

# Monitoring Cartel Behavior and Stability: Evidence From NCAA Football

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## Abstract

Most economists view the National Collegiate Athletic Association (NCAA) as a cartel. We investigate the dynamic strategic interaction among NCAA members in a cartel model with incomplete information focused on the strategic behavior induced by self-monitored enforcement of recruiting rules. Empirical results from a panel Probit model strongly support the predictions of the model. Lagged winning percentage, the discount rate of the decision maker, the institution's commitment to non-athletic activities, and the institution's demand-cost configuration, are all important predictors of institutions being placed on probation for violating the cartel rules.

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## Introduction and Motivation

Most economists view the National Collegiate Athletic Association (NCAA) as a cartel. If the cartel model of industry behavior applies to the NCAA, then this organization represents a unique opportunity to test economic theories of cartel behavior, because the NCAA has operated for almost 100 years and a considerable amount of data about member organizations exist for much of this period. Very few other examples of cartel behavior can be found in such a visible setting.

In this paper, we develop a dynamic model of the behavior of members of the NCAA football cartel under incomplete information. This paper extends the research of Fleisher et al. (1988,1992) on the enforcement of the NCAA football cartel to explicitly include dynamic interaction among cartel members both in the model and the empirical work. The model permits analysis of the enforcement mechanism when signals about rivals' behavior contain a random component and are observed with a lag. This dynamic stochastic approach has not been applied to the NCAA football cartel in previous research. Empirical estimation of this model reveals that past on-field performance is significantly linked to enforcement of the cartel agreement.

The incentive for individual members to cheat on a cartel agreement represents the basic problem faced by any cartel. In the case of the NCAA, reducing competition for inputs, in this case student-athletes, by controlling input prices constitutes a key component of the cartel agreement. Implications for the output market also exist; see Eckard (1998) for one example. According to NCAA regulations, each prospective student-athlete can be offered an identical compensation package from each institution, the "full-ride" grant-in-aid package consisting of tuition and fees, room and board, books, and a small stipend, often called "laundry money." Requiring each institution to offer recruits the same compensation package clearly restricts competition in the input market. Absent this restriction, institutions could offer highly-regarded recruits other inducements to attend an institution; in a competitive market, each student-athlete would be offered up to the expected value of his value of marginal product by institutions.

As in any cartel, the payoff to an individual school for cheating on the agreement can be considerable. By attracting star-quality athletes, institutions can improve their performance on the playing field and draw more fans; make more appearances on television; increase opportunities for merchandise licensing and corporate sponsorship; and make lucrative post-season appearances, all of which increase revenues directly and indirectly by increasing the prestige of the institution. Brown (1992) estimates the marginal revenue product of a premium college football player to be over 500,000 dollars annually. The NCAA football cartel agreement restricts the effective player wage to an amount considerably below the marginal revenue product.

In the NCAA, the incentive to cheat on the cartel agreement also extends to coaches. Relatively successful

coaches earn more than unsuccessful coaches in all NCAA sponsored sports, even in non-revenue generating sports like women's basketball [see Humphreys (1999).] Higher winning percentages also signal higher quality coaching ability and raise coaches' opportunity wage in the labor market.

Monitoring institution's actions in the input market would be prohibitively expensive. Thousands of high school seniors are recruited by NCAA member institutions each year. Each NCAA institution has thousands of alumni, many of whom are interested in promoting the athletic success of the institution and are organized into well-financed athletic booster clubs. To avoid these high monitoring costs, cartels typically turn to indirect and probabilistic methods to detect cheating on the cartel agreement [Stigler (1964).] Fleisher, Goff, Shughart, and Tollison (1988) and Fleisher, Goff and Tollison (1992) posit that NCAA member institutions and the NCAA Committee on Infractions, the body charged with enforcing the NCAA recruiting regulations, monitor outputs (on-field performance) rather than inputs to determine if an institution has cheated on the cartel agreement. Further, because the staff of the NCAA Committee on Infractions is relatively small (in 1988 it consisted of 28 employees), much of the monitoring must be done by individual institutions.

Monitoring of the cartel agreement creates a rich environment for strategic interaction among the members of the NCAA cartel and provides an interesting setting for the analysis of cartel behavior. Consider two possible scenarios. A perennial .500 team begins to consistently attract high-quality recruits and enjoys several years of winning records, conference championships, etc. This team's rivals infer that the school has been violating the cartel agreement by offering cash payments to recruits in exchange for enrolling. The rivals request an investigation by the NCAA Committee on Infractions into the school's recruiting practices. As a second example, consider two institutions who are both violating the cartel agreement by bidding for the services of an athlete. The loser knows it was out-bid by the other school, and can turn its rival in to the NCAA.

The NCAA Committee on Infractions can impose severe penalties on institutions found to be cheating on the cartel agreement. These penalties included bans on television and postseason appearances, reductions in the number of scholarships that could be offered, and even the "death penalty," a complete shut down of an athletic program. All of these penalties carry potentially large economic consequences, given the average size of the payment for an appearance on television or in a bowl game.

