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Examining the Relationship Between Athletic Program Expenditure and Athletic Program Success Among NCAA Division I Institutions: A Dynamic Panel Data Approach

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Abstract

This study examines the impact of athletic expenditure on athletic performance among National Collegiate Athletic Association Division I institutions. A series of dynamic panel data models are estimated to explore differential impacts of expenditure throughout athletic programs. Results suggest that a dollar spent on women's sport programs may be more effective than a dollar spent on men's sport programs. Analysis is conducted at the aggregate, relative division, relative conference, and individual sport levels. Together, all analysis suggests that alternative distributions of athletic, financial resources could increase an institution's athletic success.

Keywords

athletic expenditure, athletic success, dynamic panel data regression, effective financial distributions

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Annual growth in athletic expenditure, among National Collegiate Athletic Association (NCAA) Division I colleges and universities, exceeds that of all other educational expenditure by as much as 2.3% (Fulks, 2015). With yearly, nominal, athletic expenditure growth rates as high as 20%, now 10% of all NCAA Division I schools spend over US$100 million on athletic programs each year (Berkowitz et al., 2016). During the 2014-2015 academic year, the University of Texas topped the category with athletic expenditures totaling $173 million. In the same year, Ohio State University spent $154 million and the University of Michigan spent $151 million (Berkowitz et al., 2016).

NCAA program officials, coaches, athletic directors, and university presidents justify the large athletic expenditures, insisting that spending leads to athletic success which in turn leads to institutional benefits (Suggs, 2003). The results of many studies support the claim that athletic program success may lead to institutional benefits such as enhanced national profiles (Smith, 2008), generated athletic revenue (Litan, Orszag, & Orszag, 2003; Orszag & Orszag, 2005; Zimbalist, 1999), increased quality of student applicants (Anderson, 2012; Osborne, 2004; Pope & Pope, 2008), increased retention rates (Terry, Macy, Cooley, & Peterson, 2014), and increased alumni donations (Anderson, 2012; Baade & Sundberg, 1996; Humphreys & Mondello, 2007; Stinson & Howard, 2008; Sigelman & Bookheimer, 1983; Turner, Meserve, & Bowen, 2001). However, authors who investigate the primary claim that growth in expenditure leads to increased athletic success have found conflicting results (Jones, 2013; Katz, Pfleegor, Schaeperkoetter, & Bass, 2015; Lawrence & Li, 2007; Lawrence, Li, Regas, & Kander, 2012; Litan et al., 2003; Orszag & Israel, 2009; Orszag & Orszag, 2005; Sparvero & Warner, 2013).

Early studies involve the investigation of the impacts of football and men's basketball team expenditures on measures of team success. Litan, Orszag, and Orszag (2003) study over 100 NCAA Division I institutions, apply institutional and yearly, fixed effects regression analysis to panel data from 1993 to 2001, and find no significant relationships between expenditure and team performance for either of the two sport programs. Similar results are found by Orszag and Orszag (2005) who study these relationships among NCAA Division II colleges and universities. Using more recent data, Orszag and Israel (2009) study only Football Bowl Subdivision (FBS) schools and a subset of NCAA Division I institutions. With a differentiated approach and restricted set of schools, the authors find that football team expenditure positively and significantly impacts football team winning percentages and the probability that teams are named to the Associated Press Top 25 poll. Conversely, their results for men's basketball analysis suggest that there is no statistically, significant relationship between men's basketball expenditure and related measures of team success.

While these authors focus on the most profitable collegiate sports, they fail to investigate relationships between all other program expenditures and respective measurements of team success. Noted above, profitability is only one possible benefit of athletic performance. Success among other sport programs could lead

to alternative benefits such as increased applications or retention rates. As expenditures across many sport programs begin to expand at rapid rates (Sparvero & Warner, 2013), recent studies involve more comprehensive analyses. Authors now examine impacts of total athletic program expenditure on overall athletic program success.

In each study, the National Association of Collegiate Directors of Athletics (NACDA) Directors' Cup competition score is used to measure overall program performance. The NACDA Directors' Cup competition awards points to each institution for its sponsored sports in which the institution's team achieves a certain level of success.[1] The points earned by all of the institution's qualifying teams are then aggregated into one Directors' Cup score for each institution.[2] Steinbach (2006) argues that athletic directors who distribute their financial resources across many men's and women's sport programs will score highest within the Directors' Cup competition.

Lawrence, Li, Regas, and Kander (2012) conduct one of the first studies that uses the NACDA Directors' Cup point system as a measurement of overall athletic program success. The authors examine 400 NCAA Division I, II, III, and National Association of Intercollegiate Athletics (NAIA) schools during the 2006-2007 academic year. Findings suggest that athletic expenditure significantly and positively impacts Directors' Cup scores for only NAIA schools. Sparvero and Warner (2013) explore the same relationship among both Division I and III institutions for 2, nonconsecutive years: 2002-2003 and 2010-2011. Their results show a much stronger impact of expenditure on points among Division I schools. These results are similar to those found by Katz, Pfleegor, Schaeperkoetter, and Bass (2015) who examines the relationship among only Division III schools.

Jones (2013) also adds to the analysis of Lawrence et al. (2012) and employs a panel data method of institutional and yearly, fixed effects regression analysis over 4 consecutive academic years. Controlling for differences in football subdivision with interaction terms, the author finds that athletic program expenditure has a significant and positive impact on Directors' Cup points for FBS schools but not for non-FBS schools. Jones is also the only author to acknowledge the potential endogeneity of expenditure within athletic performance models. The author uses undergraduate enrollment and institutional assets as potential instrumental variables, but results of a Hausman test suggest that a one-equation model accurately represents expenditure as exogenous. However, theoretically, these two factors could be linked to athletic performance. Schools with larger enrollments may enjoy higher probabilities of having good athletes among their student populations. Higher enrollments might also lead to larger assets that could provide student athletes with more support on and off the field. These associations diminish the reliability of the Hausman test.

Beyond failing to account for endogeneity in the regression analysis, authors of previous studies may reduce the reliability, effectiveness, and applicability of their results by employing methodologies that fully aggregate measurements of expenditure and performance. Expenditure across men's and women's aggregate and

individual sport programs may impact their respective measurements of success differently. If the goal of the analysis is to be able to advise athletic directors on more effective allocations of expenditure, further analysis is needed for all sport programs.

While athletic directors may have diverse objectives for their athletic programs, such as generating revenue or increasing applications, this study examines the impact of athletic expenditure on athletic performance. This approach is taken since performance is likely the intermediary needed for athletic programs to achieve any other institutional goal, as suggested by previous studies (Anderson, 2012; Baade & Sundberg, 1996; Humphreys & Mondello, 2007; Litan et al., 2003; Orszag & Orszag, 2005; Osborne, 2004; Pope & Pope, 2008; Sigelman & Bookheimer, 1983; Stinson & Howard, 2008; Terry et al., 2014; Turner et al., 2001; Zimbalist, 1999). In this study, athletic performance is measured by the points earned by an institution in the annual NACDA Director's Cup competition. Regression analysis is conducted at the aggregate, relative division, relative conference, and individual sport levels to measure differential impacts of expenditure throughout athletic programs. Dynamic panel data estimation techniques are used throughout the study to account for any potential endogeneity in the regression models and provide robust and reliable results.

