrington and Chang (2009). On the other hand, the long-run effects are captured by the sum of End05 and Beg05, the latter indicating cartels which started after 2005. The sign of the estimated coefficient of End05 is in line with the theoretical predictions by Harrington and Chang (2009), a short-run impact raising observed cartel durations; the long-run effect—the sum of the coefficients of End05 and Beg05—is considerably smaller with a sign that depends on whether year dummies are included or not (as noted above the theoretical predictions are not clear).[11]

The number of participating firms seems not to play the expected role in determining cartel duration and we do not find a consistent significant difference in cartel longevity in local conspiracies, despite work of Levenstein and Suslow (2011) who find that both monitoring costs and incentive for deviation are low when geographical coverage of a cartel is local. The chaebol effect is generally not quite significant,[12] while there is a hint of a possible positive impact of foreign participation on cartel duration (though only significant in the OLS results).

As we have discussed already, the role of leniency in cartel stability is complicated and difficult to fully capture with the limited information in the data. Another attempt to examine more closely the effects of the enhanced leniency policy starting in 2005 involves analysis of only the cartel cases that remain after April 2005. Provided that cartel behavior has changed systematically after the adoption (or reinforcement) of leniency program, such analysis may more fully separate out the effects of potential determinants on cartel duration from policy effects. These results are shown in the last four columns of Table 3. The explanatory variables are the same as for the full sample of cases, except that End05 is dropped since all cases ended after 2005, but the dependent variable is the entire duration less the number of months prior to April 2005.

Focusing again on the WLS results, we see in both specifications that larger expected fines imply shorter durations; increasing numbers of firms do as well, though this effect is only significant when no year dummies are included. Post-2005, effects of local conspiracies and the leniency policy variable, Beg05, indicating newly formed cartels after April 2005, are positive but not both statistically

[10] We tried as well dropping all bid-rigging cases, with results similar to those reported here.

[11] In preliminary regressions we found a similar pattern, but smaller magnitudes, for the effect of the introduction of leniency in 1997 (and results for other variables were generally similar to those reported here when the variables End97 and Beg97 were included. It should be noted that very few of the cartels in our sample were formed or ended prior to 1997.

[12] One explanation for our failure to find chaebol effects may be an overly-broad definition, which really may capture any large conglomerates rather than the traditional family-dominated groups which might be more likely to exercise "ringleader" control over a cartel.

significant in the same specification. The foreign participation variable also no longer has a significant impact on cartel stability in any of the post-2005 specifications.[13]

However, it is plausible that the relationships examined here are best examined in nonlinear specifications. In the next two tables we present results with variables in logs and using hazard models. In Table 4, we present log–log regressions (dropping the squared terms for number of firms, which was never significant in the earlier results). Focusing on the WLS specification, results are similar to the regressions in levels, with some exceptions. Increases in recent fines continue to reduce cartel durations, stronger and more often significant post-2005. However the number of firms now has a significant negative effect on cartel duration both for the full sample and post-2005. Foreign participation has a positive and significant impact for the full sample, and now as well (though smaller and less often significant) in the post-2005 period. The leniency policy effects are quite similar to those found in Table 3, with increases in duration for existing cartels and somewhat ambiguous effects on cartels newly-formed after 2005.

Finally, we estimated a semi-parametric Cox proportional hazard model, reported in Table 5, again for both the full sample of cases and those remaining after April 2005 (and again, with and without year dummies). Results are similar to those found from the regression analysis, with higher fines and larger numbers of cartel participants increasing the hazard of cartel collapse, the foreign dummy reducing the hazard, and leniency policy showing a similar impact to that found earlier—a short-run reduction in the hazard (equivalent to a lengthening of average duration) and a smaller long-run impact (with a sign not robust to specification). Also consistent with expectations is a higher hazard for bid-rigging cases. As before, we find limited and/or inconsistent effects of economic growth, local cartels and chaebol participation.

As noted earlier, we use the KFTC's reported cartel duration in the results presented here. Alternatively, we measure cartel duration from the first agreement-meeting (if earlier than the reported cartel start date). This alternative measure yields, as expected, slightly longer durations on average by about 2 months—with the same median duration. Results for our main variables of interest are little changed.

We performed various other robustness exercises, dropping outliers in cartel duration (the highest and lowest 2 % of cases), dropping one extremely large cartel (with 67 participants), and performing separate regression analysis on cases only begun after April 2005—results were very similar to what is presented here. We also attempted a Tobit estimation, reflecting the skewed nature of the distribution of durations, truncated below at 1. Results are again quite similar to those from the log–log specification reported in Table 4.

[13] While purely speculative, this may simply imply that as the Korean economy has matured, domestic firms are now able to collude without any outside help.

