1. Introduction

As a result of Title IX, there has been a large increase in the participation of women in college sports. While Title IX greatly increased athletic opportunities for college women, the regulation has been controversial, because of a perceived negative effect on men's sports. However, most studies of the issue find that male participation in college sports has been flat, rather than declining. Why has Title IX resulted in an increase in resources devoted to women's sports, with little or no decrease in resources devoted to men's sports?

In this paper, we develop a model in order to better understand how these changes could result from the Title IX regulation. We use standard contest success functions in a model where two universities allocate resources to their women's and men's sports. The Title IX regulation is modeled as a requirement that resources devoted to women's sports equal or exceed a fixed fraction of the resources devoted to men's sports. If the university attempts to satisfy the Title IX requirement solely by increasing resources to an existing women's sport we obtain a strong, but counterfactual, result. In particular, the model predicts that the total amount of resources devoted to sports is unchanged, and that the increase in resources devoted to women's sports is matched by a one-for-one decrease in the resources devoted to men's sports.

We next consider the addition of a women's sport. In part this is motivated by the idea that it is simply not possible for a university to satisfy Title IX by pouring an arbitrary amount of resources into a given set of sports. If there is an upper limit on the amount of resources which can be utilized in a given sport, then the universities may face the choice of either adding an additional sport, or having this constraint bind, and taking additional cutbacks in resources devoted to men's sports. If the universities do indeed add a women's sport, we may obtain the result which is observed in the data; resources devoted to women's sports are increased, while resources devoted to men's sports are unchanged. The problem is that if the university found it undesirable to add the women's sport prior to Title IX, it will always prefer the cutbacks in men's sports to the addition of the women's sport. This is strongly counterfactual, and suggests some important element is missing from the simple model.

We next discuss additional elements which might be added to the model in order to explain the outcomes we have observed in the data. We first consider the possibility that there are binding minimum resource requirements in the men's sports which may force the university to either drop a men's sport or add a women's sport in order to be in compliance with Title IX. In the face of such a constraint, the university may add a women's sport. We also consider the possibility that Title IX may have helped solve a coordination problem across conferences, in the sense that investing in women's sports became more desirable when these investments were widely spread across the country. Finally, Title IX resulted in a large increase in the number of girls playing high school sports, and this increase supply of athletes may have raised the returns to investing in women's sports at the college level.[1]

[1] The effect of Title IX on high school sports is documented in Stevenson (2007). She also expresses the idea that Title IX may have helped solve a coordination problem in the provision of girls sports at the high school level. Stevenson (2010) provides empirical evidence that the increased female participation in sports at the high school, which occurred due to Title IX, led to increased college attendance and improved labor market outcomes for women.

2. Background

Title IX of the 1972 Education Amendments addressed equal access to all school activities, including sports.[2] In subsequent years, regulations regarding the implementation of Title IX were developed, and these began to bind in 1978. Universities can satisfy Title IX in one of three ways: The first way is to have female athletic participation which is proportional to the number of women in the student body when compared with male participation. The second way to satisfy the Title IX requirement is to have a continuing record of improvement in providing access to women's sports.[3] The last way to satisfy the Title IX requirement is to demonstrate that the University has fully accommodated the interests of female athletes.[4]

It is clear that Title IX has led to a large increase in the number of women participating in college sports. Between 1971 and 1998, the number of women participating in college sports rose from 30 thousand to 167 thousand with most of this increase occurring after 1981.[5] The rate of participation rose from 1.7% to 5.5% during this period. The changes in male participation are much smaller in magnitude, and the sign of the change is sensitive to the starting date. Depending on the starting date, it is possible to conclude that there has been a small decrease in the absolute level of male participation (about 4.5%), or that the absolute level of participation has been flat. To the extent that there is a decline in the rate of participation, it less than 1 percentage point and any declines which occurred were prior to 1981.[6] Since 1981, there have been small increases in both the absolute level of participation and the participation rate for men. Meanwhile, much of the increase in women's sports participation has occurred since 1981.[7]

Data on the number of men's and women's teams has been reported back to 1981.Since then, there has been a sharp rise in the number of women's teams and a much smaller increase in the number of men's teams.[8] The picture that emerges from the data is that the dominant response to Title IX has been to increase women's sports rather than to decrease men's sports. This does not mean that there are not instances of men's sports which were cut in response to Title IX, but rather that in the aggregate, the opportunity for male participation in college sports has remained approximately constant since the enactment of this regulation.[9]

---

[2] Additional background on Title IX may be found in Suggs (2005). The appendices of this book include the text of Title IX as well as interpretations of this regulation which have been issued over the years.

[3]Some commentators have noted that this criteria can only serve to satisfy Title IX in a transitional sense. In the long run, universities must satisfy Title IX via one of the other two criteria.

[4] For a fuller descriptions of the three pronged test used to determine whether a university is in compliance with Title IX, see appendix H of Suggs (2005).

[5] See Table 6 in GAO (2000: 38) This table is also a source for some of the other figures discussed below. These numbers represent athletic participation at four year colleges and universities.

