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More Evidence that University Administrators are Utility Maximizing Bureaucrats

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Abstract Coates and Humphreys (2001) found evidence that administrators affect enrollment supply and faculty demand using a panel of eleven public colleges and universities in Maryland, implying that institutions have enough market power to permit the preferences of administrators to influence these variables. We extend this framework to include political constraints on administrators' behavior and add data from public higher education in Virginia. These results are consistent with the earlier findings. However, political considerations and differences in the governance of higher education in the two states have relatively little influence on enrollment supply and faculty demand decisions of university administrators.

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1 Introduction

Institutions of higher education are bureaucratic organizations. Beginning with the work of Niskanen (1971), economists have modeled bureaucratic behavior in terms of government officials attempting to maximize the budget of a particular agency. In this approach, an agency's budget proxies for a variety of factors that are important to the bureaucrat, like prestige or perquisites of office. The key prediction of the Niskanen model is that utility maximizing government bureaucrats will over supply government services.

The provision of higher education is an important government service. Interestingly, the supply of higher education, defined here as enrollment, has been largely ignored in the economics of education literature, particularly studies of the effects of a university's administration on enrollment. We think this is a large oversight given the prediction of over supply in Niskanen's model.

Coates and Humphreys (2001) applied the Niskanen framework to the decisions of college administrators. Their interest was in how college or university administrators select the level of enrollment for their institutions whereas much of the existing literature has focused on the demand for enrollments.[1] In particular, they assumed that the preferences of utility maximizing bureaucrats had an effect on the supply of enrollments and the quantity and quality of faculty and facilities at institutions of higher education. Their empirical work found strong support for this assumption as they found that a system of enrollment supply and faculty demand equations including the tenure of individual campus presidents or provosts outperformed the estimates of a similar set of equations containing only campus specific effects.

[1] See Manski and Wise (1983), Paulsen (1990), Manski (1993), Hauser (1993), Cook and Frank (1993), Savoca (1990), Hoenack and Weiler (1979), Hoenack and Pierro (1990), Betts and McFarland (1995), and McPherson and Schapiro (1991) among others.

This research extends the analysis of Coates and Humphreys (2001) to include political constraints on the behavior of university presidents and provosts imposed by state-level regulators of higher education and other officials who can affect higher educational policy. Data from a second state are also used, providing a robustness check on previously published results.

1.1 The Literature on Enrollment Supply and Politics

Many previous studies of enrollment supply modeled university behavior from the perspective of a unitary actor with a well defined utility function. Examples of this approach include Garvin (1980) and James (1990). This approach assumes utility functions resulting from consensus or, at least, from politicking within the faculty, students and administrators. In this framework, the preferences of administrators have no more bearing on the decisions than do those of a student or Assistant Professor. Garvin did not, in other words, allow for individual specific tastes or preferences to influence university behavior. This earlier line of research also focuses on the allocation of resources across departments within a university and the internal politics associated with this allocation. Our approach assumes that administrators are the only individuals whose preferences matter in making decisions for a university. If this assumption is valid, we should find, and we do, that enrollment decisions at the various campuses of the state university systems in Virginia and Maryland depend upon which academic administrator is in office at the time.

Several studies have focused on empirical analysis of enrollment at colleges and universities. Ehrenberg, Rees and Brewer (1993) examined the effects of increased federal support for graduate students on the behavior of universities using a regression model explaining the number of full time science and engineering graduate students supported by institutional funds. This study found support for the hypothesis that universities reallocate their own source funds away from the support of graduate students as outside support for those students increases.

Interestingly, Ehrenberg, et al., assumed that there was an institution specific error that is constant over time, and they took first differences to control for this effect. However, this approach is only appropriate if the administrators of the university, or the institutional behavior, do not change over time. Administrators do change over time, and Coates and Humphreys (2001) found that university administrators act like Niskanen style bureaucrats. This means that first differencing does not control for the fixed effects as Ehrenberg, et al., intended. Finally, if there is correlation between the administration effect and the explanatory variables, as would be the case if administrators are influential in making the resource allocation decisions, then coefficients on those variables are biased and inconsistent.