Together, results of the dynamic panel data regression analyses indicate that although expenditure significantly and positively impacts Directors' Cup points, levels of expenditure have varying impacts on these points across aggregate and individual sport programs. Relative division, relative conference, and sport-level analyses also suggest that there may be more effective distributions of athletic funds which could increase an institution's success within the NACDA Directors' Cup competition.

Data Description and Preliminary Analysis

Data used to explore differential impacts of athletic expenditure on athletic success were collected for 310 NCAA Division I schools, for 8 consecutive academic years, from 2006-2007 to 2013-2014.[3] The measurement of overall athletic program success was extracted from the NACDA Directors' Cup previous standings archive (NACDA, 2016). As stated, the NACDA Directors' Cup competition awards points to institutions based on each of their sponsored sport teams' seasonal performances. In each sport category, teams earn between 0 and 100 points. Teams that win their respective NCAA tournament championship earn their school 100 points toward the overall Directors' Cup score. Teams that fail to reach a certain performance threshold may earn their schools 0 points for those sport categories. All points are aggregated into one overall score.[4]

Stanford University has consistently finished the competition with the highest point totals, earning 1,482 in the 2013-2014 academic year, 1,261.25 in the 2012-

2013 academic year, and 1,448.25 in the 2011-2012 academic year. Although these scores suggest high team achievements in many sports, the Directors' Cup score may not accurately reflect the true athletic performance of every team. Schools are only able to score points in 10 men's and 10 women's sport categories each year. In the 2013-2014 academic year, although Stanford sponsored women's golf, women's lacrosse, men's tennis, and men's track and field, these teams were not able to contribute any points toward their school's overall Directors' Cup score. This is because at least 10 additional women's and 10 additional men's teams had earned the school higher points in other categories. In this study, the Directors' Cup score is adjusted to allow the performance of all sponsored teams to factor into the institution's measurement of total Directors' Cup points, regardless of the number of contributing teams.[5] This measurement is used as the primary dependent variable in the analysis and is denoted, DirectorsCupTotal.

It should also be noted that while all teams that finish first in the overall division earn 100 points in their sport category, teams that finish in the same lower positions across different sport categories may not earn the same number of points. For example, a men's basketball team which finishes fifth overall earns 73 points, while a women's ice hockey team that finishes fifth only earns 25 points. These differences are due to the number of total competitors in each sport category. Theoretically, it might be easier to finish fifth when competing against 50 teams rather than competing against 300 teams. This assumption is embedded in the scoring system. These differences in scoring provide additional motivation for examining the impacts of expenditure at both the individual sport and aggregate program levels.

Table 1 presents the average, adjusted Directors' Cup points for all schools within the data set. The metric is calculated for the full, men's, and women's aggregate programs. It is then broken down by each individual sport. Seventeen men's and 17 women's sports are included in the adjusted Directors' Cup score.[6] On average, schools earn a total of about 228 points each year. The points are evenly distributed among men's and women's sport categories. At the individual sport level, the averages provide information pertaining to the popularity of the sport. When a school does not participate in a sport, the school earns 0 points in that category. When many schools do not participate in the same sport, the sample average is driven down. Men's volleyball and women's ice hockey are the two least popular sports sponsored by NCAA Division I institutions.

Total athletic program expenditure was extracted from the Equity in Athletic Data Analysis Cutting Tool (EADA) that is published each year by the U.S. Department of Education (2016). The tool provides detailed information on total team expenditures for all athletic teams sponsored by each of the 310 schools. The aggregate athletic expenditure is then calculated by adding all expenditures for each team. However, many sports in the EADA data set are not counted in the Directors' Cup competition. These sports include archery, badminton, beach volleyball, diving, equestrian, rodeo, sailing, squash, synchronized swimming, table tennis, team handball, and weight lifting. Therefore, the aggregate expenditure must also be adjusted

Table 1. Average Aggregate and Sport-Level Directors' Cup Scores.

Average Aggregate Directors' Cup Scores								
DirectorsCupTotal			DirectorsCupMens			DirectorsCupWomens		
227.910			113.674			114.236		
Men's Sports: Average Directors' Cup Scores								
Baseball	Basketball	Cross country	Golf	Gymnastics	IA football	IAA football	Ice hockey	Lacrosse
9.792	11.280	9.404	10.184	2.808	16.981	5.449	2.213	2.380
Soccer	Swimming	Tennis	T&F spring	T&F winter	Volleyball	Water polo	Wrestling	
12.532	9.138	9.912	10.123	11.305	0.794	1.283	10.333	
Women's Sports: Average Directors' Cup Scores								
Basketball	Bowling	Cross country	Golf	Gymnastics	Field hockey	Ice hockey	Lacrosse	Rowing
11.146	1.400	9.348	10.046	8.508	4.023	1.196	2.958	3.212
Soccer	Softball	Swimming	Tennis	T&F spring	T&F winter	Volleyball	Water polo	
15.143	10.055	9.938	9.922	10.088	11.335	15.474	1.623	

to include only team expenditures of sports included in the Directors' Cup competition.[7] The aggregate, athletic program expenditure is denoted, ExpenditureTotal, and is adjusted for inflation in all years.

The two main data sources, combined with College Results Online (The Education Trust, 2016), also provide information on a number of control factors for each institution. These include the number of sponsored sport teams that are able to contribute to the overall Directors' Cup score, the number of student athletes participating in these sports, total undergraduate enrollment, in-state tuition and fees, and the school's acceptance rate. The number of teams, number of athletes, and total enrollment are also collected as men's and women's aggregate statistics, and the number of athletes is collected for each individual sport program as well. Tuition is also adjusted for inflation.

Table 2 presents detailed descriptions and summary statistics for each aggregate factor. A large range of values is observed for the Directors' Cup total points and the total expenditures. The largest point total is 1,781.5. This is the statistic for Stanford University in the 2013-2014 competition but is now higher than the previously stated 1,482 due to the adjustment that allows all teams to contribute to the total score. In regard to expenditure, on average, schools spend about $20 million on total athletic expenditure, with nearly 70% of overall expenditure distributed to men's programs.

Table 3 presents average aggregate and individual sport program expenditures. This table also presents the percentage change in expenditure, at each level, between the first and second half of the studied time period. These statistics suggest that real, total athletic program expenditure has increased by 16.85% over the studied period. Men's aggregate program expenditure has increased by 17.46% and women's has increased by 15.72%, which is a smaller percentage of a smaller level. The men's sport program with the highest average expenditure is football within the IA division. IA football team expenditure is nearly 5 times that of the next two highest team expenditures: men's basketball and IAA football. On the women's side, basketball is the sport program with the highest expenditure followed closely by ice hockey.

Here, it is evident that the trend of schools spending more on men's programs than women's programs does not translate to the individual sport level for all sport programs with both men's and women's teams (i.e., basketball, baseball/softball, cross country, golf, gymnastics, ice hockey, lacrosse, soccer, swimming, tennis, track and field spring, track and field winter, volleyball, and water polo). In fact, 10 of the 14 programs with women's and men's teams have higher expenditures for the women's teams. This effect is masked in the aggregate by large expenditures on football, men's basketball, men's ice hockey, and men's lacrosse. Moreover, 9 of these 10 sport programs have experienced larger percentage increases in the men's expenditures, suggesting that these expenditures may eventually catch up and surpass the expenditures of the women's programs in these categories.

Finally, the primary conference affiliation was collected for each of the schools in each year.[8] The teams in the data set represent all 34 of the NCAA Division I athletic conferences.[9] Table 4 presents the average, aggregate program expenditures and

Table 2. Summary Statistics: Aggregate Variables.