[6] There is a sharp decline in the male participation rate in the five years prior to 1971, during which the rate fell from 11.9 to 10.4 percent. This is prior to the time during which the influence of Title IX would have been felt. Between 1971 and 1981, the participation rate falls to 9.1%, but by 1998 it drifted back up to 9.5%. It is difficult to know how much of this movement was due to Title IX and how much to other factors, since the decline in the five years prior to enactment exceeds the decline in the 27 years after enactment.

[7] For an empirical analysis of the decision to add women's sports and drop men's sports, see Anderson and Cheslock (2004).

[8] See GAO (2001) and GAO (2007). Some men's sports, such as wrestling, have seen cuts on net. In the aggregate, these cuts have been more than offset by increases in other sports.

[9] Stevenson (2007) reports that this is also true at the high school level, where the dominant effect of Title IX has been to increase girls participation rather than reduce boys participation in sports. Zimbalist (2005: p. 76, note 1) notes the ambiguity in the data for men's participation, but also concludes that men's participation is basically flat in the wake of Title IX.

To the best of our knowledge, there has been only one previous theoretical treatment of Title IX in the economics literature. This is work by Carroll and Humphreys (2000), who use a utility based analysis in order to examine the effects of Title IX. In particular, they assume the athletic director has a utility function which depends positively on staff hired for men's and women's sports, prestige, and revenue generated by the sports. They assume that only men's sports generate prestige, and model Title IX as creating a linkage between resources devoted to men's sports and the minimum level of resources which must be devoted to women's sports. The model implies that the athletic director will either have to cut staffing in men's athletic programs or cut resources devoted to men's sports in response to Title IX. The authors do not explicitly model the decision to add a women's sport or drop a men's sport. In our paper, we link these decisions with the technology of the provision of a sporting contest, while their paper does not focus on this type of issue.

We use contest success functions in modeling Title IX. This is in line with much work in the sports economics literature. For a survey of this literature, see Szymanski (2003).[10] We model the Title IX regulation in a way which is similar to Carroll and Humphreys by requiring that resources in women's sports equal or exceed a fixed fraction of resources devoted to men's sports. In our model, we are able to consider the effects of Title IX on the total resource allocation to college sports, as well as the breakdown of this allocation between men's and women's sports. We are also able to consider the conditions under which a women's sport would be added and a men's sport would be dropped.

3. The Baseline Model

There are two risk neutral universities, A and B which compete in men's and women's sports. It is useful to think of these two universities as being members of a conference. Initially we assume that there are two men's sports and one women's sport. Variables associated with men's sports are denoted by Y and variables associated with women's sports are denoted by X. There is a prize associated with the sports competition denoted by R, where R_{Yi}, $i = 1, 2$ denotes the prizes associated with the two men's sports and R_{X1} is the prize associated with the one women's sport. The perceived prize from winning each sporting contest is valued equally by the two universities, where the prizes exhibit the following relationship: $R_{Y1} > R_{Y2} > R_{X1}$. Thus, both men's sports have a higher perceived prize than the women's sport. We can think of R as the monetized value of the prize associated with the sport, but this prize when realized by the university will not necessarily be in the form of money. While sports do provide revenue from ticket sales and other sources, they also provide the university with prestige and publicity. Even prior to Title IX, there were non-revenue sports, but they were mainly men's sports. The fact that the university was willing to sponsor these sports suggests that there was some perceived non-monetary benefit from participating in these activities.

The resources devoted by the universities to the men's sports are denoted Y_{ji}, $j = A, B$, $i = 1, 2$. Similarly, the resources devoted by the schools to the women's sport are denoted X_{j1}, $j = A, B$. The probability that university A wins the first men's contest is denoted p_{Y1}^{A}. Note that the probability that university B wins this contest is $p_{Y1}^{B} = 1 - p_{Y1}^{A}$. The probabilities of victory for the

[10] See Nitzan (1994) for a survey on the related rent-seeking literature. Konrad (2009) is a book length treatment of contest theory.

other contests are denoted in an analogous fashion. We use a simple contest success function first introduced by Tullock (1975, 1980). Thus, for the first men's sport we have

$$p_{Y1}^{A} = \frac{Y_{A1}}{Y_{A1} + Y_{B1}}, \qquad (1)$$

where we have analogous expressions for the probability of victory in the other sporting contests.[11]

Initially, the two universities are unconstrained in allocating resources to the three contests. The cost of an input into the contests is normalized to 1. We do not impose a budget constraint on the university, but rather each university will invest in a contest until the marginal benefit equals the constant marginal cost of 1.[12] The objective functions of the universities are as follows:

$$\Pi_j = \frac{Y_{j1}}{Y_{A1} + Y_{B1}} R_{Y1} + \frac{Y_{j2}}{Y_{A2} + Y_{B2}} R_{Y2} + \frac{X_{j1}}{X_{A1} + X_{B1}} R_{X1} - Y_{j1} - Y_{j2} - X_{j1}, j = A, B. \qquad (2)$$

where Π_j is used to denote the payoff of university *j*.