Evidence exists suggesting that sanctions imposed for violations of recruiting rules are used to enforce the NCAA cartel agreement. Fleisher, Goff, Shughart, and Tollison (1988) and Fleisher, Goff and Tollison (1992) studied 85 big-time football programs over the period 1953-1983 and found that the probability of a school receiving sanctions to be positively correlated with the variability of an institution's on-field performance in football. However, these studies did not examine the dynamic interaction among NCAA member institutions.

The nature of the monitoring process for the cartel agreement suggests a number of potentially interesting applications for testing strategic behavior in a dynamic setting.

## Model

Our model of the NCAA football cartel is adapted from a model developed by Spence (1978) to examine the effects of imperfect information on tacit coordination. In setting up the game played by NCAA cartel members, we follow the modelling strategy adopted by DeBrook and Hendricks (1997) in modelling the NCAA as a club.

Let  $N$  denote the number of schools in the NCAA football cartel. In each period, each school must choose the level of commitment to athletic and non-athletic activity. Let  $\theta_i$  denote the commitment to athletics and let  $x_i$  denote the commitment to non-athletic activities by school  $i$ . Although  $\theta_i$  can be interpreted in several ways, we find it natural to think of commitment to athletics as representing the quality of athletic programs or the prestige afforded an institution because of its high quality athletic programs. Schools can increase  $\theta_i$  with investment in time, money and cheating.

Schools face a constrained optimization problem and must choose  $\theta_i$  and  $x_i$  subject to a budget constraint. The cost of producing an athletic program of quality  $\theta_i$  is captured in the cost function for commitment to athletics,  $C(\theta_i)$ . Let  $p_x$  be the price of non-athletic commitments,  $I_i$  be income from non-athletic commitments, and  $r_i$  be returns to the school from its football program. Returns from football could be revenue from ticket sales, television contracts or post-season bowl game appearances.

An individual school's problem is to choose  $\theta_i$  and  $x_i$  to maximize expected utility subject to the budget constraint. A school's maximization problem is written as

$$\max_{x_i, \theta_i} E_\alpha [U_i(x_i, \theta_i, \alpha)] \quad (1)$$

subject to

$$p_x x + C(\theta_i) \leq I_i + r_i. \quad (2)$$

where  $\alpha$  is a random variable.

The simplest decision-making structure is one in which the president of the university chooses both  $\theta_i$  and  $x_i$ . It may be that the president does not have the time, information or will required to make the best decisions regarding the university's commitment to athletics. The president may respond to this situation by delegating such decision making to the athletic director and coaches of the school's sports teams. In this

context,  $\theta_i$  for football is chosen by the head football coach and  $x_i$  is chosen by other university personnel. The delegation of decision-making to athletic directors, head coaches, deans, and other university personnel creates a hierarchical organizational structure within universities which is amenable to analysis within a principal-agent framework. While the dynamics of the university's internal decision making processes within a principal-agent framework is interesting, we do not approach the maximization problem from a principal-agent perspective because we are interested in analyzing the behavior of the cartel, rather than the internal decision-making processes of a single university.

Since the head coach is the university representative that is closest to the cartel of NCAA football programs, it is useful to think of this maximization problem as that of the head coach of the institution's football team.<sup>1</sup> The head coach chooses  $\theta_i$  but does not choose or directly influence the choice of  $x_i$ . However,  $x_i$  is an argument of the utility function because the head coach gets utility from the school's commitment to non-athletic activities and may affect the school's choice indirectly. Taken from the head coach's perspective, then, the maximization problem is reduced to choosing  $\theta_i$  subject to the school-wide budget constraint and taking  $x_i$  as given.

Cartels are difficult to sustain because there are incentives to cheat on the cartel agreement. If member schools could directly observe their competitors' behavior, then detecting cheating and enforcing the cartel agreement would be relatively easy. However, schools have imperfect information to the extent that they cannot directly or immediately monitor each other's strategies. In addition, schools cannot perfectly control all factors that affect the utility they derive from their respective commitments to athletic and non-athletic activity. When the imperfect monitoring capability is coupled with exogenous randomness, the set of sustainable collusive outcomes is reduced. To formalize the notion of imperfect information, schools choose their levels of commitment to athletic activity based on signals, denoted  $s_i$ , they receive from the environment. The signals depend upon the cartel members' levels of athletic commitment and the random variable, which is denoted  $\alpha$ . An important aspect of the signals is that the same signal can suggest good luck, good management or cheating on the cartel agreement. The inability to differentiate the meaning of signals further weakens cartel stability. Signals are determined by

$$S_i = M_i(\theta_i, \theta_j, \alpha). \quad (3)$$

The specification of  $M_i$  determines the informational structure of the market. An example of a signal for the NCAA football cartel is on-field performance, which can be measured by winning percentage. Schools

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<sup>1</sup>The athletic director may also be viewed as a university representative that is close to the NCAA cartel. The maximization problem does not change if it is viewed from the athletic director's perspective rather than the head coach's perspective.

can directly observe its competitors' winning percentages over time and make inferences about adherence to the cartel agreement. A perennial loser may suddenly have a higher winning percentage either because it cheated on the cartel agreement by inappropriately compensating players or because the team over-achieved or was on the right side of the scoreboard in some closely contested games. Rival school responses to the observed winning percentage will depend on how the signal is interpreted.