Hoenack and Pierro (1990) examined the demand of the state legislature for enrollments in the University of Minnesota. At the same time, they estimated a per student cost function and a graduate enrollment supply function for the university. Their model accounts for the influence of politicians and politics on university funding and enrollments. They introduce measures of beneficiaries of funding for universities and competing interest groups into the analysis, but they do not examine or control for differences in the political institutions and actors. One goal of the current paper is to integrate the political environment into the decision calculus of the university administrator through controls for the governorship and leadership of the agencies charged with oversight of public higher education.

Lowry (2001a) also shows that funding for state universities is dependent on politics. Interestingly, his results indicate that public colleges and universities in those states that grant more financial autonomy to the university administrators report higher net tuition and fee revenues than universities in states with greater centralized control of public higher education finance. “The price of attending college thus depends in part on whether the relevant decision makers are state government officials or university administrators.” However, Lowry’s model does not introduce university and college administrators as independent decision makers. Instead, he infers their influence from a measure of autonomy based on the ranking of Volkwein and Malik (1997). Moreover, in Lowry’s (2001a) analysis enrollment is taken as exogenous.

Lowry (2001b) turns to an estimation of the level of enrollment as a function of political factors.[2] His data set includes all 4 year institutions of higher learning in the United States, and the focus is on the effects of the state regulatory structure. Discussion includes mention of administrator, faculty, and student behavior, and there is a model of decisions by a multiproduct firm, but the analysis treats the university as a unitary actor. In his enrollment equation, the (natural logarithm of) tuition and fees is statistically significant and positive, though the equation is a reduced form as it includes the number of high school graduates in the state and information on SAT and ACT scores of entering freshmen, each of which is reasonably thought to be a determinant of demand for enrollment.[3]

In the following section we extend the Niskanen-style bureaucratic supply model of the enrollment decisions of universities developed by Coates and Humphreys (2001) by introducing a political constraint. We suggest how this constraint may influence and alter the comparative static implications of the Coates and Humphreys model. In section 3 we describe the empirical approach to testing the theoretical implications, and in section 3.1 we describe our sample.[4] Section 3.2 reports and discusses our basic results and section 3.3 reports results from the extension of the model to include the regulatory and political environment. Conclusions are provided in section 4.

2 Modeling Enrollment Supply

Colleges and universities are generally not-for-profit organizations. In this section we develop a model of the behavior of a decision maker at an institution of higher education who seeks to maximize his or her own utility subject to revenues from the operation of the college being at least as large as costs. The decisions that would result if the institution operated as a profit maximizer serve as a useful

[2] His analysis also includes estimation of equations explaining small class sizes, graduation rates, and separately budgeted research expenditures.

[3] The test score, tuition and fees, and state appropriations variables may also be endogenous.

[4] Appendix A provides details on variable construction.

benchmark against which the predictions of our model can be compared.[5] Coates and Humphreys (2001) made this comparison and found that under the usual assumptions about utility functions, the bureaucratic model leads to both greater enrollment supply and greater faculty demand than would be indicated by profit maximization.

Garvin's (1980) and James' (1990) model of university behavior are similar to ours. In both models, however, the university is, implicitly, an organic entity with preferences of its own. Our model differs from theirs because we assume that it is the campus president or provost whose preferences matter for determining the direction of the school and its resource allocations. We extend the analysis in Coates and Humphreys (2001) by introducing political and regulatory constraints on administrative decisions. Lowry (2001c) has addressed a similar issue by examining the levels of tuition and fees net of financial aid for influences of the governmental structure and the means of selection of trustees for the institutions. His model does not focus on the decisions of the university administrators, though he does argue that the choices made by governing boards may reflect the desires of administrators and faculty who are the trustees' sources for important information.

In our analysis, the individual university administrator, who can be thought of as a president or provost, has a utility function which depends upon the level of enrollment, the number and quality of faculty, the quality of the library and laboratory facilities, the success of the university athletic teams, the success of the university's graduates, and his or her own income.[6] The administrator's

[5] One could question the use of profit maximizing behavior as a benchmark on the grounds that there is no presumption that profit maximization leads to efficient allocation of resources. Coates and Humphreys (2001) addressed this issue by examining the case where institutions are price setters rather than price takers in the enrollment supply decision. Their analysis suggested that control of universities by utility maximizing bureaucrats could be beneficial compared to the case of prices setting profit maximizers precisely because the bureaucrats would offer larger supplies of enrollments than would the for profit institutions.