Because the contests are separable, maximizing the payoff above is equivalent to maximizing the payoffs in three separate contests. The first order conditions from maximizing (2) plus symmetry yields the following standard solutions to this problem:

$$Y_{Ai} = Y_{Bi} = R_{Yi}/4, i = 1, 2. \qquad (3a)$$

$$X_{A1} = X_{B1} = R_{X1}/4 \qquad (3b)$$

Letting *T* be the total resources each university devotes towards the sporting contests we have

$$T_j = R_{Y1}/4 + R_{Y2}/4 + R_{X1}/4, j = A, B. \qquad (4)$$

The equilibrium payoff of each university is

$$\Pi_j = R_{Y1}/4 + R_{Y2}/4 + R_{X1}/4, j = A, B. \qquad (5)$$

The analysis above provides a baseline to which we can compare the outcome under Title IX, which we introduce in the next section.

---

[11] All of the results to follow would hold if instead of the probability of victory, the right-hand side of equation (1) represented the share of the associated prize earned by university *A*. Also note that while the specific model solutions would be affected, the flavor of our results would be unchanged if we used the contest success function $p_{Y1}^{A} = (Y_{A1})^{\rho} / [(Y_{A1})^{\rho} + (Y_{B1})^{\rho}]$, where $0 < \rho \leq 2$.

[12] In the data, the primary response we observe is for universities to add women's sports rather than contract men's sports. This could not occur in the model if we impose a hard budget constraint. Thus, instead we impose a constant opportunity cost of funds.

4. Introducing Title IX, While Holding the Number of Sports Constant

We will initially assume that Title IX is satisfied by an increase in resources in the existing women's sport, but in Section 5, we will consider the possible addition of a second women's sport and in Section 6, we consider the conditions under which a men's sport would be dropped.

We model Title IX as imposing the following requirement: $X_{j1} \geq \gamma(Y_{j1} + Y_{j2})$, $j = A, B,$ where $0 < \gamma \leq 1$. Thus, Title IX is modeled as requiring that inputs into women's sports be a specified fraction of the inputs into men's sports. Assuming that the Title IX constraint is binding, equation (3) implies that $\gamma > (R_{X1}/(R_{Y1}+R_{Y2})$. The objective function of the two universities may be expressed as follows:

$$\Pi_j = \frac{Y_{j1}}{Y_{A1}+Y_{B1}} R_{Y1} + \frac{Y_{j2}}{Y_{A2}+Y_{B2}} R_{Y2} + \frac{\gamma(Y_{j1}+Y_{j2})}{\gamma(Y_{A1}+Y_{A2})+\gamma(Y_{B1}+Y_{B2})} R_{X1} - (1+\gamma)(Y_{A1}+Y_{A2}),\ j = A,\ B. \tag{6}$$

The first order conditions from maximizing the payoffs in (6) are

$$\frac{Y_{ji}}{(Y_{A1}+Y_{B1})^2} R_{Yi} + \frac{Y_{j1}+Y_{j2}}{(Y_{A1}+Y_{A2}+Y_{B1}+Y_{B2})^2} R_{X1} = (1+\gamma),\ \ i = 1,\ 2, j = A,\ B, \tag{7}$$

Making use of symmetry, we can solve these equations to obtain the following:

$$Y_{ji} = \frac{R_{Yi}}{4(1+\gamma)}\left(1 + \frac{R_{X1}}{R_{Y1}+R_{Y2}}\right),\ i = 1, 2,\ j = A, B., \tag{8a}$$

$$X_{j1} = \frac{\gamma}{4(1+\gamma)}(R_{Y1}+R_{Y2}+R_{X1}),\ j = A,\ B. \tag{8b}$$

The total resources devoted to sports are $T = (1+\gamma)(Y_{j1} + Y_{j2}) = (1/4)(R_{Y1} + R_{Y2} + R_{X1})$, which is the same as in equation (4). Similarly the equilibrium payoff is the same as in (5). Thus, the Title IX regulation does not affect either the total resources devoted to sports or the payoffs of the universities. [13]

Title IX does, however, affect the allocation of resources between women's and men's sports with women's sports receiving an increase and men's sports a decrease. The fact that the overall level of resources is unchanged implies that any increase in resources devoted to women's sports is match by a one-for-one decrease in resources devoted to men's sports. Using equations (3) and (8), we can calculate the reduction in resources allocated to men's sports undertaken by each university:

---

[13] These two results are analogous results found in Glazer and Konrad (1999) when they consider the effect of taxing inputs into a rent seeking contest. In particular, see their Proposition 1.

$$\text{Reduction in men's resources per team} = \left(\frac{R_{Yi}}{4(1+\gamma)}\right)\left(\gamma - \frac{R_{X1}}{R_{Y1}+R_{Y2}}\right) > 0\ ,\ i = 1,\ 2. \qquad (9)$$

Recall that when Title IX is binding, $\gamma > (R_{X1}/(R_{Y1}+R_{Y2})$ which ensures the positive sign in (9). Note that the reduction in resources devoted to each men's sport is increasing in γ, which reflects the stringency of the Title IX regulation. Since $R_{Y1} > R_{Y2}$, the absolute reduction resources is greater in the men's sport with the larger prize. However, if the reduction is calculated as a percentage change by dividing (9) by the initial level of resources in each sport, we see that there is an equal percentage decrease in resources for the two men's sports given by $\left(\frac{1}{1+\gamma}\right)\left(\gamma - \frac{R_{X1}}{R_{Y1}+R_{Y2}}\right)$.