The set of possible equilibrium outcomes are defined by reaction function equilibria. In general, a reaction function specifies an action for a firm given its rivals' actions. In context of the NCAA football cartel, the reaction function for school  $i$  specifies the level of commitment to athletic activities given other member schools' levels of commitment to athletic activities. In a game of imperfect information, school  $i$  cannot observe its competitors' behavior directly but must instead rely on signals, such as winning percentage or success in recruiting athletes, it receives. The reaction functions in this situation depend on the signals rather than competitors' actions. The reaction function for school  $i$  is denoted by  $R_i(S_i)$ .

Suppose that a set of reaction functions for the NCAA cartel given by  $R_j(S_j), j = 1, \dots, n$  and a vector of actions,  $\theta_j^*$ , constitute the status quo strategy adopted by the cartel such that  $R_i(s_i) = \theta_i^*$ . The status quo strategy is to compensate each student-athlete with an identical package and to adhere to particular rules regarding recruiting visits and signing periods. Cartel members are better off by following the status quo strategy than a non-cooperative strategy because the cost to the football program is reduced and revenues are increased, holding all else equal. The extent to which the status quo strategy is sustainable depends upon the expected payoff to following the cartel agreement, the expected payoff to cheating, the penalties associated with cheating and the probability of detecting cheating.

Define the expected payoff to following the cartel agreement by

$$\bar{P}_i(\theta^*) = E_\alpha[U_i(\theta^*), \alpha]. \quad (4)$$

The members of the cartel must have an incentive to maintain the outcome  $\theta^*$ . The set of reaction function equilibria includes a maximum penalty that each school can impose on the others should a deviation from  $\theta^*$  occur. If an incentive to maintain  $\theta^*$  cannot be created with the maximum penalty, then it cannot be created with any set of reaction functions. Define the maximum penalty as the minimum payoff school  $j$  can impose on school  $i$

$$m_i = \max_{a_i \in A_i} \min_{a_j \in A_j} \bar{P}_i(a_i, a_j). \quad (5)$$

In the NCAA cartel, the maximum penalty is the "death penalty" which is a complete shut-down of an

institution's football program for a period of years. Such a penalty was imposed on Southern Methodist University in the mid 1980s. Note that the maximum penalty is more severe than the penalty required to sustain the cartel agreement. The NCAA football cartel has been sustained for a number of years without frequent imposition of the maximum penalty; thus, we interpret the imposition of less severe as probation or public reprimand as sufficient penalties to maintain the cartel agreement.

Assume that school  $j$  plays  $\theta_j^*$  if the signal it receives is in the set of signals that call for playing  $\theta_j^*$ ; otherwise, it imposes the maximum penalty. For two pairs of strategies  $\theta^*$  and  $\theta^{**}$ , define the set

$$T_j(\theta^*, \theta^{**}) = \{\alpha | M_j(\theta^*, \alpha) \in \Gamma_j(b)\}. \quad (6)$$

This is the set of all  $\alpha$  such that the signal school  $j$  receives when  $\theta^*$  is played is one of the signals it would have received when  $\theta^{**}$  is played. Let  $F(\alpha)$  be the distribution of  $\alpha$

$$Q_j(\theta^*, \theta^{**}) = \int_{T_j(\theta^*, \theta^{**})} dF(\alpha) \quad (7)$$

which defines the probability of not being detected when deviating from the status quo strategy. The expected payoff to school  $i$  from playing strategy  $\theta^*$ , conditional on the signal to school  $j$  being the same as it would have been if school  $i$  played strategy  $\theta^{**}$  as

$$D_i(\theta^*, \theta^{**}) = E_\alpha(P_i(\theta^*, \alpha) | \alpha \in T_j(\theta^*, \theta^{**})). \quad (8)$$

This is the payoff to school  $i$  to deviating from the status quo strategy conditional on school  $j$  being unable to detect the deviation from status quo. The conditional payoff to deviating from the status quo strategy,  $\theta^*$ , to  $\theta$  can now be defined as

$$Q_j(\theta_i, \theta_j^*, \theta^*)[D_j(\theta_i, \theta_j^*, \theta^*)] + (1 - Q_j(\theta_i, \theta_j^*, \theta^*))m_i \quad (9)$$

where the first term is the expected payoff to undetected cheating on the cartel agreement and the second term is the expected payoff to getting caught.

The expected payoff to playing the status quo strategy is given by (4). School  $i$  has no incentive to cheat if and only if for all  $\theta_i$

$$Q_j(\theta_i, \theta_j^*, \theta^*)[D_j(\theta_i, \theta_j^*, \theta^*)] + (1 - Q_j(\theta_i, \theta_j^*, \theta^*))m_i \leq \bar{P}_i(\theta^*). \quad (10)$$

Collecting and rearranging terms permits expressing (10) in terms of the probability of a deviation from the status quo strategy going undetected

$$Q_j(\theta_i, \theta_j^*, \theta^*) \leq \frac{\bar{P}_i(\theta^*) - m_i}{D_i(\theta_i, \theta_j^*, \theta^*) - m_i}. \quad (11)$$

If (11) holds for all schools, then the status quo strategy,  $\theta^*$  can be a reaction function equilibrium. The set of all possible equilibrium outcomes is the set of vectors  $\theta^*$  that satisfy (11) for  $i = 1, \dots, n; j \neq i$ . For the NCAA cartel, the status quo strategy includes compliance with agreed upon rules governing compensation for athletes and recruiting practices. The longevity of the NCAA football cartel suggests that members of the cartel are playing the status quo strategy  $\theta^*$  rather than some noncooperative strategy.