Variable	Description	Mean (Standard Deviation)	Maximum	Minimum
DirectorsCupTotal	Sum of all points scored by each eligible team included in the Directors' Cup competition for each college or university in each academic year. Note that all qualifying teams' scores are added into the total and may include more than 10 men's and 10 women's teams.	227.910 (286.971)	1,781.5	0
DirectorsCupMens	Sum of all points scored by each eligible men's team included in the Directors' Cup competition for each college or university in each academic year. Note that all qualifying teams' scores are added into the total and may include more than 10 men's teams.	113.674 (138.099)	856	0
DirectorsCupWomens	Sum of all points scored by each eligible women's team included in the Directors' Cup competition for each college or university in each academic year. Note that all qualifying teams' scores are added into the total and may include more than 10 women's teams.	114.236 (159.776)	997.5	0
ExpenditureTotal	Total seasonal expenditure calculated as the sum of all team expenditures for sports included in the DirectorsCupTotal score. Calculated in real 2015 dollars.	19,952,646 (16,008,280)	94,015,192	2,330,735
ExpenditureMens	Total seasonal expenditures calculated as the sum of all men's team expenditures for all men's sports included in the DirectorsCupMens score. Calculated in real 2015 dollars.	13,711,149 (12,396,619)	69,939,352	919,005
ExpenditureWomens	Total seasonal expenditure calculated as the sum of all women's team expenditures for all women's sports included in the DirectorsCupWomens score. Calculated in real 2015 dollars.	6,241,498 (3,891,500)	32,840,409	401,532
TeamsTotal	Total number of sport teams sponsored by the school and which are also included in the DirectorsCupTotal score.	13.777 (3.514)	25	5
TeamsMens	Total number of men's sport teams sponsored by the school and which are also included in the DirectorsCupMens score.	6.220 (1.888)	12	3

(continued)

Table 2. (continued)

Variable	Description	Mean (Standard Deviation)	Maximum	Minimum
TeamsWomens	Total number of women's sport teams sponsored by the school and which are also included in the DirectorsCupWomens score.	7.557 (1.861)	13	2
AthletesTotal	Total number of athletes participating in the sports included in the DirectorsCupTotals score.	351.709 (126.477)	795	91
AthletesMen	Total number of male athletes participating in the men's sports included in the DirectorsCupMens score.	198.531 (70.936)	455	40
AthletesWomen	Total number of female athletes participating in the women's sports included in the DirectorsCupWomens score.	153.179 (66.668)	387	21
EnrollmentTotal	Total undergraduate enrollment. Measured in hundreds of students.	124.686 (83.600)	503.940	13.410
EnrollmentMen	Total male undergraduate enrollment. Measured in hundreds of male students	59.264 (42.204)	249.500	5.800
EnrollmentWomen	Total female undergraduate enrollment. Measured in hundreds of female students.	65.620 (42.430)	255.050	1.110
Tuition	Total in-state tuition and fees, in hundreds of real 2015 dollars.	164.430 (133.340)	491.380	29.623
Admission	Percentage of applicants admitted.	0.627 (0.208)	1.000	0.057

Number of observations: 2,185

Table 3. Average Aggregate and Sport-Level Expenditures, Over Time.

Average Total Athletic Programs Expenditure			
Years	Total Expenditure	Total Men's Program Expenditure	Total Women's Program Expenditure
2006-2013	19,952,646	13,711,149	6,241,498
2006-2009	18,359,871	12,582,376	5,777,495
2010-2013	21,478,342	14,792,383	6,685,959
Percentage change	+16.85	+17.46	+15.72

Men's Sports: Programs Expenditure									
Years	Baseball	Basketball	Cross Country	Golf	Gymnastics	IA Football	IAA Football	Ice Hockey	Lacrosse
2006-2013	1,184,073	3,255,492	118,405	358,186	665,123	15,104,624	3,246,878	2,129,039	944,448
2006-2009	1,084,149	2,980,750	116,550	327,625	635,878	13,746,789	3,009,105	1,896,885	821,510
2010-2013	1,281,234	3,518,662	119,982	387,666	695,538	16,419,399	3,474,743	2,351,755	1,053,299
Percentage change	+18.18	+18.05	+2.94	+18.33	+9.38	+19.71	+15.47	+23.98	+28.21
Years	Soccer	Swimming	Tennis	T&F Spring	T&F Winter	Volleyball	Water Polo	Wrestling	
2006-2013	722,243	597,853	372,717	239,199	163,441	520,042	354,668	751,452	
2006-2009	670,366	552,741	345,931	262,654	151,584	481,740	328,881	701,001	
2010-2013	754,703	642,964	398,807	220,007	172,271	556,851	377,741	799,084	
Percentage change	+12.58	+16.32	+15.29	−16.23	+13.65	+15.59	+14.86	+13.99	

Women's Sports: Program Expenditure									
Years	Basketball	Bowling	Cross Country	Golf	Gymnastics	Field Hockey	Ice Hockey	Lacrosse	Rowing
2006-2013	1,830,310	205,397	154,556	376,287	947,111	709,173	1,310,303	732,887	912,248
2006-2009	1,713,447	178,873	142,100	348,223	868,642	664,498	1,138,750	667,709	831,610
2010-2013	1,942,229	229,100	165,572	402,207	1,022,932	752,553	1,476,137	788,526	991,093
Percentage change	+13.12	+28.08	+16.52	+15.50	+17.76	+13.25	+29.63	+18.09	+19.18
Years	Soccer	Softball	Swimming	Tennis	T&F Spring	T&F Winter	Volleyball	Water Polo	
2006-2013	839,941	789,546	699,075	433,413	254,664	202,038	835,582	434,926	
2006-2009	777,885	732,345	652,568	401,917	281,727	212,033	778,253	404,824	
2010-2013	898,599	843,624	743,889	463,968	233,644	193,709	890,396	463,180	
Percentage change	+15.51	+15.19	+13.99	+15.44	−17.07	−8.64	+14.41	+14.42	

Table 4. Average Aggregate Directors' Cup scores and Average Expenditure by Conference.

Variable	Athletic Conference					
	American Athletic	*American East*	*Atlantic 10*	*Atlantic Coast*	*Atlantic Sun*	*Big East*
DirectorsCupTotal	220.656	104.279	87.296	602.289	66.963	274.926
ExpenditureTotal	33,018,261	12,053,384	14,756,761	41,820,129	8,221,088	31,401,225
	Big Sky	*Big South*	*Big Ten*	*Big Twelve*	*Big West*	*Colonial Athletic*
DirectorsCupTotal	73.602	68.207	686.804	558.575	133.357	99.257
ExpenditureTotal	9,091,611	9,861,379	50,070,885	40,672,812	9,873,244	14,934,503
	Conference USA	*Great West*	*Horizon League*	*Independents*	*Ivy League*	*Metro Atlantic*
DirectorsCupTotal	156.148	40.438	53.697	58.900	206.423	75.813
ExpenditureTotal	21,698,872	7,341,327	7,319,199	8,586,727	11,305,581	8,917,014
	Mid-American	*Mid-Eastern*	*Missouri Valley*	*Mountain West*	*Northeast*	*Ohio Valley*
DirectorsCupTotal	101.000	57.026	113.019	239.545	51.922	49.577
ExpenditureTotal	15,794,074	6,735,506	10,384,069	23,740,424	9,975,185	7,732,598
	Pac-12	*Patriot League*	*Southeastern*	*Southern*	*Southland*	Southwestern
DirectorsCupTotal	798.624	85.513	685.779	78.069	62.715	34.594
ExpenditureTotal	43,207,820	13,852,837	48,874,250	10,659,009	7,794,534	5,164,363
	Sun Belt	*Summit League*	*West Coast*	*Western Athletic*		
DirectorsCupTotal	101.492	84.924	149.246	119.574		
ExpenditureTotal	12,995,764	7,795,962	13,626,278	15,276,750		

average, total Directors' Cup scores for schools in each conference. The Pac-12 leads the nation in Directors' Cup points throughout the time of the study.[10] Schools affiliated with the Pac-12 conference include Stanford University, the University of California, Los Angeles (UCLA), and the University of Southern California. These three schools have won the most NCAA Division I championships of all schools within the division.