The analysis of the model thus far is summarized as Result 1:

Result 1: When a binding Title IX regulation is imposed on our model, and the number of women's sports is held constant at 1, (i) The total level resources devoted to sports and the payoffs of the universities are both unchanged. (ii) There is an increase in resources devoted to women's sports matched by a one-for-one decrease in resources devoted to men's sports, where the reduction for each men's sport, given by equation (9), is increasing in γ, the stringency of the Title IX regulation

While Result 1 contains a strong prediction on the effects of Title IX, we have not yet allowed for the possibility that teams might be added or dropped in response to the regulation. In addition, the result appears counterfactual, since the dominant effect of Title IX has been an increase in resources devoted to women's sports, while resources devoted to men's sports have been approximately constant. In the next section we consider the possibility of adding a second women's sport.

5. The Addition of a Second Women's Sport

To motivate the addition of a second women's sport, we need to add some ingredients to our basic model. The prize for the second women's sport is denoted R_{X2}. In the absence of Title IX, competition in this additional sport would yield each university of net benefit of $R_{X2}/4$, yet the sport was not added prior to the implementation of Title IX. One way to explain this is by appealing to there being a sunk cost from adding a sport. Let this sunk cost be S_{x2}. Since the sport was not added prior to the implementation of Title IX, this implies that $S_{x2} > R_{X2}/4$ as this condition ensures that adding the sport is unprofitable.

For technical purposes, we need to assume that the prize in the second women's sport is only available if both universities undertake the sunk cost S_{X2}. Otherwise, if $S_{X2} < R_{X2}$, there could never be a Nash equilibrium in which 0 resources were invested in this sport by both schools. Given the nature of sporting competition, however, this assumption seems quite reasonable.

A second ingredient we need is that there be some limits on the ability of the university to satisfy Title IX by squeezing resources into the first sport. Suppose there is an upper limit on the resources which may be employed in the first women's sport, $\overline{X}_1$. If this upper limit becomes binding, then each university can either add a second sport, or constrict resources in its men's sports such that $Y_{j1} + Y_{j2} = (1/\gamma)\ \overline{X}_1$, $j = A, B$. We will analyze what happens if a second women's sport is added, and then analyze the conditions (if any) under which the universities would prefer to add a women's sport rather than cut resources devoted to the men's sports in accord with the restriction above.

Adding a second women's sport involves a coordination problem, since it never pays to incur the sunk cost of adding the sport if the other university does not also do so. Thus, it would always be a Nash equilibrium not to add the sport. However, sports conferences exist in part to overcome this type of coordination problem, so we assume that if it is in the joint interest of the two universities to add the second sport, they will in fact do so.

When a second women's sport is added, there are two cases worth considering. Under the first, Title IX is not binding at the margin when the second sport is added. Under the second, Title IX is still binding at the margin after the addition of the second sport. If Title IX is not binding at the margin after a second sport is added, the payoffs of each university may be expressed as[14]

$$\Pi_j = \frac{Y_{j1}}{Y_{A1}+Y_{B1}} R_{Y1} + \frac{Y_{j2}}{Y_{A2}+Y_{B2}} R_{Y2} + \frac{X_{j1}}{X_{A1}+X_{B1}} R_{X1} + \frac{X_{j2}}{X_{A2}+X_{B2}} R_{X2} - Y_{j1} - Y_{j2} - X_{j1} - X_{j2}, \quad j = A, B. \tag{10}$$

This is equivalent to solving four separate contests, where the solutions for solutions for Y_{j1}, Y_{j2} and X_{j1} are the same as those given in (3a-c) and $X_{j2} = R_{X2}/4$. Title IX will not bind at the margin after the second sport is added if $\gamma(R_{Y1} + R_{Y2}) < R_{X1} + R_{X2}$. Not including sunk costs, the sum of the resources devoted to sports are

$$T_j = R_{Y1}/4 + R_{Y2}/4 + R_{X1}/4 + R_{X2}/4, \; j = A, B, \tag{11}$$

and the payoffs for each university are

$$\Pi_j = R_{Y1}/4 + R_{Y2}/4 + R_{X1}/4 + R_{X2}/4 - S_{X2}, \; j = A, B. \tag{12}$$

Note that the payoff in (12) reflects the sunk cost required in order to establish the new women's sport.

When Title IX is not binding after a second women's sport is added, the allocation of resources to men's sports matches the level prior to the implementation of Title IX, while women's sports realize an increase in resources equal to $R_{X2}/4$. Thus, total resources devoted to sports also increases by $R_{X2}/4$. The attractive aspect of this outcome is that it approximates what we observed in the data on men's and women's sports.

[14] After a second sport is added, the maximum resource constraint in sport 1 $\overline{X}_1$ typically will no longer bind at the margin, because the university will want to optimally distribute its resources across the two women's sports.