Next consider the effect of reaction lags on the incentives not to cheat. Reaction lags can occur if there is time between when a school adopts a course of action and rival schools either observe or respond to it. This case clearly applies to the NCAA football cartel, as institutions perform much of the monitoring of rivals' compliance with the cartel agreement and must wait until the outcomes of games played are known before deciding if another institution has deviated from the status quo strategy.

Divide time into periods where the number of periods between the occurrence of cheating by school  $i$  and the response to cheating by rival schools is  $k$ . The discount rate is

$$\phi = \frac{1}{1 - \delta} \quad (12)$$

where  $\delta$  is the single period discount rate. The present value of deviating from the status quo strategy  $\theta^*$  to  $\theta_i$  under maximum penalties is

$$P_i(\theta_i, \theta_j^*) \frac{[1 - \phi^k]}{1 - \phi} + m_i \frac{\phi^k}{1 - \phi}. \quad (13)$$

Similarly, the present value of playing the status quo strategy is

$$\frac{\bar{P}_i(\theta^*)}{1 - \phi}. \quad (14)$$

Under this scenario, school  $i$  finds it preferable not to deviate from the status quo strategy,  $\theta_i^*$  if for all  $\theta_i$

$$P_i(\theta_i, \theta_j^*) \frac{[1 - \phi^k]}{1 - \phi} + m_i \frac{\phi^k}{1 - \phi} \leq \frac{\bar{P}_i(\theta^*)}{1 - \phi} \quad (15)$$

Collecting and rearranging terms permits writing (15) as

$$1 - \phi^k \leq \frac{\bar{P}_i(\theta^*) - m_i}{P_i(\theta_i, \theta_j^*) - m_i}. \quad (16)$$

In this equation,  $\phi^k$  is the probability of an institution being detected deviating from the status quo strategy and  $Q_j = 1 - \phi^k$  is the probability of not being detected. The right hand side of (16) is the ratio of the present value of the benefit to standing pat ( $\bar{P}_i(\theta^*)$ ) to the present value of the benefit from switching away from the status quo strategy ( $P_i(\theta_i, \theta_j^*)$ ).

## Empirical Analysis

Consider an empirical model based on the equilibrium conditions from the model developed in the previous section. Equation (16) forms the basis for our empirical model. This equation shows the probability of a deviation from the status quo strategy going undetected. It can be rearranged to

$$\phi^k \geq 1 - \frac{\bar{P}_i(\theta^*) - m_i}{P_i(\theta_i, \theta_j^*) - m_i} \quad (17)$$

where  $\phi^k$  is the probability of a deviation from the status quo strategy being detected. As was the case above, the right hand side of (17) depends on the ratio of the expected payoff to following the status quo strategy to the expected payoff to not following the status quo strategy.

From (17), factors which raise the present value of the payoff to adhering to the NCAA cartel agreement relative to the present value of the payoff to deviating from the agreement reduce the probability of institutions being detected. Factors which raise the present value of the payoff to deviating from the cartel agreement relative to the present value of standing pat will increase the probability of institutions being detected.

The payoff for schools to adhering to the NCAA football cartel agreement stem from the monoposony power they gain in input markets. Institutions can pay football players a wage, in this case the value of a scholarship, room, board, and books, which may be less than the value of marginal revenue product produced by these players, thus raising the return from football to the institution. Absent the cartel, institutions would have to bid for the services of football players and the wage would rise in many cases.

Deviating from the cartel agreement means offering some form of payment, which could take the form of direct cash payments, employment for friends or relatives, co-signing loans, or providing the player with goods or services at below-market prices, in order to attract certain players to the institution. The payoff to deviating from the cartel agreement comes in the form of higher quality football teams which raise the prestige of the institution and can also increase the revenues earned by the football team through more television exposure, higher ticket sales, appearances in bowl games and greater alumni contributions to the athletic department.

Table 1: Variables in Equation (18)

| Variable       | Definition                                                                                                               |
|----------------|--------------------------------------------------------------------------------------------------------------------------|
| $ENF_{i,t}$    | Dummy variable, =1 if institution $i$ detected cheating on the NCAA football cartel agreement and punished in period $t$ |
| $WPCT_{i,t-k}$ | Winning percentage of football team at institution $i$ in year $t - k$                                                   |
| $CEXP_{it}$    | Years of head coaching experience of head football coach at institution $i$ in year $t$                                  |
| $TEGE_{it}$    | Total educational and general expenditures per FTE, in real 1982 dollars, by institution $i$ in year $t$                 |
| $STA_{it}$     | Capacity of football stadium in 1,000's at institution $i$ in year $t$                                                   |

Also note that from (17), as  $k$ , the length of the reaction lags, increases  $\phi^k$ , the probability an institution is detected cheating on the cartel agreement falls. This result highlights the importance of dynamics in the model. Averaging explanatory variables over long periods of time, a common practice in this literature, may obscure the relationship between recruiting violations and the observable factors schools use to monitor compliance with the NCAA cartel agreement.