These statistics show that the five conferences with the highest average expenditures are also the five conferences with the highest average Directors' Cup points. Schools within these conferences earn an average of 666.36 points, while the schools in the five conferences with the lowest expenditures earn only 47.2 points, on average. With expenditures less than 16% of those schools in the five highest expenditure conferences, these schools earn less than 8% of the respective Directors' Cup points.

Empirical Specifications

Preliminary analysis of the data motives the use of a series of dynamic panel data regression models to fully investigate the impact of expenditure on Directors' Cup points throughout athletic programs. The base model, Model 1, is presented in Equation 1 with a specification which allows for the estimation of the impact of total expenditure on total Directors' Cup points.

Model 1: Full Athletic Program Specification

$$P_{it} = \beta_0 + \beta_1 P_{i,t-1} + \beta_2 \ln E_{it} + \sum_{k=1}^{K} \beta_k x_{kit} + \sum_{t=2}^{T} \tau_t D_t + \varepsilon_{it}. \qquad (1)$$

Here, DirectorsCupTotal for school i in year t is represented by P_{it}. Directors' Cup total points are assumed to be persistent over time and influenced by the school's past year's score, $P_{i,t-1}$, since past performance may attract better athletes in following years. Theoretically, expenditure may be unbounded, while the maximum number of points is fixed at 3,400 (teams at a particular school would need to finish first in all 34 sport categories to earn 3,400 Directors' Cup points in 1 year). Therefore, ExpenditureTotal of school i in year t is represented by E_{it} and is log transformed. And, x_{kit} represents the value of the kth control variable for school i in year t. The control variables are TeamsTotal, AthletesTotal, EnrollmentTotal, Tuition, and Admission. Time dummy variables, D_t, are also included to capture time, fixed effects that impact all schools similarly over time, such as changes in NCAA rules and regulations.[11] Finally, ε_{it} represents the error term.

Due to the differences across expenditures and potential Directors' Cup scoring at the aggregate and individuals sport levels, Model 1 is adapted to allow for analysis of men's and women's aggregate and individual sport programs with all corresponding

explanatory variables in each specification. Equations 2, 3, 4, and 5 present specifications of Model 1 for analysis of men's aggregate, women's aggregate, men's individual sport, and women's individual sport programs, respectively.

Model 1: Men's Aggregate Program Specification

$$P_{(i_m t)} = \beta_0 + \beta_1 P_{i_m,t-1} + \beta_2 \ln E_{i_m t} + \sum_{k=1}^{K} \beta_k x_{ki_m t} + \sum_{t=2}^{T} \tau_t D_t + \varepsilon_{i_m t}. \quad (2)$$

Here, $P_{i_m t}$ represents DirectorsCupMens, $\ln E_{i_m t}$ represents the log of *Expenditure-Mens*, and $x_{ki_m t}$ represents the men's specific statistic for the kth control variable: TeamsMens, AthletesMen, EnrollmentMen, Tuition, and Admission.

Model 1: Women's Program Specification

$$P_{(i_w t)} = \beta_0 + \beta_1 P_{i_w,t-1} + \beta_2 \ln E_{i_w t} + \sum_{k=1}^{K} \beta_k x_{ki_w t} + \sum_{t=2}^{T} \tau_t D_t + \varepsilon_{i_w t}. \quad (3)$$

Similarly, $P_{i_w t}$ represents DirectorsCupWomens and $\ln E_{i_w t}$ represents the log of the ExpenditureWomens, while control variables include TeamsWomens, Athletes-Women, EnrollmentWomen, Tuition, and Admission.

Model 1: Men's Specific Sport Specification

$$P_{(is_m t)} = \beta_0 + \beta_1 P_{is_m,t-1} + \beta_2 \ln E_{is_m t} + \sum_{k=1}^{K} \beta_k x_{kis_m t} + \sum_{t=2}^{T} \tau_t D_t + \varepsilon_{is_m t}. \quad (4)$$

For individual sport program analysis, $P_{is_m t}$ represents Directors' Cup points for school i's, men's sport s's team, in year t, and $\ln E_{is_m t}$ represents the log of expenditure spent by school i on men's sport s in year t. Control variables include Teams-Mens, the number of male athletes participating in sport s, EnrollmentMen, Tuition, and Admission. This specification is run for all 17 men's sports separately.

Model 1: Women's Specific Sport Specification

$$P_{(is_w t)} = \beta_0 + \beta_1 P_{is_w,t-1} + \beta_2 \ln E_{is_w t} + \sum_{k=1}^{K} \beta_k x_{kis_w t} + \sum_{t=2}^{T} \tau_t D_t + \varepsilon_{is_w t}. \quad (5)$$

Finally, $P_{is_w t}$ represents the Directors' Cup points for school i's, women's sport s's team, and $\ln E_{is_w t}$ represents the log of the expenditure spent by school i on women's sport s. Control variables include TeamsWomens, number of female athletes participating in sport s, EnrollmentWomen, Tuition, and Admission. This specification is run for each of the 17 women's sports separately.

While Model 1 allows for the investigation of the relationship between expenditure and Directors' Cup points, it does not take into consideration the expenditure of all other schools in the division. Theoretically, if all schools increase expenditure by the same percentage, there should be no change in the outcome

of the Directors' Cup competition. Therefore, to better capture the impact of the expenditure of one school, the model must fully control for the expenditure of all other schools. Model 2 allows for the investigation of the relationship between relative expenditure and relative Directors' Cup points, at the entire division level. The specification of Model 2, which allows for the analysis of the impact of relative division, total expenditure on relative division, and overall Directors' Cup points, is presented in Equation 6.

Model 2: Full Athletic Program Specification

$$\mathrm{d}P_{it} = \beta_0 + \beta_1 \mathrm{d}P_{i,t-1} + \beta_2 \mathrm{d}\,E_{it} + \sum\nolimits_{k=1}^{K} \beta_k \mathrm{d}x_{kit} + \sum\nolimits_{t=2}^{T} \tau_t D_t + \varepsilon_{it}. \qquad (6)$$

Here, $\mathrm{d}P_{it}$ is calculated by dividing school i's, DirectorsCupTotal in year t, by the average of the DirectorsCupTotal earned by all schools within the data set in the same year. Expenditure is no longer log transformed and $\mathrm{d}E_{it}$ is calculated by dividing school i's, ExpenditureTotal in year t, by the average of the ExpenditureTotal of all schools within the data set in year t. Variables represented by $\mathrm{d}x_{kit}$ are the same as those represented by x_{kit} in Model 1 but are calculated in relative division terms. Model 2 is also adapted to allow for the analysis of all men's and women's aggregate and individual sport programs. The preface *Div* is attached to all variables in the regression tables to indicate that variables are calculated as relative division factors. Implications of the results of Model 2 should be similar to those of the results of Model 1 and provide a robustness checks on the base model.