If $\gamma > (R_{X1} + R_{X2})/(R_{Y1} + R_{Y2})$, then Title IX will bind at the margin even after the second sport is added.[15] When this is so, we will have $X_{j1} + X_{j2} = \gamma(Y_{j1} + Y_{j2})$, *j = A, B*. The payoff functions may now be expressed as

$$\Pi_j = \frac{Y_{j1}}{Y_{A1}+Y_{B1}}R_{Y1} + \frac{Y_{j2}}{Y_{A2}+Y_{B2}}R_{Y2} + \frac{X_{j1}}{X_{A1}+X_{B1}}R_{X1} + \frac{\gamma(Y_{j1}+Y_{j2})-X_{j1}}{\gamma(Y_{A1}+Y_{A2})-X_{A1}+\gamma(Y_{B1}+Y_{B2})-X_{B1}}R_{X2} - (1+\gamma)(Y_{A1}+Y_{A2}) \quad , j = A, B. \tag{13}$$

The first order conditions from the maximization of (13) imply

$$\frac{Y_{ji}}{(Y_{A1}+Y_{B1})^2}R_{Y1} + \frac{\gamma(\gamma(Y_{j1}+Y_{j2})-X_{j1})}{\left((\gamma(Y_{A1}+Y_{A2})-X_{A1})+(\gamma(Y_{B1}+Y_{B2})-X_{B1})\right)^2}R_{X2} = (1+\gamma), \; i = 1, 2, j = A,B, \tag{14a}$$

$$\frac{X_{j1}}{(X_{A1}+X_{B1})^2}R_{X1} - \frac{\gamma(Y_{j1}+Y_{j2})-X_{j1}}{\left((\gamma(Y_{A1}+Y_{A2})-X_{A1})+(\gamma(Y_{B1}+Y_{B2})-X_{B1})\right)^2}R_{X2} = 0, \; j = A,B. \tag{14b}$$

Using symmetry, these equations yield the following solutions:

$$Y_{j1} = \frac{R_{Yi}}{4(1+\gamma)}\left(\frac{R_{Y1}+R_{Y2}+R_{X1}+R_{X2}}{R_{Y1}+R_{Y2}}\right), \; i = 1, 2, j = A,B, \tag{15a}$$

$$X_{j1} = \frac{\gamma R_{Xi}}{4(1+\gamma)}\left(\frac{R_{Y1}+R_{Y2}+R_{X1}+R_{X2}}{R_{X1}+R_{X2}}\right), \; i = 1, 2, j = A,B. \tag{15b}$$

The total resources devoted to sports by each university, and the resulting payoffs to each university are the same as in (11) and (12). Thus, we have something akin to the earlier invariance result, whereby total resources devoted to sports and total payoffs are not a function of whether or not Title IX is binding at the margin. However, as before, when Title IX is binding at the margin, the resources devoted to each men's sport are reduced. Before Title IX, $R_{Yi}/4$ is devoted to each men's sport. Subtract (15a) from this to obtain

$$\text{Reduction in men's resources per team} = \left(\frac{R_{Yi}}{4(1+\gamma)}\right)\left(\gamma - \frac{R_{X1}+R_{X2}}{R_{Y1}+R_{Y2}}\right) > 0, \; i = 1, 2. \tag{16}$$

Since Title IX is binding, $\gamma > (R_{X1} + R_{X2})/(R_{Y1} + R_{Y2})$, ensuring the positive sign in (16). A comparison with (9) reveals that the reduction resources devoted to men's sports is smaller when

[15] When this expression holds, the level of resources the universities would choose when Title IX does not bind at the margin does not satisfy the Title IX constraint.

a women's sport is added.[16] As before, the men's sport with the higher prize (sport 1) has the greater absolute reduction in resources, while the percentage reduction is equal across the two sports. The reduction in resources devoted to men's sports is increasing in γ, the parameter which reflects the stringency of the Title IX regulation

To compute the total increase in resources devoted to women's sports, sum the total across sports in (15b) and subtract $R_{X1}/4$:

$$\text{Total Increase in Women's Resources} = \frac{\gamma(R_{Y1} + R_{Y2} + R_{X2}) - R_{X1}}{4(1+\gamma)} > 0 . \qquad (17)$$

Because Title IX was binding when there was only one women's sport, we have $\gamma(R_{Y1} + R_{Y2}) > R_{X1}$, which guarantees the positive sign on (17). Taking the derivative of (17) reveals that the increase in resources devoted to women's sports is increasing in γ, the parameter which reflects the stringency of the Title IX regulation. Since the total resources devoted to all sports is the same as in (11), we know that the net increase in resources resulting from the implementation of Title IX is again $R_{x2}/4$, but this can also be verified by summing the losses from the two men's sports in (16) and subtracting from (17).

The analysis of what happens when a women's sport is added is summarized as Result 2:

> <u>Result 2</u>: When a second women's sport is added, the total resources devoted to sports increase by $R_{X2}/4$. If Title IX does not bind after the second sport is added, resources devoted to women's sports increase by $R_{X2}/4$ at each university, while resources devoted to men's sports do not change. If Title IX is still binding after the second sport is added, resources devoted to women's sports increase by the amount in equation (17), while resources devoted to men's sports decrease by the amount in equation (16). The magnitude of the changes in resources devoted to men's and women's sports is increasing in γ.