We adopt the empirical model

$$ENF_{it} = \beta_{1,i} + \beta_2 WPCT_{i,t-k} + \beta_3 CEXP_{it} + \beta_4 TEGE_{it} + \beta_5 STA_{it} + \gamma Z_i + \eta_{it} \quad (18)$$

as an estimable version of equation (17). The variables in (18) are defined on Table 1. The  $\beta$ s and  $\gamma$ s are unknown parameters to be estimated.  $\beta_{1,i}$  is an institution-specific intercept capturing factors common to institution  $i$  that affect the probability of detection but do not vary over time. These factors include relative age of the institutions, and geographical location of the institution, institution-specific monitoring costs, and other factors.  $\eta_{it}$  is an institution-specific random error term that reflects the randomness inherent in the monitoring process due to the inability of institutions to directly monitor the behavior of other institutions.

The dependent variable,  $ENF$ , is a dummy variable that takes the value 1 in years when an institution's football program was on probation for violating NCAA regulations governing recruiting of football players and zero in other years. Football programs were on probation in about 3% of the institution-years in our sample.

$WPCT$ , the winning percentage of institution  $i$ 's football team, is predicted to have a positive sign. From equation (17), the winning percentage of an institution's football team has no effect on the benefit to

complying with the cartel agreement because the benefit flows from rents generated by paying players less than their value of marginal product. Higher winning percentages increase the benefit to not complying with the cartel agreement by increasing the prestige of the athletic program and the revenues generated by higher quality football programs. This increases the denominator of the fraction on the right hand side of (17) and the probability of detection.

*CEXP* is the years of head coaching experience of the head football coach at institution  $i$  in season  $t$ . We use this as a proxy for the discount rate of the decision maker, which affects  $\phi^k$  directly. The sign on the parameter on this variable should be negative. The longer a head coach remains at an institution, the more closely the coach becomes associated with the institution and the more the coach cares about the future of the institution. This raises the discount rate of the head coach and decreases the probability of detection breaking the cartel agreement. The less time a head coach has been at an institution, the less certain he is that he will remain at the institution for a long period of time, and the lower the coach's discount rate, other things equal.

*TEGE* is total educational and general expenditure per FTE student at institution  $i$  in year  $t$ . Total educational and general expenditure per student is a commonly used measure of the quality of education at an institution. This variable excludes expenditure on athletics, which are classified as part of expenditures on auxiliary enterprises in the Integrated Post-secondary Educational Data System (IPEDS), as well as its predecessor HEGIS, that are the source of this variable.

*TEGE* can be interpreted as a measure of an institution's commitment to non-athletic activity, which enters the head coach's utility function. Commitment to non-athletic activity also affects the payoff to cheating on the cartel agreement. The greater the institution's commitment to non-athletic activity, the smaller the payoff to cheating and the lower the probability of being detected cheating.

*STA* is the capacity of the football stadium at institution  $i$  in year  $t$  in thousands. As Fleisher, et al. (1988) point out, one common problem in cartels is that individual members often face different demand-cost configurations. In the NCAA cartel, institutions that have higher and more inelastic demand for their football program have larger benefits to cheating, and will have a higher probability of being detected breaking the cartel agreement. Stadium size is a reasonably good proxy for demand when the size of the stadium adjusts to meet changes in demand conditions. Many of the institutions in the sample have increased stadium capacity at one or more points in the sample.

$Z$  is a vector of observable institution-specific factors that affect the probability of detection but do not vary over time. This vector includes conference dummy variables, a dummy variable indicating institutions that have been placed on probation for recruiting violations in men's basketball, dummy variables for football

teams ranked in the previous season’s final top 20 or 25 poll, and a dummy variable indicating schools that changed their head football coach.

Equation (18) is estimated using a panel data probit technique on a panel of data drawn from NCAA member institutions that play football in Division IA, the largest classification of football playing schools. The panel probit estimator used is a “random effects” estimator that models the intercept term in equation (18) as a random variable

$$\beta_{1,i} = \overline{\beta_1} + \mu_i \quad (19)$$

where  $E[\mu_i] = 0$  and  $var(\mu_i) = \sigma_\mu^2$ . The intercept term for each institution should be modeled as a random variable because it captures the effect of the institution-specific signal function, equation (3), on cartel behavior. This function captures the notion that incomplete information and high monitoring costs make it difficult for cartel members to detect cheating on the cartel agreement, as well as the fact that schools cannot perfectly control all factors that affect the utility they derive from their respective commitments to athletic and non-athletic activity. An important aspect of signals is that the same signal can suggest good luck or cheating on the cartel agreement.

## Data

Our sample consists of all 104 institutions that played Division IA football in each year from 1978 to 1990. This sample was selected because of the relative stability of conference membership over the period as well as data availability considerations. Most of the major college football conferences (the Atlantic Coast, Southeast, Southwest, Big 8, Big 10 and Pacific 10 conferences) had relatively stable membership over this period. The Atlantic Coast Conference added one member (Georgia Tech), one school moved from the Southwest conference to the Southeast Conference (Arkansas), and the membership of the other conferences was static during this period. The Big East football conference began play in the last year of the sample. The early 1990s brought wide-spread changes to football conferences that affected every major conference except the Pacific 10 conference. The Southwest conference disappeared entirely and its members were absorbed by the Big 8 and Big West conferences. The Southeast Conference added schools and began divisional play, as did the Big 12 (formerly the Big 8) conference.