[6] Alternatively, one could hypothesize that the university administrator's utility depends upon the number of graduates, which is an increasing function of the number of enrollees. While making the comparative static expressions messier, this alternative approach does not materially affect the implications.

utility function exhibits the usual curvature, except that we will assume it is separable in income, and is expressed as

$$U = \mu(E, F, L, S; I) = \phi(E, F, L, S) + f(I). \tag{1}$$

We have assumed separability in income for two reasons. First, the administrator's income (I) is not discretionary to the administrator, but is exogenously determined by an outside body. Second, for the empirical work that follows we do not have access to income information for specific presidents and provosts. Our assumption of separability means that the level of an administrator's income has no impact on his or her choices of enrollment, faculty, or facilities.

In our model administrators maximize utility by selecting the enrollment (E), the quantity and quality of the faculty (F), and the quality of the library and the laboratories (L) of the university. By assumption, the administrators do not select the tuition, fees and state appropriation that constitute the "price" a student must pay to be enrolled. Rather, after the legislature sets tuition, etc., for each institution, administrators offer enrollment. The enrollment figures for an institution reflect the quantity demanded for education by that campus at the going tuition and fees as well as the administrator's desired mix of faculty, facilities, and students.

The success of the graduates (S) of an institution is a function of the quality and quantity of faculty and laboratories and library materials.[7] For simplicity, S is dropped and its effects on utility

[7] Garvin distinguished the prestige of the university and the prestige of departments within the university. He stated that "the university will respond to the change in price by increasing the prestige of that department" in response to an outside source increasing the level of research funding in a particular area. But the university is incapable of changing a department's prestige. All the university can do is allocate more faculty to that department and offer higher salaries to faculty in that area to attract better researchers. If the university is successful, then the prestige of the department will rise, but this is a long term process. Moreover, the prestige of an institution or one of its departments is not solely a function of the research performed there. Teaching activities and the uniqueness and success of academic programs are also sources

are captured via F and L. Choices of enrollment, faculty and labs are also constrained. In particular, the institutions cannot run a (current account) budget deficit, constraining spending by the level of support via tuition and fees and state assistance, and other outside funding from sources like the federal government and grant making institutions. The tuition and fees (TF) and at least some state assistance (SA) are each collected by the institution on a per enrollee basis. $(SA + TF)E$ is one source of funding. G represents the non-enrollment dependent funds the university receives from the state. Outside funding (OF) is a function of enrollment, the quantity and quality of faculty, and the quality of the laboratories and other facilities, $OF(E, F, L)$. The first partial derivatives of the outside funding function are assumed to be positive.

The costs incurred by the university or college depend upon the salaries paid to faculty and staff (W_f), the quantity and quality of faculty (F), the number of students (E), and the laboratories and libraries (L). The university's costs are $C(W_f, F, E, L)$ with each of the first partial derivatives positive. The nature of the cost function is, however, highly complex. For public institutions, Cohn, Rhine and Santos (1989) found economies of scale with respect to research and graduate teaching at any size public institution. However, they found economies of scale with respect to undergraduate teaching at any of these institutions below the average size but diseconomies of scale at institutions at or above average size. Additionally, Cohn, Rhine and Santos found ray diseconomies of scale starting about the average size.[8] In other words, whether marginal costs of undergraduate enrollment are rising or falling seems to depend upon the size of the institution. However, for stability no marginal costs can be decreasing too fast. Consequently, in the analysis below we implicitly assume that if

of prestige for the campus. Whatever the source of the prestige, it is clear that the university cannot increase its own prestige or that of individual departments quickly or unilaterally.

[8] A ray economy of scale is based on increasing all outputs by a given proportion rather than only a single output by that proportion. Formally, ray economies of scale are based on the ratio of the total cost of a vector of outputs to the sum of the output-weighted marginal costs of the individual outputs. If this ratio is greater than 1 then ray economies of scale exist; if it is less than one, ray diseconomies of scale exist.

marginal costs are falling with respect to enrollment, faculty or facilities, they are doing so more slowly than marginal revenues from those variables.