Result 2 offers the possibility that an increase in resources devoted to women's sports is accompanied by an unchanged level of resources devoted to men's sports. This can occur, conditional on the addition of a women's sport, but we next need to determine the conditions (if any) under which a women's sport will be added.

The alternative to adding a women's sport is to allow the constraint $\overline{X}_1$ to bind in the first women's sport and to derive the payoffs when resources are optimally allocated to the two men's sports in this situation. The constraint $\overline{X}_1$ will bind if the solution for X_1 in (8b) exceeds $\overline{X}_1$. This condition can be expressed as follows:

$$(1/4)(R_{Y1} + R_{Y2} + R_{X1}) > ((1+\gamma)/\gamma)\overline{X}_1 . \qquad (18)$$

---

[16] While the overall level of men's participation in sports has been approximately unchanged in the Title IX era, there have been scholarship cutbacks in football, where limits were imposed for the first time in 1977. Prior to 1977, there was no limit on scholarships. In 1977, the limit became 95, but this was further reduced to 85 in 1992 (Sutter and Winkler (2003: 3)). This reduction is consistent with the idea that Title IX was still binding at the margin after women's sports were added. However, even in the absence of Title IX this type of scholarship limitation may have been viewed as an attractive cost cutting measure by the NCAA.

The Title IX constraint combined with the limitation on resources in the first women's sport implies that $\gamma(Y_{j1} + Y_{j2}) = \overline{X}_1, j = A, B$. The payoff function of the universities may now be expressed as

$$\Pi_j = \frac{Y_{j1}}{Y_{A1} + Y_{B1}} R_{Y1} + \frac{(1/\gamma)\overline{X}_1 - Y_{j1}}{(2/\gamma)\overline{X}_1 - Y_{A1} - Y_{B1}} R_{Y2} + \frac{1}{2} R_{X1} - \left(\frac{1+\gamma}{\gamma}\right)\overline{X}_1, j = A, B. \tag{19}$$

The first order conditions from the maximization of (19) may be expressed as

$$\frac{Y_{j1}}{(Y_{A1} + Y_{B1})^2} R_{Y1} - \frac{(1/\gamma)\overline{X}_1 - Y_{j1}}{((2/\gamma)\overline{X}_1 - Y_{A1} - Y_{B1})^2} R_{Y2} = 0, \ j = A, B, \tag{20}$$

Using symmetry and solving we obtain

$$Y_{ji} = \left(\frac{R_{Yi}}{R_{Y1} + R_{Y2}}\right)\left(\frac{\overline{X}_1}{\gamma}\right), j = A, B, i = 1, 2. \tag{21}$$

The payoff to each university when the constraint in the first women's sport binds is

$$\Pi_j = R_{Y1}/2 + R_{Y2}/2 + R_{X1}/2 - ((1+\gamma)/\gamma)\overline{X}_1, j = A, B. \tag{22}$$

To find out whether it is preferable to add a second women's sport, or to allow the constraint in sport 1 to bind, we can subtract the payoff in (12) (when a women's team is added) from the payoff in (22). This can be expressed as follows:

$$\text{Difference} = \left[(1/4)(R_{Y1} + R_{Y2} + R_{X1}) - ((1+\gamma)/\gamma)\overline{X}_1)\right] + \left[S_{X2} - R_{X2}/4\right] > 0. \tag{23}$$

The first term in brackets is positive by the condition in (18), while the second term in brackets is positive because it is the condition which ensured that it was unprofitable to add the second women's sport absent Title IX. Thus, it is always more profitable to allow the constraint to bind in sport 1 than it is to add the second women's sport. This leads immediately to Result 3:

> Result 3: Payoffs are always higher when resources are cut in men's sports compared to when there is an increase in the number of women's sports. Thus, a second women's sport is never added.

There are two reasons we obtain this result. First, adding the second women's sport is unprofitable. Second, allowing the constraint in the first women's sport to bind implies a cutback in resources devoted to the two men's sports. This actually raises the payoff to the universities, because the inputs into the contest fall, while the prizes are fixed.[17]

---

[17] It is possible to imagine that an increase in resources expended on the sporting contest might raise the available prize. However, there would need to be a very large marginal effect in order to reverse the result that a reduction in

Result 3 is problematic in the sense that it rules out the adjustment in response to Title IX which we actually observed – a large increase in resources devoted to women's sports with little change in resources devoted to men's sports. Thus, we need to think about how to amend the model in such a way as to allow for this empirically observed outcome. We do this in the next section.

6. What is Missing?

In this section we discuss possible additions to the model which will allow it to better explain the outcomes we have observed in the wake of title IX. Note that the explanations we offer below are not mutually exclusive.