Because conference membership may have a strong effect on the signal function of institutions - conference members play each other annually and are located in the same regions of the country - we restrict our sample to a period of conference stability in order to control for any impact of changes in conference membership

on the behavior of cartel members. For this reason we ended our sample in 1990.

A second reason for restricting the sample to exclude data from the 1990s is provided by Zimbalist (1999). In 1994, the NCAA eliminated mandatory penalties for recruiting violations. Since this time, institutions have been allowed to “investigate themselves” when accused of committing a recruiting violation. The effects of this change in operating procedure on the model presented here are unclear. Although on the surface it would seem to lead to a reduction in the maximum penalty imposed on members, as defined in equation (5), which affects both the numerator and denominator of equation (17) and thus has an ambiguous impact on the probability of being detected. However, this change could signal some fundamental change in the operation of the cartel which could reduce the set of possible equilibrium outcomes. In any case, the NCAA appears to be operating by a different set of rules, in terms of enforcement of recruiting violations, since the early 1990s.

Data on winning percentage, stadium capacity and coaching experience come from various issues of *NCAA Football*, an annual publication of the National Collegiate Athletic Association. Data on recruiting violations were provided to the authors by the NCAA, based on the Committee on Infractions Summary Cases.

## Results and Discussion

Empirical estimates of equation (18) using a random effects panel data probit estimator are shown on Table 2. Details on the estimator can be found in Greene (2000) or in Butler and Moffitt (1982). This table shows both the parameter estimates and the P-values on a two-tailed test of the significance of these parameter estimates. The hypothesis tests that the reported P-values represent have null hypotheses of the form:  $H_o : \beta_i = 0$  for  $i = 2, 3, 4$ . The parameter estimates for the vector of institution-specific control variables,  $Z$ , are not reported.

Model 1, shown in the first two columns on Table 2, includes the winning percentage variable lagged one year. The results from this empirical specification support the predictions of the model. The winning percentage variable is positive and significant, suggesting that higher winning percentages in the previous year are associated with a higher probability of being detected cheating in the current year, other things held constant. The sign and significance of this variable supports the idea that institutions use the observed winning percentage of football teams to monitor compliance with the cartel agreement.

The other parameters have the correct signs and are statistically significant at conventional levels. The parameter on the years of experience of the head football coach is negative and significant, suggesting

Table 2: Estimation Results

| Variable        | Model 1 |         | Model 2 |         |
|-----------------|---------|---------|---------|---------|
|                 | Coeff.  | P-Value | Coeff.  | P-Value |
| $WPCT_{i,t-1}$  | 1.839   | .002    | —       | —       |
| $CEXP_{i,t}$    | -.065   | .002    | -.077   | .004    |
| $TEGE_{i,t}$    | -.007   | .054    | -.009   | .061    |
| $STA_{i,t}$     | .013    | .099    | .010    | .274    |
| $CV_{i,t-3}$    | —       | —       | .0004   | .717    |
| $\bar{\beta}_i$ | -3.533  | .000    | -2.351  | .000    |
| $\rho$          | .319    |         | .385    |         |
| $N$             | 1243    |         | 925     |         |

that coaches with higher discount rates are less likely to be detected cheating. This is consistent with the predictions of the model. Real educational and general expenditure per FTE is negative and significant (at slightly over the 5% level) suggesting that institutions with greater commitment to non-athletic activities are less likely to be detected cheating. The stadium capacity variable is positive and statistically significant, suggesting that institutions with higher and more inelastic demand for football are more likely to be detected cheating.  $\rho$  is the proportion of total variance contributed by the panel-level (in this case institution-level) variance component. For Model 1, about 30% of the total variance is contributed by variation across schools in the sample.

Reaction lags are an important feature of the model. The longer the time between the adoption of a particular course of action, like cheating on the cartel agreement, and its observation by rival institutions, the smaller the probability of an institution being detected cheating. We perform a simple test of the effect of reaction lags on the probability of detection by adding additional lags of the winning percentage variable to equation (18). A second lag of  $WPCT$  was statistically significant, but a third lag of this variable was not. Adding these additional lags of  $WPCT$  had little effect on the sign and significance of the other variables in the model.<sup>2</sup> The differences in the significance of  $WPCT$  across these three specifications suggests that although a team's winning percentage in the previous two seasons help to explain which schools were on probation in a given year, that team's winning percentage three seasons before being put on probation does

<sup>2</sup>These results are available on request from the authors

not.

Fleisher et al. (1988) estimated a model similar to equation (18). Fleisher et al. found that the coefficient of variation of winning percentage, and not the winning percentage, had significant explanatory power. Model 2 in (2) replaces the lagged winning percentage with  $CV_{i,t-3}$ , the coefficient of variation in program  $i$ 's winning percentage over the past three seasons. The coefficient of variation is clearly not statistically significant in this empirical specification, although the other explanatory variables have similar signs and significance. Furthermore, when both  $WP_{i,t-1}$  and  $CV_{i,t-3}$  are included in the model, the lagged winning percentage variable is positive and statistically significant (P-value 0.021) and the coefficient of variation is not statistically significant.<sup>3</sup>

A plausible explanation for the differences in the results is the lack of dynamics in the Fleisher et. al. model. In their model, a similar set of variables for 85 institutions that played Division 1A football over the period 1953-1983 were used and the variables were averaged over the entire sample period. Averaging over the entire sample period removes any randomness from the signal function, as it implicitly treats the entire time-path of each football team's won-loss record as a part of the information set for each institution. Removing randomness from the signal function effectively removes much of the randomness from the monitoring function of the cartel. In the context of the model developed in this paper, the game underlying the empirical model used by Fleisher, et al. is a one-shot game.