Finally, the university administration faces a political constraint. One might think of the constraint as representing the goodwill the university administrator has built up with the state authorities. Alternatively, the constraint may reflect legal and policy requirements imposed on the institution. For our purposes, we will assume that the constraint embodies both of these. This constraint will be written implicitly as $PC(E, F, L; R, ID)$, where R indicates the regulatory environment and ID the political ideology or policy proclivities of the higher education regulatory establishment. Both R and ID can be thought of as vectors of variables which together capture the relevant regulatory and political influences. We will have more to say about these vectors when we discuss the data below. The signs of the partial derivatives of this political constraint are ambiguous.

The university administrator then maximizes

$$\begin{aligned} \phi(E, F, L, S) + \lambda((SA + TF)E + G \\ + OF(E, F, L) - C(W_f, F, E, L)) + \gamma PC(E, F, L; R, ID) \end{aligned} \tag{2}$$

through the choice of E, F, L, λ and γ. The first-order-conditions for this problem are:

$$\phi_E + \lambda[(SA + TF) + OF_E - C_E] + \gamma PC_E = 0 \tag{3}$$

$$\phi_f + \lambda[OF_f - C_f] + \gamma PC_f = 0 \tag{4}$$

$$\phi_l + \lambda[OF_l - C_l] + \gamma PC_l = 0 \tag{5}$$

$$(SA + TF)E + G + OF(E, F, L) - C(W_f, F, E, L) \geq 0 \tag{6}$$

$$\lambda \geq 0 \tag{7}$$

$$\lambda((SA + TF)E + G + OF(E, F, L) - C(W_f, F, E, L)) = 0 \tag{8}$$

$$\gamma \geq 0 \tag{9}$$

$$\gamma PC(E, F, L; R, ID) = 0 \tag{10}$$

The bracketed term in the first three of the first-order-conditions can be interpreted as the net marginal revenue to the university from increasing each of the three choice variables. If the university behaved as a profit maximizer, then these bracketed terms would each equal zero. Coates and Humphreys derived similar conditions, except that the γPC_i term was not present. They argued that the difference between the first order conditions of the profit maximizing institution and the utility maximizing bureaucrat implied excessive enrollment, faculty employment and laboratory facilities by institutions relative to what the profit maximizing firms would choose.

The effect of adding the political constraint is ambiguous. In the event that the $\gamma PC_i = -\phi_i$, the political constraint acts to ameliorate the influence of utility maximization so that even with Niskanen style bureaucrats the enrollments, employment and facilities of the institution are the same as would be found under profit maximization. This is, of course, in part what regulation and oversight by the state government and higher education regulatory agencies should hope to accomplish as it suggests efficient use of resources. Lowry (2001b) states that several of the 21 states that had multiple governing boards also created a statewide coordinating board "for the purpose of planning the 'rational' development of state public university systems and ensuring that individual campuses adhered to their declared missions." Indeed, one object of the Maryland Higher Education Commission (MHEC), about which more will be said below, is to ensure that the colleges and universities in Maryland do not waste resources through duplication of programs.

It is also possible that γPC_i and ϕ_i are of opposite signs but not of equal size. In this case, regulation reduces enrollments, etc., relative to what the unconstrained bureaucrat would select. However, without further information it is not possible to determine theoretically whether this reduction still results in enrollments, faculty employment, and facilities that are too large, compared to the profit maximizing levels, or whether the regulations lead to levels of these variables that are below those chosen under profit maximization.

If γPC_i is positive, then the regulatory environment and political constraints push the university to expand beyond the profit maximizing levels of enrollment, faculty employment and facilities even more than it would under unconstrained utility maximization. James (1990) and Lowry (2001b) each suggest that public officials support expanded enrollments, for example. The intuition is that enrollments are a public service the greater availability of which pays off in terms of political support for those politicians who work toward its provision. Consequently, James and Lowry would predict that introduction of the political constraints will lead to increased enrollment supply. James does not estimate an enrollment supply function; Lowry discusses his model as one of supply but the inclusion of demand side variables, like high school graduates and SAT scores, suggest his equation is a reduced form. Nonetheless, Lowry (2001b) finds that tuition and fees are lower in states where there is greater political control of the universities and where trustees are selected by nonacademic stakeholders. In equilibrium, an increased supply would induce lower tuition and fees, and would result in a greater quantity of enrollments.