Although Model 2 captures the impact of relative division expenditure on relative division Directors' Cup points, it does not fully examine this relationship at the conference level. Conference-level analysis is necessary for a more comprehensive understanding of the relationship between expenditure and Directors' Cup points. First, schools must do well in their own conference to move on to the post season where most points are earned in the competition. Second, some athletic directors at small schools, or schools which are new to the division, may be most concerned with success within their own conference.

Model 3 controls for conference affiliation and provides a means for the analysis of the impact of relative conference expenditure on relative conference Directors' Cup points. The specification of Model 3, which allows for the analysis of the impact of relative conference, total expenditure on relative conference, and overall Directors' Cup points, is presented in Equation 7.

Model 3: Full Athletic Program Specification

$$cP_{it} = \beta_0 + \beta_1 cP_{i,t-1} + \beta_2 cE_{it} + \sum\nolimits_{k=1}^{K} \beta_k cx_{kit} + \sum\nolimits_{t=2}^{T} \tau_t D_t + \varepsilon_{it}. \qquad (7)$$

Here, cP_{it} is calculated by dividing school i's, DirectorsCupTotal in year t, by the average of the DirectorsCupTotal earned by all schools within school i's conference

in the same year. Relative conference expenditure, cE_{it}, is also calculated by dividing school i's, ExpenditureTotal in year t, by the average of the ExpenditureTotal of all schools within school i's conference in year t. Variables represented by cx_{kit} are the same as those represented by x_{kit} in Model 1 but are calculated in relative conference terms. Model 3 is also adapted to allow for the analysis of all men's and women's aggregate and individual sport programs. The preface *Conf* is attached to all variables in the regression tables to indicate that variables are calculated as relative conference factors.

Estimation Procedure: Dynamic Panel Data Regression

Estimating Models 1, 2, and 3, under any specification, with traditional institutional, fixed effects, panel regression techniques will cause biased results (Roodman, 2006). The institutional, fixed effects may be correlated with other explanatory variables, and the lagged dependent variable exhibits correlation with the error term. Additionally, each of the explanatory variables, except for the time dummies, may exhibit reverse causality relationships with the Directors' Cup points, as noted by Jones (2013). Moreover, other explanatory variables may be correlated. For example, schools with more teams will have more athletes and will likely have higher total expenditure due to both the fixed and variable costs associated with additional programs.

To fully control for all endogeneity, the Blundell–Bond, two-step, system GMM estimation procedure is used to estimate all regression models (Blundell & Bond, 1998). This methodology first transforms each model from a level into a first differenced equation. In doing so, any endogeneity related to the institutional, fixed effects is removed as these do not vary over time. And, instruments used to control for each of the endogenous, explanatory variables are internal to the model. The process uses the lagged levels and lagged first differences of all endogenous variables to create Generalized Method of Moments (GMM) style instruments. Time dummies are used as Instrumental Variable (IV) instruments. Given the small number of years and the large number of institutions, this study is an ideal candidate for the application of the Blundell–Bond approach (Baum, 2013).

With 8 consecutive years of data available in the analysis, the estimation can make use of one to seven lags. Three criteria are used to choose the optimal number of lagged dependent variables to use in the model along with the optimal number of lagged differences and lagged levels of endogenous variables to use as instrumental variables. These three criteria require that enough statistical evidence is available to suggest that (1) the differenced residuals exhibit an AR(1) process, (2) the differenced residuals do not exhibit an AR(2) process, and (3) the instruments, as a group, are exogenous (Roodman, 2006). Each test is automatically performed after the model is estimated.

Every specification, of all three models, uses only a one-period lag of the dependent variable as an explanatory variable. This is done since the models with one-period lag structures pass all three criteria for all aggregate and most sport-level model specifications. However, results are robust to other lag structures of the model which include additional lags of the dependent variables. Only the results of the one-period lag specification are presented in the results section of the article to condense the analysis. Alternatively, each specification uses the maximum number of lags for the instruments which allows the model to pass all three criteria. The number of lags used to create instruments under each specification of Models 1, 2, and 3 ranges from one to seven. The flexibility of instrumental variable construction ensures that each specification of the models is able to capture as much economic information as possible and adds to the reliability and robustness of the results.

One additional robustness check was also performed. Since some observations take 0 values for dependent variables, it is possible that the models may not accurately account for possible truncation or censoring of the data. To ensure that results are reliable and robust, dynamic tobit models were run under each specification with instruments created from first period lagged values of the endogenous regressors. Significant results are qualitatively and quantitatively similar under this estimation procedure. Only results of the models estimated using the Bundell–Bond technique are reported because it is believed that these models capture more economic information than the less flexible tobit models.

Results

Results of the estimation of Model 1, for analysis of the full athletic programs, are presented in the first column of Table 5. Lagged Directors' Cup points are significant and positive indicating that athletic performance in the competition is persistent. This is consistent with the competition dominance of schools like Stanford and UCLA. The positive and significant coefficient on the total expenditure indicates that a 1% increase in total expenditure leads to a small 0.92 point increase in the total Directors' Cup points. Since average total expenditure is nearly $20 million, and schools now increase budgets at the million dollar margin, on average, a $1 million increase in total expenditure would likely lead to about 4.6 additional points in the competition. Given that schools earn an average of 228 points, this million dollar increase in overall expenditure would likely result in a 2% increase in average, total points for the institution, holding all else constant.

Although these results suggest that expenditure and Directors' Cup points are significantly related, these do not yet give any indication of how to effectively allocate limited, athletic funds. To being to explore this further, Model 1 is run separately for the men's and women's aggregate programs. The results of these estimations are presented in columns 2 and 3 of Table 5, respectively. For each, estimated impacts of expenditure are significant and positive. These results suggest

Table 5. Model 1: Estimation Results, by Aggregate Category.

Variable	Full Athletic Program	Men's Athletic Program	Women's Athletic Program
Dependent variable: Director's Cup points; total, men's, and women's			
L.DirectorsCupTotal	0.568*** (0.045)		
L.DirectorsCupMens		0.250*** (0.078)	
L.DirectorsCupWomens			0.632*** (0.045)
ExpenditureTotal	92.828*** (23.800)		
ExpenditureMens		48.195*** (16.429)	
ExpenditureWomens			76.433*** (15.073)
TeamsTotal	6.944 (4.345)		
TeamsMens		2.827 (4.138)	
TeamsWomens			2.898 (4.925)
AthletesTotal	−0.075 (0.116)		
AthletesMens		−0.122 (0.146)	
AthletesWomens			−0.031 (0.109)
EnrollmentTotal	0.317 (0.198)		
EnrollmentMen		0.848*** (0.329)	
EnrollmentWomen			−0.012 (0.166)
Tuition	0.027 (0.081)	0.097* (0.055)	−0.099*** (0.041)
Admission	35.820 (27.489)	8.524 (18.796)	−10.693 (16.594)
Constant	−1,590.695*** (371.8793)	−765.005*** (237.748)	−1,141.976*** (214.698)
Time fixed effects	Y	Y	Y
Wald χ^2	675.24	194.50	770.32
Number of observations	1,727	1,727	1,727

*, **, and *** denote statistical significance at the .10, .05, and .01 levels, respectively.

that a 1% increase in men's aggregate program expenditure would lead to 0.48 additional points, while a 1% increase in women's aggregate program expenditure leads to 0.78 additional points. However, average expenditure on men's aggregate programs is currently more than double that of women's programs. Therefore, on average, a $1 million increase in women's aggregate program expenditure would lead to an increase of 12.2 Directors' Cup points (a 10.7% increase in average, women's program points), while the same increase in men's aggregate program expenditure would only lead to 3.5 additional points (a 3.1% increase in average, men's program points). This indicates that a dollar spent on women's programs may be more effective than a dollar spent on men's programs.