## Assessment of Empirical Results

Limited dependent variable models have relatively few measures of goodness of fit. In order to better understand the performance of the empirical model, we examine within sample forecasts based on the results reported for Model 1 on Table 2. These estimates were used to generate a predicted probability that a given institution's football program was put on probation for each year in the sample. These predicted probabilities were based on the assumption that the institution specific random effect was zero in each year.

Table 3 summarizes the institutions in the tails of the distribution of these predicted probabilities. The left three columns of this table represent the 100 institution-years from the sample with the smallest predicted probability of being on probation. The right five columns represent the 100 institution-years with the highest predicted probability of being on probation. In both cases, institutions which appeared only once in the subsamples were omitted.

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<sup>3</sup>Including the squared Coefficient of Variation had no impact on the results; both terms were not statistically different from zero.

First, consider the subsample composed of the 100 institution-years with the highest predicted probabilities - the right panel on Table 3. The column headed “Probation” contains a Y if that institution was on probation in any of the institution-years in the subsample. So, for example, based on the estimates reported on Table 2, the empirical model predicts that there was a 26% probability that the University of Houston would be on probation in 1990 (the second highest predicted probability in the sample), a 24% probability in 1989, and a 7% probability in 1987. All three of these institution-years fall in the top 100. Houston’s football program was on probation in 1989 and 1990, so our model correctly predicted this punishment. In all, there were 41 probationary institution-years in the sample; 17 of these institution-years fall in the 100 highest probabilities.

The column headed “Violation” contains a Y if an institution was found to be in violation of NCAA football recruiting rules but was not placed on probation. We obtained detailed records of each recruiting violation that the NCAA investigated during the period 1978-1990 from the NCAA. The NCAA refers to these records as the “Committee on Infractions Summary Cases.” These instances represent a unique diagnostic tool for the performance of the empirical model, because we can compare the within sample predictions from the model to a set of “near misses” - cases where an institution was detected violating the cartel agreement but was not formally punished for the infraction.

There were 38 instances where institutions were detected but were not put on probation in the sample. 13 of these involve institutions that appear on the right hand panel of Table 3. For example, the predicted probabilities that Louisiana State would be on probation for the period 1980-1990 all fall in the top 10%, including a 26.4% probability in 1986, the largest predicted value in the sample. Louisiana State was never on probation during the sample period, although the football program was found to be in violation of NCAA football recruiting rules in 1986. There was either not enough evidence to place Louisiana State on probation, or the institution was able to convince the NCAA that the violations were not severe enough to warrant probation. Texas and Georgia each have two Y’s in the Violation column because these institutions were found to be in violation of NCAA recruiting rules on two separate occasions.

From the right panel of Table 3, the empirical model does a relatively good job of predicting the most likely candidates for probation. Of the 24 institutions that appear in the highest 10% of the predicted probabilities for more than one year, only three were not on probation, or found to be in violation of NCAA recruiting rules and not put on probation. These three institutions are the University of Maryland in 1983, 1984 and 1987, and the University of Washington in 1979 and 1981. The predicted probabilities for these years range from 4% to 7% at these institutions.

The institution-years with the 100 smallest predicted probabilities, shown on the left panel of Table 3,

Table 3: Predicted Probability of Violation

| Smallest 100 Team-Seasons |       | largest 100 Team-Seasons |       |           |           |
|---------------------------|-------|--------------------------|-------|-----------|-----------|
| Institution               | Years | Institution              | Years | Probation | Violation |
| Air Force                 | 12    | Texas                    | 12    |           | YY        |
| Navy                      | 11    | Louisiana St.            | 11    |           | Y         |
| Army                      | 10    | Arizona St.              | 9     | Y         |           |
| Northwestern              | 9     | Arizona                  | 7     | Y         |           |
| Stanford                  | 7     | Texas Tech               | 7     |           | Y         |
| Iowa                      | 5     | Missouri                 | 6     |           | Y         |
| Utah St.                  | 5     | Auburn                   | 4     | Y         |           |
| Vanderbilt                | 4     | Oklahoma St.             | 4     |           | Y         |
| Wake Forest               | 4     | Texas A&M                | 4     |           | Y         |
| Colorado St.              | 4     | UCLA                     | 4     |           | Y         |
| New Mexico St.            | 4     | Florida                  | 3     | Y         |           |
| Eastern Mich.             | 3     | Kansas                   | 3     | Y         |           |
| Michigan                  | 3     | Oregon                   | 3     |           | Y         |
| Alabama                   | 2     | N. Carolina St.          | 3     |           | Y         |
| Boston College            | 2     | Houston                  | 3     | Y         |           |
| Duke                      | 2     | Maryland                 | 2     |           |           |
| Michigan State            | 2     | Clemson                  | 2     | Y         |           |
| Notre Dame                | 2     | Oklahoma                 | 2     | Y         |           |
| Rutgers                   | 2     | Southern Meth.           | 2     | Y         |           |
|                           |       | Georgia                  | 2     |           | YY        |
|                           |       | Washington               | 2     |           |           |