First, it may be the case that there are minimum input requirements into the men's sports below which the contests cannot be held. For example teams of a certain minimum size must be fielded before a game may be held. Assume these minimum input requirements are the same across the two universities, and denote these minimum requirements as $\underline{Y}_1 < R_{Y1}/4$ and $\underline{Y}_2 < R_{Y1}/4$. The restrictions on $\underline{Y}_1$ and $\underline{Y}_2$ guarantee that they lie below the unconstrained optimal level of resource investment in these two contests. If both teams do not equal or exceed the minimum level of resources, we assume that the contest is not held and no prize is awarded. If $\gamma(\underline{Y}_1 + \underline{Y}_2) > \overline{X}_1$, Title IX will force the university to either eliminate one of the men's sports or add a second women's sport. If the second men's sport is dropped (recall it has the smaller prize), the payoff to the university will be $(1/4)(R_{Y1} + R_{X1})$.[18] If the second women's sport is added, the payoff is given by (12). By taking the difference in these payoffs we find that the universities add the second women's sport if

$$R_{Y2}/4 + R_{X2}/4 - S_{X2} > 0 . \qquad (24)$$

The condition in (24) simply requires that the gain from maintaining the second men's sport exceeds the loss incurred on the second women's sport. This leads to Result 4:

> <u>Result 4</u>: If there are binding minimum requirements in the two men's sports such that $\gamma(\underline{Y}_1 + \underline{Y}_2) > \overline{X}_1$, then the second women's sport will be added and the second men's sport retained if $R_{Y2}/4 + R_{X2}/4 - S_{X2} > 0$. The second women's sport will not be added, and the second men's sport will be dropped if $R_{Y2}/4 + R_{X2}/4 - S_{X2} < 0$.

Result 4 does not guarantee that the predominant response will be the addition of women's sports, with men's sports held constant, but this outcome is consistent with Result 4.[19] Note that for some women's sports, the sunk costs of adding the sport are fairly low, because of the ability to double up on facilities used in men's sports. Basketball, swimming, track, soccer

---

expenditure in the contest raises the payoff of both universities. In addition, the NCAA's concern with the facilities arms race suggests that they would prefer to see a cutback in marginal resources devoted sporting contests.

[18] It is straightforward to verify that this expression is valid regardless of whether or not Title IX is binding at the margin after the second men's sport is dropped.

[19] Given the low dimensionality of the model, we either have the addition of a women's sport, or the dropping of a men's sport. If we added more men's sports and more possible women's sports, we might get a mixture of these responses, with some women's sports being added and some men's sports being dropped.

and golf fall into this category. The smaller the sunk cost of adding the sport, the more likely it is that the condition in (24) will hold.

How else might we amend the model so as to allow for a case where the universities would add a second women's sport? Assuming universities *A* and *B* are in the same conference, there are certain coordination problems we expect that they should be able to solve (such as scheduling and adding sports when it is mutually advantageous), but there may be important coordination problems whose scope lies outside the reach of a single conference to solve. For example, if all the universities in a conference decide to add women's basketball, they may find that the benefits of the program are small if other conferences across the country do not follow suit. Thus, from the perspective of the conference $R_{X2}/4 - S_{X2} < 0$. However, when universities in a large number of conferences invest in women's basketball, this may raise the prestige value of the sport directly and via national tournaments which take place subsequent to conference play. It is notable that subsequent to Title IX, in 1981, women's sports were incorporated into the NCAA. In this sense, large investments in women's basketball (and other sports) which take place across conferences may have the effect of raising the prize associated with the sport. If this investment leads to a new prize $R_{X2}' > R_{X2}$, we could have $R_{X2}'/4 - S_{X2} > 0$, in which case universities *A* and *B* would want to add the second sport.

Under this explanation, there always existed (in some larger game) a Nash equilibrium under which many conferences added the second women's sport, but it took Title IX to make this outcome a focal point and allow the overcoming of the multi-conference coordination problem.

Another factor to consider is the effect that Title IX had on high school sports which was to greatly increase the supply of female athletes to the colleges. This increase in the supply of trained athletes may have either lowered the effective cost of fielding a women's team at the college level and/or raised payoff associated with women's sports.[20] This again is a factor which could, by raising the net payoff associated with women's sports, induced universities to add these sports.

These explanations are not mutually exclusive and there may have been some interaction among the forces we have identified. For example, it may be that across board investments in women's sports did raise the prize associated with these sports, but that $R_{X2}'/4 - S_{X2} < 0$, so that adding the women's sport was still unprofitable. In the presence of minimum input requirements for men's sports however, this would still make the addition of a women's sport more likely by increasing the likelihood that equation (24) is satisfied.

7. Conclusion

The dominant response to the imposition of Title IX has been an increase in participation in women's sports, with men's participation being roughly constant. We have developed a model using standard contest success functions in order to analyze the effects of Title IX. Assuming that it was not considered desirable to add a women's sport prior to Title IX, we find in our basic model that no women's sports are added after the implementation of this regulation. We then add elements to the model in order to remove this counterfactual result. If there are minimum input requirements for men's sports, then Title IX may force a university to choose between adding a

[20] In our formal model, the cost of a unit of resources is constant at 1, but it is a straightforward extension to allow this to be some constant other than 1. Reductions in the cost parameter might then induce universities to add a sport which it previously was undesirable to add.

women's sport and eliminating a men's sport. Under certain conditions, a women's sport is added, and we can at least roughly replicate the response observed in the data. There are, however, other possible explanations for why women's sports get added, and these include positive network externalities from the addition of these sports and an increased supply of women athletes resulting from compliance with Title IX at the high school level.