Recall, however, that the finishing place of teams across different sport programs may not result in the same number of Directors' Cup points. Therefore, though aggregate-level analysis consistently indicates that expenditure impacts Directors' cup points, it still remains unclear which sport-level expenditure may have the most effective impact. Therefore, the analysis is broken down once more to the individual sport level. Model 1 is run separately for each of the 34 individual sport programs. Results of the estimations are presented in Table 6.

Notice that only expenditure coefficients and standards errors are presented to condense the analysis. However, the entire dynamic panel data models, with the associated independent variables, are estimated for each sport category.[12] Here, significance levels and magnitudes of estimated impacts of expenditure vary greatly across individual sport programs. These results suggest that expenditure has significant impacts on team Directors' Cup points for over 50% of the sponsored sports. Expenditure spent on baseball, men's and women's basketball, men's and women's golf, women's gymnastics, women's field hockey, IA football, IAA football, men's ice hockey, men's and women's lacrosse, women's soccer, men's and women's swimming, men's and women's tennis, and women's volleyball significantly and positively impacts team Directors' Cup points. These results also indicate that a 1% increase in men's ice hockey, men's IA football, men's lacrosse, women's volleyball, and women's gymnastics team expenditures would likely create the largest increases in team Directors' Cup points. However, these sport programs are also among those with the highest average expenditures.

Therefore, Table 7 is constructed to show the average impact of an additional $100,000 increase in program expenditure on team Directors Cup points for specific sport programs with significant, estimated expenditure impacts. The first rows in the table (under men's and women's analyses) presents the impact on team Directors' Cup points in levels, while the second rows present the percentage changes in team Directors' Cup points that would likely result given the average number of points for each sport category. At the point level, results suggest that the most productive men's and women's sport program to spend an extra $100,000 on might be golf resulting in 1.9 additional points for the men's team and 2.7 additional points for the women's team. The second best options might be men's lacrosse and women's volleyball, resulting in 1.72 and 1.77 additional points, respectively. However, based on the differences in average points at the individual sport level, an extra $100,000

Table 6. Model 1: Estimation Results, by Sport.

Men's Sports: Expenditure Coefficients and Standard Errors								
Dependent Variable: Men's Sport Level, Directors' Cup Points								
Baseball	Basketball	Cross country	Golf	Gymnastics	IA football	IAA football	Ice hockey	Lacrosse
14.176*** (3.855)	11.940*** (2.605)	3.154 (2.010)	6.829*** (2.502)	204.067 (577.073)	16.526*** (3.968)	13.129* (6.753)	26.520** (12.875)	16.071** (7.721)
Soccer	Swimming	Tennis	T&F spring	T&F winter	Volleyball	Water polo	Wrestling	
9.547 (5.922)	9.711*** (2.082)	5.472** (2.357)	2.211 (1.658)	−0.212 (2.595)	96.510 (107.443)	−58.560 (78.965)	6.528 (7.461)	
Women's Sports: Expenditure Coefficients and Standard Errors								
Dependent Variable: Women's Sport Level, Directors' Cup Points								
Basketball	Bowling	Cross country	Golf	Gymnastics	Field hockey	Ice hockey	Lacrosse	Rowing
11.284*** (3.360)	17.602 (15.868)	0.911 (1.149)	10.029*** (3.064)	14.320*** (4.291)	11.593*** (3.291)	15.625 (14.668)	7.766** (3.444)	2.635 (2.821)
Soccer	Softball	Swimming	Tennis	T&F spring	T&F winter	Volleyball	Water polo	
9.954* (5.599)	6.502 (5.307)	6.897*** (2.298)	4.845** (2.193)	5.798 (4.124)	0.204 (2.076)	14.794*** (4.165)	8.519 (7.143)	

*, **, and *** denote statistical significance at the .10, .05, and .01 levels, respectively.

Table 7. Average Impact of Additional $100,000 on Directors' Cup points for Each Sport Program.

Men's Sports: Average Impact of $100,000 Increase in Program Expenditure; Level and Percentage Change									
Change	Baseball	Basketball	Cross Country	Golf	Gymnastics	IA Football	IAA Football	Ice Hockey	Lacrosse
Point change	+1.20	+0.37	—	+1.90	—	+0.12	+0.40	+1.25	+1.72
Percentage change	+12.25	+3.28		+18.66		+0.70	+7.3	+56.48	+72.27
	Soccer	Swimming	Tennis	T&F Spring	T&F Winter	Volleyball	Water Polo	Wrestling	
Point change	—	+1.62	+1.47	—	—	—	—	—	
Percentage change		+17.73	+14.83						
Women's Sports: Average Impact of $100,000 Increase in Program Expenditure; Level and Percentage Change									
Change	Basketball	Bowling	Cross Country	Golf	Gymnastics	Field Hockey	Ice Hockey	Lacrosse	Rowing
Points change	+0.62	—	—	+2.67	+1.51	+1.63	—	+1.06	—
Percentage change	+5.56			+26.56	+17.75	+40.52		+35.84	
	Soccer	Softball	Swimming	Tennis	T&F Spring	T&F Winter	Volleyball	Water Polo	
Point change	+1.19	—	+0.99	+1.12	—	—	+1.77	—	
Percentage change	+7.86		+9.96	+11.29			+11.44		

Table 8. Model 2: Estimation Results, by Aggregate Category.

	Full Athletic Program	Men's Athletic Program	Women's Athletic Program
Dependent variable: relative division, Directors' Cup points, total, men's and women's			
L.DivDirectorsCupTotal	.630*** (.039)		
L.DivDirectorsCupMens		.311*** (.058)	
L.DivDirectorsCupWomens			.629*** (.046)
DivExpenditureTotal	.384*** (.073)		
DivExpenditureMens		.517*** (.094)	
DivExpenditureWomens			.535*** (.139)
DivTeamsTotal	.411* (.240)		
DivTeamsMens		.184 (.198)	
DivTeamsWomens			.223 (.281)
DivAthletesTotal	−.045 (.157)		
DivAthletesMens		−.014 (.189)	
DivAthletesWomens			−.070 (.119)
DivEnrollmentTotal	.028 (.063)		
DivEnrollmentMen		.123 (.103)	
DivEnrollmentWomen			.055 (.082)
DivTuition	−.033 (.047)	.039 (.081)	−.054 (.072)
DivAdmission	.007 (.065)	−.004 (.093)	−.091 (.079)
Constant	−.427** (.293)	−.262 (.191)	−.274 (.257)
Time fixed effects	Y	Y	Y
Wald χ^2	1,938.94	431.58	1,633.60
Number of observations	1,727	1,727	1,719

*, **, and *** denote statistical significance at the .10, .05, and .01 levels, respectively.

increase in expenditure may have the largest impact on men's lacrosse and women's field hockey resulting in 72.27% and 40.52% increases in average points, respectively. Recall that these sport programs are among the least popular at the Division I level. This analysis suggests that as the competition in the sport category increases, effective impacts of increased expenditure may become smaller and smaller.