is primarily composed of three types of schools: service academies (Air Force, Army and Navy), private universities with elite academic reputations (Northwestern, Stanford, Vanderbilt, Duke, Wake Forest) that play in high profile conferences, and perennially weak programs from low profile conferences (Utah State, Colorado State, New Mexico State, Eastern Michigan, Rutgers, cumulative within-sample winning percentage 0.357). The service academies and the small, elite private universities are very selective and may have difficulty recruiting football players at all. These perennially weak teams may also have trouble attracting any players, although for different reasons.

There are also a handful of team-seasons from perennial powerhouses (Alabama, Notre Dame, Michigan, Michigan State), but these team-seasons make up less than 10% of the 100 smallest team-seasons, and they tend to fall in the larger end of this range. These team-years are also anomalous for these football programs. The two seasons for Alabama, 1981 and 1982, are among the last few seasons Bear Bryant coached Alabama. Alabama went 11-0 and 10-1 the two seasons prior to these seasons and Bryant had over 30 years coaching experience at the time. The predicted probabilities for Alabama in the other seasons in the sample are several orders of magnitude larger than these seasons. The two seasons for Notre Dame, 1989 and 1990, were seasons where the coach had 19 and 20 years of experience and the team went 8-3 and 11-0 in the prior seasons, including a national championship. The predicted probabilities for Notre Dame in the other 9 seasons in the sample range between 0.004 and 0.008, or about .2 to .3 standard deviations from the mean predicted probability of 0.016. Even though Notre Dame falls in the small end of the distribution of predicted probabilities, only these two seasons fall in the extreme tail.

The performance history of the Iowa football program provides an example of outcomes potentially attributable to the randomness of the signal function. Recall a property of the signal function is that the same signal can suggest different behavior. A sudden change in winning percentage may suggest cheating on the cartel agreement, good luck or aggressive recruiting within the constraint of the cartel agreement. The Iowa football team averaged over seven wins per year during the eight years in this subsample (1979, 1981, 1985, 1987-1990). Iowa went 2-9, 5-6 and 4-7 from 1978-1980 but then won a minimum of seven games per season for the next seven seasons and won the Big 10 Championship in 1985. Based on the model developed above, this sudden improvement in Iowa's football program would seem to signal a possible violation of the cartel agreement. However, Iowa was not put on probation, as the empirical model predicts. This suggests that members of cartel interpreted the winning percentage signal as something other than cheating in this case.

## Conclusions

In this paper, we develop and estimate a model of the enforcement of the NCAA football cartel. Our model is dynamic in that reaction lags are explicitly modelled. It also accounts for imperfect information in monitoring compliance with the cartel agreement stemming from the inability of schools to directly observe rivals' behavior. Instead, schools must infer this behavior from observable factors.

Our empirical results confirm the key predictions of the model. Lagged winning percentage, an observable indicator, is a significant predictor of cartel enforcement but the significance of this variable declines over time. Decision maker's discount rates, as proxied by years of head coaching experience and variables related to the demand for football at institutions also significantly affect cartel enforcement.

This paper increases our understanding of cartel behavior. Cartels are formed because the expected rewards to cooperative behavior are greater than the rewards obtainable under non-cooperative regimes. However, cartels are difficult to sustain because the payoffs to undetected deviation from the cartel agreement are even higher. Despite these difficulties, the NCAA football cartel has successfully sustained itself for over 50 years.

In a paper on the dynamics of a stable cartel, Grossman (1996) suggests that two factors are key to creating stability: proficiency in deterring entry and the ability to prevent defection among members. With respect to entry, the NCAA requirements for participating in Division I-A football, which include a minimum stadium size and fielding a minimum number of other athletic programs at the Division I level, are sufficiently onerous to deter entry. In addition, the possibility of a start-up professional minor league football league competing with college football seems remote.

With respect to preventing defection, our results show that, even under imperfect information, effective signals of deviation from the status quo strategy exist, enhancing the ability of members to monitor and maintain the cartel agreement. Furthermore, even in the presence of large payoffs to cheating and relatively modest payoffs to complying, effective deterrents can be employed to maintain cartel agreements.

Certain industry characteristics also contribute to cartel stability. For example, differences in cost structures among cartel members can lead to instability because members with larger cost structures have a greater incentive to cheat. This cartel has removed much of the variation in cost structures by standardizing compensation packages for student-athletes and the size of coaching staffs. The variation in cost structures attributable to differences in athletic staff salaries may not be sufficiently large to encourage cheating by higher cost programs.

A particularly striking characteristic of this cartel is the large number of participants, which suggests

that market power would not be easily obtained or persistent. A key to the cartel's success in monitoring members behavior may lie in the absoluteness of the observable output. Unlike other industries that do not have perfect information about production, on-field performance is accurately and publicly reported in this cartel. The strength contained in that signal appears to outweigh the inherent weakness in a cartel with many members.

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