An important question to ask is what would happen if the Title IX regulation were weakened or removed? In our model if the women's sport is added due to minimum input requirements in the men's sports, then the implementation of Title IX reduces the payoffs of the universities. This is consistent with the observed resistance of universities to the implementation of this policy. However, in our model, once a women's sport is added, it would not later be dropped, if the Title IX requirement were removed. The reason is that the sunk cost associated with the sport will have already been incurred. This suggests there might be a small response to the weakening or elimination of Title IX.[21] There is probably some element of truth in this, and athletic departments, having incurred the sunk costs for women's sports, might not cut back in a wholesale fashion. However, it is possible to alter the technology of sports competition in the model in such as way that the gains under Title IX would be reversible. As it stands in the model, once the sunk cost has been incurred, it is always beneficial to engage in the sporting contest. If the prize associated with the second women's sport R_{X2} is very low, and if there is a minimum input requirement associated with this sport such that $\underline{X}_2 > R_{X2}/2$, then (absent Title IX) it would be undesirable to continue competing in the sport, even after sunk costs have been incurred.[22] This issue will not arise if women's sports were added due to network externalities or an increased supply of female athletes, but it could a arise if a sport was added due to binding minimum resource constraints in men's sports. The issue probably does not apply in sports that generate a fair amount of publicity and prestige (e.g., women's basketball), but may apply to the more marginal sports. Thus, realistic additions to model suggest that Title IX probably still has an effect at the margin in determining the number of college sports available to women.

We believe that contest success functions are the appropriate tool for understanding Title IX, and to our knowledge, this is the first paper to apply this tool to this particular policy issue. The use of the contest success function puts the focus on the technology of the sporting contest, which is clearly central in understanding the response to Title IX. This approach can be usefully applied to other issues affecting college sports. For example, the NCAA has expressed quite a bit of concern about the facilities arms race, and an approach based on the contest success function would be central towards gaining an understanding of this issue.[23]

---

[21] This presumes that we are now in some sort of long run equilibrium. If we are still adjusting to a long-run equilibrium with more women's sports than we currently have, a weakening or elimination of the Title IX requirement would clearly short circuit this process.

[22] Sports are sometimes dropped for reasons having nothing to do with Title IX, and some addition to the model needs to be made to allow for this possibility. The mechanism discussed in the text, is one way to generate the endogenous dropping of a sport after, say, there is a reduction in the perceived prize. Note that under the restriction $\underline{X}_2 > R_{X2}/2$, a women's sport might still be added under Title IX, if the loss associated with the sport were less than the gain associated with the second men's sport.

[23] For a discussion of the facilities issue, see "A Weak Policeman Talks Tough When Tackling College Sports and Its Critics", *Wall Street Journal*, November 1, 2006.

References

Anderson, Deborah J. and John J. Cheslock. 2004. “Institutional Strategies to Achieve Gender Equity in Intercollegiate Athletics: Does Title IX Harm Male Athletes?” *American Economic Review* 94 (May): 307-311.

Carroll, Kathleen, A. and Brad R. Humphreys. 2000. “Nonprofit Decision Making and Social Regulation: The Intended and Unintended Consequences of Title IX.” *Journal of Economic Behavior and Organization* 43: 359-376.

Glazer, Amihai and Kai A. Konrad. 1999. “Taxation of Rent-Seeking Activities.” *Journal of Public Economics* 72: 61-72.

Government Accounting Office. 2000. *Gender Equity: Men’s and Women’s Participation in Higher Education*. GAO-01-128.

Government Accounting Office. 2001. *Intercollegiate Athletics: Four Year Colleges’ Experiences Adding and Discontinuing Teams*. GAO-01-297.

Government Accounting Office. 2007. *Intercollegiate Athletics: Recent Trends in Teams and Participants in National Collegiate Athletic Association Sports*. GAO-07-535.

Konrad, Kai A. 2009. *Strategy and Dynamics in Contests*. New York: Oxford University Press.

Nitzan, S. 1994. Modeling rent-seeking contests. *European Journal of Political Economy* 10: 41-60.

Stevenson, Betsey. 2007. “Title IX and the Evolution of High School Sports.” *Contemporary Economic Policy* 25: 486-505.

Stevenson, Betsey. 2010. “Beyond the Classroom: Using Title IX to Measure the Return to High School Sports.” *Review of Economics and Statistics* 92: 284-301.

Suggs, Welch. 2005. *A Place on the Team: The Triumph and Tragedy of Title IX*. Princeton: Princeton University Press.

Sutter, Daniel and Stephen Winkler. 2003. NCAA Scholarship Limits and Competitive Balance in College Football.” *Journal of Sports Economics* 4: 3-18.

Szymanski, S. (2003). The economic design of sporting contests. *Journal of Economic Literature* 41: 1137-1187.

Tullock, G. (1975). "On the efficient organization of trials." *Kyklos* 28: 745-762.

Tullock, G. (1980). Efficient rent seeking. In J. M. Buchanan, R. D. Tollison and G. Tullock eds. *Toward a Theory of the Rent-Seeking Society.* College Station, Texas: Texas A&M University Press.

Zimbalist, Andrew. 2005. “What to Do about Title IX.” In Rita J. Simon ed., *Sporting Equality*. New Brunswick, NJ: Transaction Publishers.