Solving the first-order-conditions, one obtains the university administrator's supply of enrollments and demands for faculty and facilities. For the university administrator, enrollments are a good to be offered for sale. As in Coates and Humphreys (2001), these supply and demand functions depend upon the utility function of the administrator. That is, the institutional responses to higher tuition and fees will vary by administrative regime. But the presence of the political constraint means that these functions also will depend upon the political and regulatory environment variables R and ID. Consequently, if the current model is correct, then Coates and Humphreys' empirical work is misspecified, and their estimates may be biased in unknown ways. Their conclusion that university presidents and provosts act like Niskanen's utility maximizing bureaucrats may be in error. Moreover, the estimated elasticity of supply of enrollments may be biased.

3 Empirical Analysis

The structural model developed in the previous section cannot be directly estimated without making assumptions about specific functional forms. These assumptions would likely lead to mis-specification bias in the empirical estimation. Like Coates and Humphreys (2001), we estimate the linearized forms of the supply and demand functions implied by the model. Although we cannot explicitly test the restrictions on the structural parameters implied by the model using this framework, we can specify and estimate complete demand and supply functions.[9]

A university is an organization that uses multiple inputs like libraries, classrooms, computers, textbooks, and a wide variety of other factors to produce multiple outputs like scholarly research, educated students, etc. The first-order conditions from the model developed above could be manipulated to show an inter-related set of demand functions for inputs and supply functions for outputs. These supply functions would take a general form

$$Y_{it} = f(\Phi_{it}, W_{it}, \Gamma_{s,it}) \tag{11}$$

where Y_{it} is a vector of outputs for institution i in period t, Φ_{it} is a vector of prices for the outputs produced by institution i in period t, W_{it} is a vector of input prices for institution i in period t and $\Gamma_{s,it}$ is a vector of other factors that shift supply at institution i in period t. The demand functions take a general form

$$X_{it} = g(W_{it}, \Phi_{it}, \Gamma_{d,it}) \tag{12}$$

where X_{it} is a vector of inputs for institution i in period t, Φ_{it}, W_{it} are vectors of output and input prices defined above and $\Gamma_{d,it}$ is a vector of other factors that shift demand at institution i in period t.

We focus on an enrollment supply function which relates the enrollment decisions made by a utility-maximizing college or university administrator to the price paid by each student who enrolls at an institution, as well as to other input prices and state government appropriations, and a faculty demand function which relates decisions about the number of faculty at an institution to these factors. The specific enrollment supply function estimated is

[9] Freeman (1975) formulated and estimated a similar model, although the focus of that analysis was the faculty labor market.

$$E_{it} = \beta_{i,s} + \alpha_{1,s}TF_{it} + \alpha_{2,s}G_{it} + \gamma_{1,s}W_{op,it} + \gamma_{2,s}W_{ser,it} + \gamma_{3,s}W_{fac,it} + \eta_{s,it} \quad (13)$$

and the empirical faculty demand function estimated is

$$F_{it} = \beta_{i,d} + \alpha_{1,d}TF_{it} + \alpha_{2,d}G_{it} + \gamma_{1,d}W_{op,it} + \gamma_{2,d}W_{ser,it} + \gamma_{3,d}W_{fac,it} + \eta_{d,it}. \quad (14)$$

The interpretation of each function is straightforward.[10] Enrollment supply E_{it} is a function of its own price, TF_{it}, other input prices, and the government subsidy to each institution, G_{it}. Higher TF_{it} and G_{it} should each raise enrollment supply. The behavioral model predicts that higher input prices should reduce the supply of enrollments, other things equal.[11] Consequently, in the enrollment supply equation we expect that $W_{fac,it}$, and $W_{op,it}$ will have negative signs, as they are effectively prices . $W_{ser,it}$, on the other hand, is the total cost of student services such as student health services, dining facilities, and dormitories. We expect this to be positively associated with enrollments. The idea is that provision of these services is largely a fixed cost. Consequently, more enrollment means that these fixed costs are spread over a larger number of tuition paying students. The institution will, other things constant, offer larger enrollments given its fixed costs to provide these student services.

Faculty demand F_{it} is expressed as a function of its own price, $W_{fac,it}$, other input prices, $W_{op,it}$ and $W_{ser,it}$, the price of output, TF_{it}, and the government subsidy to each institution, G_{it}. The faculty salary, as the price of another faculty member, is expected to have an inverse relationship

[10] Although the demand for labs and libraries was discussed in the context of the behavioral model developed in section 2 above, we chose to omit this input from the empirical analysis. This decision was made primarily because of the poor quality of the physical plant data in the IPEDS data; only book value data are available for buildings, labs, and other real property.