To better capture the competition throughout the division, Model 2 is estimated at all levels and controls for the expenditure of all other schools in the analysis. Table 8 presents the results of the estimation of Model 2 for the analysis of full, men's, and women's aggregate programs. Results are presented in columns 1, 2, and 3, respectively. These results suggest that increases in relative division expenditure lead to increases in relative division Directors' Cup points. Moreover, while the same increase in relative, division-level expenditure for both men's and women's aggregate programs may lead to nearly the same relative increase in Directors' Cup points, again, a dollar spent on women's programs at the relative division level will likely lead to a larger percentage increase in relative division points than a dollar spent on men's aggregate programs.

Estimated point differentials resulting from a $1 million increase in expenditure are similar to those of Model 1, even when controlling for relative division factors. Here, a $1

million increase in total, men's, and women's program expenditures would lead to about 4.4, 4.6, and 9.8 additional points for the full, men's, and women's programs, respectively (see Note 12). Together the analyses of Models 1 and 2 suggest that the impact of an additional $1 million in expenditure, holding all else equal, would likely result in a 1.9–2.0% increase in points for the full program, a 3.1–4.0% increase in points for the men's program, and a 8.6–10.7% increase in points for the women's programs, on average.

Table 9 presents the estimated, relative expenditure coefficients and standard errors from the estimation of Model 2 for individual sport programs.[13] Most result are qualitatively similar to those of Model 1. Notice again that the relative expenditure is significant for over 50% of the sport programs. Those men's programs that lose some significance continue to have positive coefficients on the expenditure variables. In addition, a few more men's and women's sport programs' expenditures becomes significant. Effective financial distribution recommendations also remain consistent. These results continue to suggest than an extra $100,000 spent on men's golf, men's lacrosse, and women's field hockey would likely lead to the largest percentage increases in average, team Directors' Cup points.

Finally, results of the estimation of Model 3 at the aggregate and individual sport levels are presented in Tables 10 and 11, respectively. Results are consistent with those of Models 1 and 2. Results indicate that when a school increases its women's aggregate program expenditure relative to all other schools in the conference, the resulting increase in relative conference points is larger than that of the same percentage increase in the relative men's aggregate program expenditure. Most results at the individual sport level are also qualitatively similar to those of Models 1 and 2. For those sport models that lose some level of significance, the signs of the coefficients remain consistent. This is most likely due to the loss of power when analysis is condensed at the conference level, as the rescaling of the variables reduces the variability of these factors.[14]

It should also be noted that when schools increase expenditure relative to the division, the estimated impact on relative division Directors' Cup points is smaller than the estimated impact of relative conference expenditure on relative conference Directors' Cup points at all aggregate and most significant sport levels. This is likely due to the fact that teams must first do well in their conference to advance to the post season. In addition, those schools that do advance beyond their conference will likely earn many more points than most other schools in their conference which do not advance. Therefore, relative expenditure spent with respect to the conference will likely have larger impacts on the spread between a school's points and the average points of all other schools in the conference.

Discussion and Future Work

With rapidly increasing athletic program expenditures across NCAA Division I institutions, the need for exploration into more effective distributions of limited, athletic funds has become increasingly important. This study builds on previous

Table 9. Model 2: Estimation Results, by Sport.

Men's Sports: Relative Conference Expenditure Coefficients and Standard Errors								
Dependent Variable: Relative Division, Men's Sport Level, Directors' Cup Points								
Baseball	Basketball	Cross country	Golf	Gymnastics	IA football	IAA football	Ice hockey	Lacrosse
1.018*** (0.187)	0.759*** (0.145)	0.272 (0.181)	1.009*** (0.228)	45.508 (62.388)	0.467*** (0.123)	6.630 (2.625)	6.655 (4.467)	9.193*** (1.977)
Soccer	Swimming	Tennis	Track and Field spring	Track and Field winter	Volleyball	Water polo	Wrestling	
0.603 (0.406)	0.315*** (0.096)	0.709** (0.324)	0.319 (0.222)	−0.178 (0.664)	−22.452 (51.405)	−11.280 (50.156)	1.518** (0.658)	
Women's Sports: Relative Conference Expenditure Coefficients and Standard Errors								
Dependent Variable: Relative Division, Women's Sport Level, Directors' Cup Points								
Basketball	Bowling	Cross country	Golf	Gymnastics	Field hockey	Ice hockey	Lacrosse	Rowing
1.209*** (0.271)	23.573 (15.493)	0.065 (0.153)	0.719** (0.344)	1.647** (0.770)	1.962** (0.897)	5.170* (3.144)	2.244*** (0.815)	1.314 (0.975)
Soccer	Softball	Swimming	Tennis	Track and Field spring	Track and Field winter	Volleyball	Water polo	
0.479* (0.290)	1.175*** (0.445)	0.510*** (0.102)	1.019*** (0.318)	0.780*** (0.178)	0.122 (0.215)	0.905*** (0.235)	6.207 (5.808)	

*, **, and *** denote statistical significance at the .10, .05, and .01 levels, respectively.

Table 10. Model 3: Estimation Results, by Aggregate Category.

	Full Athletic Program	Men's Athletic Program	Women's Athletic Program
Dependent variable: relative conference, Directors' Cup points, total, men's and women's			
L.ConfDirectorsCupTotal	0.207*** (0.043)		
L.ConfDirectorsCupMens		0.182*** (0.168)	
L.ConfDirectorsCupWomens			0.189*** (0.044)
ConfExpenditureTotal	0.956*** (0.168)		
ConfExpenditureMens		0.551*** (0.168)	
ConfExpenditureWomens			1.354*** (0.283)
ConfTeamsTotal	0.680* (0.363)		
ConfTeamsMens		0.624 (0.384)	
ConfTeamsWomens			0.609 (0.442)
ConfAthletesTotal	−0.374 (0.291)		
ConfAthletesMens		−0.387 (0.339)	
ConfAthletesWomens			−0.435* (0.232)
ConfEnrollmentTotal	0.162 (0.067)		
ConfEnrollmentMen		0.330** (0.137)	
ConfEnrollmentWomen			0.144 (0.162)
ConfTuition	−0.016 (0.067)	0.101 (0.096)	−0.149 (0.097)
ConfAdmission	−0.022 (0.126)	0.112 (0.173)	0.010 (0.146)
Constant	−0.617** (0.293)	−0.533 (0.368)	−0.754 (0.467)
Time fixed effects	Y	Y	Y
Wald χ^2	174.60	101.76	90.51
Number of observations	1,727	1,727	1,719

*, **, and *** denote statistical significance at the .10, .05, and .01 levels, respectively.

analysis and adapts empirical techniques to examine relationships between expenditure and Directors' Cup points at aggregate, relative division, relative conference, and individual sport program levels.

Results of the estimation of a series of dynamic panel data regression models suggest that expenditure does have a positive and significant impact on Directors' Cup points for aggregate and many individual sport programs. Further analysis suggests that a dollar spent on women's programs might have a more effective impact on Directors' Cup points than a dollar spent on men's programs. Athletic directors who are most concerned with competitions within their own conference should also find more success in the competition when increasing their expenditure relative to all other schools in their own conference. Together all analysis shows that more effective distributions of financial resources could be adopted to increase an institution's success in the competition.

However, it should be noted that rigorous efficiency analysis is not conducted in this study and is beyond the scope of the current analysis. Since, the conclusions of this study suggest that there may be more effective distributions of athletic funds, researchers may also follow this study with further efficiency analysis. Frontier

Table 11. Model 3: Estimation Results, By Sport.