Table 4 Log–log regressions of cartel duration

	All Cartels				Duration after 2005			
	OLS		WLS		OLS		WLS	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Bid-rigging	−0.237	0.00863	−0.146	−0.159	−0.166	0.0191	−0.210*	−0.0710
	(0.152)	(0.143)	(0.139)	(0.145)	(0.144)	(0.177)	(0.125)	(0.135)
Normalized fines	−0.281**	−0.0798	−0.0712	−0.222**	−0.817***	−1.388***	−0.491***	−1.275***
	(0.114)	(0.0778)	(0.106)	(0.0860)	(0.143)	(0.143)	(0.109)	(0.0948)
End05	1.179***	1.757***	1.486***	1.791***				
	(0.301)	(0.170)	(0.338)	(0.159)				
Beg05	−1.657***	−1.358***	−1.981***	−1.478***	0.0447	0.381***	0.0712	0.531***
	(0.141)	(0.152)	(0.148)	(0.136)	(0.131)	(0.141)	(0.122)	(0.121)
Number of firms	−0.0912	−0.0905	−0.347***	−0.667***	−0.0172	−0.131	−0.217***	−0.233***
	(0.0827)	(0.0820)	(0.0675)	(0.0818)	(0.0789)	(0.100)	(0.0500)	(0.0769)
Local	−0.243	−0.349**	−0.290**	−0.431***	0.0624	−0.0909	0.339***	−0.0329
	(0.155)	(0.143)	(0.142)	(0.130)	(0.148)	(0.150)	(0.118)	(0.138)
Foreign	0.448***	0.638***	0.636***	1.067***	0.147	0.369**	0.0760	0.445***
	(0.172)	(0.192)	(0.130)	(0.134)	(0.136)	(0.177)	(0.104)	(0.143)
Chaebol	−0.151	−0.115	−0.0791	−0.0124	−0.220**	−0.143	−0.0392	−0.121
	(0.129)	(0.127)	(0.131)	(0.136)	(0.0998)	(0.139)	(0.0995)	(0.0869)
Growth rate	−0.000370	0.00474	0.0108	−0.000615	−0.00317	−0.00961	−0.0185	0.00591
	(0.0113)	(0.0113)	(0.0117)	(0.0134)	(0.0213)	(0.0251)	(0.0145)	(0.0190)
Constant	2.619***	3.068***	1.860	5.005***	5.761***	9.991***	4.237***	8.756***
	(0.901)	(0.479)	(1.645)	(0.525)	(1.045)	(0.972)	(0.881)	(0.539)

Table 4 continued

	All Cartels				Duration after 2005			
	OLS		WLS		OLS		WLS	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Decision-year dummy	Yes	No	Yes	No	Yes	No	Yes	No
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	381	381	381	381	175	175	175	175
R^2	0.559	0.480	0.971	0.823	0.865	0.766	0.921	0.909

Robust standard errors in parentheses

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

Table 5 Estimation of survival models

	All cartels		Duration after 2005	
	(1)	(2)	(4)	(5)
Bid-rigging	0.584***	0.325**	0.789***	−0.0290
	(0.157)	(0.142)	(0.298)	(0.324)
Normalized fines	0.000701	0.00161*	0.0265***	0.0309***
	(0.00119)	(0.000911)	(0.00442)	(0.00360)
End05	−1.536***	−2.298***		
	(0.332)	(0.210)		
Beg05	2.677***	1.947***	0.0593	−0.702**
	(0.240)	(0.220)	(0.334)	(0.304)
Number of firms	0.0120	0.0154*	0.0159	0.0348
	(0.00814)	(0.00838)	(0.0198)	(0.0294)
Local	0.616***	0.503***	−0.691**	0.149
	(0.171)	(0.160)	(0.336)	(0.262)
Foreign	−0.702**	−0.916***	−0.243	−0.586
	(0.276)	(0.266)	(0.303)	(0.443)
Chaebol	0.328**	0.226*	0.382	0.205
	(0.145)	(0.131)	(0.269)	(0.265)
Growth rate	−0.0101	0.00133	0.0545	0.0613
	(0.0134)	(0.0117)	(0.0407)	(0.0533)
Decision-year dummy	Yes	No	Yes	No
Industry fixed effects	Yes	Yes	Yes	Yes
Observations	381	381	175	175

The estimates are based on the semi-parametric Cox proportional hazard model

Robust standard errors in parentheses

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

5 Conclusion

This paper analyzes a database of Korean Fair Trade Commission anti-cartel cases from 1989 through 2012 to explain determinants of reported cartel duration. Our results add to the literature on explaining cartel success, which to date has been based almost entirely on US and European case data. With the caveat that these are all formal (rather than tacit) cartels, with start and end dates as determined by the KFTC, our most robust result is that the expected fine imposed, normalized by numbers of cartel member firms and cartel duration, seems to be viewed ex ante as a cost of formal collusion—limiting duration. Our findings are generally consistent with those of Choi and Hahn (2014) in terms of leniency effects, though our measure and implications of long-run effects are slightly different from theirs. The leniency/amnesty program has the generally expected duration-increasing short-run effect (and a smaller and mixed long-run impact on cartel stability); note that this result says nothing about its impact on frequency of cartels, just on stability of those created.

Other results are more sensitive to time period and specification. We find that—consistent with theory—the number of firms often plays a role in cartel stability, reducing cartel duration as it increases (though not significant in all specifications). Foreign company involvement in cartels generally tends to promote greater cartel stability—playing a "ringleader" role—though this impact seems to have grown less important over time. Finally, there is no support for the view that chaebol participation aids in longevity of horizontal conspiracies (and in fact some suggestion of an opposite effect).

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