[11] Although the behavioral model contains a term for government appropriation per enrollee (SA) and a term for lump-sum government appropriation (G), the empirical models do not, because data on lump sum appropriations are available in the IPEDS data but the per student, or formula funding amount, is not.

with quantity demanded of faculty. The lump sum grant G_{it} works through an income-type effect, so increased government appropriation to an institution should increase demand for faculty at that institution, other things equal. Tuition and fees are, in some but not all respects, the price of the product the faculty sells. Consequently, we expect that higher tuition and fees TF_{it} will result in higher demand for faculty.

Expectations for the signs of $W_{op,it}$ and $W_{ser,it}$ are not so clear. One might argue that these are costs of other inputs into the production of education, and that faculty is another such input. Consequently, one might expect a positive sign if faculty and these inputs can be substituted for one another in the education process. However, it is possible that faculty and these other inputs are complements in the production of education. In this case the signs on the input price variables would be negative.[12] For the operating cost variable, we have no clear sign expectation. The cost of student services we expect to be positively associated with faculty demand. As for the enrollment supply equation, we think of the student services as a fixed cost. Given this fixed cost, the university president will demand more faculty to raise grant money, overhead charges from which can allay some of this fixed cost, and attract more students.

We control for the effects of unobservable institution-specific factors on the supply and demand function by allowing the constant terms in each equation ($\beta_{i,s}$ and $\beta_{i,d}$) to vary. Three types of institution-specific effects are considered. The first is simply a separate intercept for each institution. These institution-specific effects proxy for unobserved factors related to differences in the missions

[12] This may carry the production analogy too far given our utility maximizing bureaucrat approach. The university president or provost derives utility from enrollment and faculty in our model. The administrator is not assumed to derive utility from operating expenditures and student services. These latter two inputs into education are, therefore, different from faculty in an important way. Because neither of these inputs is a direct cost of hiring faculty, and because they are only very tenuously linked to the hiring of an additional faculty member, our expectation is that neither of these variables will have a significant impact on faculty demand.

of each institution, location, general composition of the student body, academic reputation, and other factors that are unique to each campus but do not change over the sample period. Statistical significance of these institution-specific effects is evidence against the competitive markets model of university behavior.

The behavioral model implies that preferences of utility-maximizing administrators and other politicians and regulators effect enrollment supply, faculty demand, and other institutional outputs and inputs. To account for these effects we constructed a series of dummy variables capturing the tenure of different presidents, politicians, and other regulators on each institution. This "presidential effects" specification is nested in the institution-specific effects specification mentioned above under the assumption that each president on a given campus had the same effect on enrollment supply and faculty demand, or alternatively under the assumption that presidents have identical preferences. Of course, if an institution has the same president for every year in our sample, it is impossible to distinguish presidential effects from institution specific effects.

As an alternative to the presidential effects specification, we also explored the idea that provosts have more influence on enrollment supply and faculty demand than presidents. It may be possible that university presidents are primarily concerned with lobbying state legislators and higher education regulators, and with off-campus fundraising efforts, and are less involved than provosts in short-term decision making on campus. If this is the case, then the tenure of provosts, the chief academic officers, may do a better job of explaining variation in enrollment supply and faculty demand. The "provost effects" specification is also nested in the institution-specific effects specification under the assumption that all of the provost effects on each campus are equal over time.

The key implication of our model is that either the president or the provost specific effects will be statistically significant in tests against either the institution-specific effects or the common intercept models. Recall that a lack of significant institutional or administrator effects reflects perfectly competitive markets; significant institution-specific effects reflect oligopolistic or monopolistically competitive markets in which institutions compete on brand name; significant administrator-specific effects reflect a bureaucratic model where administrator's preferences affect enrollments and faculty demand at institutions.

An important econometric problem may arise with the administrator-specific dummy variables.[13] If a new president or provost is selected for her skill at, or impressive plans for, managing growth of an institution that the university system plans to expand anyway or that is growing for other reasons, then what appears to be an administrator effect on enrollment or faculty is an upwardly biased estimate of that individual's true impact. Said differently, unobserved or unobservable influences on the selection of the new administrator are correlated with unobserved or unobservable influences on enrollments or faculty. This correlation between the equation error and the explanatory variable, of course, biases the estimated effects of the regressor.