Men's Sports: Relative Conference Expenditure Coefficients and Standard Errors								
Dependent Variable: Relative Conference, Men's Sport Level, Directors' Cup Points								
Baseball	Basketball	Cross country	Golf	Gymnastics	IA football	IAA football	Ice hockey	Lacrosse
1.686*** (0.620)	1.224*** (0.300)	0.674 (0.744)	2.746*** (0.397)	−5.851 (19.355)	1.087*** (0.305)	0.708 (0.778)	0.667 (2.490)	2.623*** (0.825)
Soccer	Swimming	Tennis	T&F spring	T&F winter	Volleyball	Water polo	Wrestling	
0.696 (0.738)	0.719*** (0.178)	1.292** (0.527)	0.959 (1.659)	2.417 (6.536)	−9.824 (26.160)	−31.387 (21.848)	−0.370 (0.767)	
Women's Sports: Relative Conference Expenditure Coefficients and Standard Errors								
Dependent Variable: Relative Conference, Women's Sport Level, Directors' Cup Points								
Basketball	Bowling	Cross country	Golf	Gymnastics	Field hockey	Ice hockey	Lacrosse	Rowing
1.077** (0.428)	2.353 (1.995)	0.361 (0.317)	1.825*** (0.487)	1.186 (0.785)	2.533*** (0.827)	1.888 (5.752)	0.480 (0.694)	1.086** (0.516)
Soccer	Softball	Swimming	Tennis	T&F spring	T&F winter	Volleyball	Water polo	
0.792* (0.426)	1.979*** (0.635)	0.740*** (0.260)	1.687*** (0.473)	−0.950 (1.678)	0.284 (1.170)	0.363 (0.360)	0.400 (4.789)	

*, **, and *** denote statistical significance at the .10, .05, and .01 levels, respectively.

analysis has been used in other sport contexts to examine whether current levels of expenditure may be efficient. However, most studies are conducted at the aggregate level (Collier, Johnson, & Ruggiero, 2011; Kashian & Pagel, 2014). Again, it would be useful to explore rigorous efficiency analysis at the individual sport levels as well.

Finally, although the results of the study add to a growing literature, more work is necessary to fully understand the most effective allocations of athletic resources. The purpose of this study is to examine the impact of expenditure on Directors' Cup points. Although Directors' Cup points have been used by many previous studies, it should be noted that this is only one measure of success and certainly not a perfect measure of success. To better understand more efficient allocations of athletic funds, the secondary analysis of measuring the impact of success on institutional benefits is necessary. While expenditure might be most effective for women's field hockey programs in the Directors' Cup competition, an increase in women's field hockey team Directors' Cup points might not be as effective, in generating alumni donations or revenue, as a smaller increase in the football team's Directors' Cup points (or other measures of the football team's success). Combining analysis from this study with that of previous studies that look at this secondary impact would be of great use for schools and athletic directors with diverse objectives for their athletic programs.

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Notes

1. The sponsored sports are baseball, men's and women's basketball, women's bowling, men's and women's cross country, men's and women's golf, men's and women's gymnastics, field hockey, IA football, IAA football, men's and women's ice hockey, men's and women's lacrosse, women's rowing, men's and women's soccer, softball, men's and women's swimming, men's and women's tennis, men's and women's indoor and outdoor track and field, men's and women's volleyball, men's and women's water polo, men's wrestling, fencing, rifling, and skiing.
2. Further details of the National Association of Collegiate Directors of Athletics (NACDA) Directors' Cup competition and awarding procedures are discussed in the following sections of this study.
3. The panel is unbalanced since some schools joined and left Division I athletics during the time of the study. It is also unbalanced due to the fact that data sources contained missing information for some institutions.

4. For a comprehensive description of how points are award to each school, for each sport, see http://www.nacda.com/directorscup/nacda-directorscup-scoring.html.
5. Note that the NACDA website does not directly provide the scores for teams that did not earn the 10 highest men's or women's points for their school. However, the website does give the finishing place of all teams. Looking across the NACDA tables, one can determine the number of points that the teams would have earned given their finishing position. It was assumed that the teams which finished in the same position, within the same sport category, would earn the same number of points.
6. Note that fencing, rifling, and skiing are not included in the aggregate Directors' Cup scores or analyzed at the sport level. This is due to the fact that it is not clear whether these sports are men's, women's, or coed and therefore the corresponding expenditure cannot be determined within the data sources.
7. The adjusted measurement also excludes fencing, rifling, and skiing expenditures.
8. Note that only primary conference affiliation is collected in the data, although some schools are associated members of certain conferences for only one or two sports. This is not seen as a limitation of the data and merely ensures that the results only hold for primary conference affiliation and not associated conferences.
9. Some conferences have dissolved or been created over the time of the study. All schools' conference affiliations are coded for consistency.
10. The Pac-12 conference was once the Pac-10 conference. Since the conference simply changed its name, the Pac-12 is used for both the Pac-10 and Pac-12 for consistency.
11. Note that time, fixed effects will only capture the impacts of factors that change over time and affect all schools similarly. These time, fixed effects will not capture the impact of factors that change over time but that affect schools differently such as changes to specific conference rules. In order to capture these effects, all 37 specifications of each model would need to be estimated separately for each conference. The dynamic panel data regression models cannot include conference, fixed effects since most schools in the study did not change conferences over time. The first differenced equation would wipe out conference, fixed effects as it does institution, fixed effects. The analysis at the individual conference level is beyond the scope of this study. However, Model 3 does fully control for conference affiliation in each of the aggregate and individual sport specifications. Therefore, the result of this study is assumed to be robust, reliable, and applicable.
12. Note that the calculation used to measure the impact of an additional $1,000,000 in expenditure on Directors' Cup points includes both the average expenditure across the division and average Directors' Cup points across the division. (Point differentials are calculated in levels and percentage changes for ease of comparison between the results of all models.) For example, the calculation for the impact of an additional $1,000,000 of expenditure on total Directors' Cup points at the full athletic program level is given by the following: $\Delta\text{Total Directors Cup Points} = \left(\frac{+1{,}000{,}000}{19{,}952{,}646}\right) \times (0.384) \times 227.91 = +4.38$ Points. Here, $19,952,646 is the average total expenditure across the division, 227.91 is the average total Director's Cup points across the division, and 0.384 is the estimated coefficient of the relative expenditure under the full athletic program specification of Model 2. (Note that an increase of $1,000,000 of expenditure at one school will have a minimal impact on the

average expenditure. Therefore, the average is held constant in the calculation for consistency and transparency. All estimations should be viewed as approximations.) Similar calculations are employed at the men's aggregate, women's aggregate, men's individual sport, and women's individual sport levels. Estimated impacts of increases in relative conference expenditure on relative conference Directors Cup points are calculated in a similar way. Again, both the average expenditure and average Directors' Cup points are included in the calculation at all program levels.

13. Results of the full regression models are available upon request.
14. The only specifications of all three models, with significant, estimated expenditure coefficients, which did not pass all three validity criteria were men's basketball under Model 1 and Model 2, men's lacrosse under Model 3, women's softball under Model 2, and women's spring track and field under Model 2. However, the results are consistent under any lag structure and should be viewed as robust. In addition, a few coefficients could not be fully estimated in some specifications if there was not enough variation in the variable (e.g., the coefficient on Admission in the men's gymnastics specification under Model 3). However, all expenditure coefficients in all 37 specifications of all three models were able to be estimated.

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