We don't believe this is a problem and, if it is, there is little we can do about it. First, if the problem exists, then we have as many regressors correlated with the equation error as there are president (43) or provost (65) dummies. To consistently estimate the model would require 43, or 65, separate variables that are correlated with the selection of the individual presidents or provosts but not also correlated with enrollment or faculty size. This data requirement is staggering.

Second, the correlation, if it exists, exists only for the subset of observations when a president or provost change occurs. In any year of an administrator's tenure except the first, the administrator in office is a predetermined variable. As such, it is not random or determined contemporaneously with the equation error, so the correlation between the provost variable and the error is zero. This would be the case for the vast majority of the observations unless one argues that presidents and provosts serve under one year contracts. The large search costs involved in hiring presidents and provosts make this possibility highly unlikely. However, even when it is the first year in office for a president or provost it is sometimes the case that the individual takes the job in an interim capacity in response to the sudden departure of her predecessor. In these instances, correlation between the equation error and the administrator variable also seems unlikely. Given that the number of cases

[13] We thank Amihai Glazer for raising this issue.

in which correlation in the error and the administrator variables may occur is small relative to the total number of observations, we believe the bias imparted by these cases also to be small.

We also confront a simultaneity problem in estimating the system of equations (13) and (14) because the enrollment price variable is an *ex post* average price and depends on enrollment. Consequently, OLS estimates of the response of enrollment supply and faculty demand to changes in TF will be biased. To correct for this problem, we use three-stage least squares to estimate the system of equations [see Greene (1997) for complete details]. The instruments used in the first stage regressions are the W's and G, and variables that reflect shifts in the demand for enrollment.[14] Letting s index the two states in the sample, these demand shifters include a time trend, or institution specific time trends, the number of high school graduates in Maryland and Virginia in year t ($HSGRAD_{s,t}$), the average tuition and fees at community colleges in Maryland and Virginia in year t ($RATFCC_{s,t}$), the average tuition and fees at four year state institutions of bordering states in year t ($RATFOSP_{s,t}$), and the average tuition and fees of four year private institutions in the college's own state in year t ($RATFPR4_{s,t}$).

A word needs to be said about the time trends which, we contend, are demand shifters rather than arguments in the university supply equation. These trends arise, perhaps, from college age population growth, increased awareness of the institution or of some special program it offers, a string of athletic successes, or more aggressive marketing. We exclude the trends from the enrollment supply and faculty demand equations but use them as instruments to identify the parameter on tuition and fees. We have estimated the models including the time trends as regressors in the enrollment and faculty demand equations. Doing so causes the estimated coefficient on tuition and fees in the enrollment supply equation to flip signs and become insignificant. This consequence of using the time

[14] We assume that institutions are price takers in labor markets, implying that the faculty salary variable should be treated as exogenous. Lowry (2001a) finds that governmental grants and tuition and fees are negatively associated, suggesting that G should also be treated as endogenous in our analysis. However, doing so has no effect on our results so in what follows we treat G as exogenous.

trends in the enrollment equation supports our contention that they are demand shifters instead of determinants of supply.

We also estimated an enrollment demand equation in which the time trends are demand shifters. The tuition and fees variables, at the campus of interest, in community colleges, in border states, and in private four year colleges within state, are all treated as endogenous with the faculty salary, operating and student services variables as well as the provost dummies used as instruments. Estimation of this demand equation produces quite plausible results which are available upon request. The tuition and fees at the institution are negative and statistically significant determinants of enrollment demand for that institution, greater governmental lump sum support raises demand at the institution, tuition and fees at other institutions are not statistically significant, and the institution specific time trends are almost entirely positive and statistically significant at any conventional level. Consequently, we feel confident concluding that these trends reflect growing demand for enrollments at a given institution not trends in the enrollments offered by institutions.

3.1 Data Description

Our empirical analysis focuses on public four-year colleges and universities in Maryland and Virginia. Both states have extensive systems of public institutions of higher education. Each state also has different approaches to the oversight and regulation of higher education. There are 26 public institutions of higher education included in this study which among them had 43 separate presidents and 65 different provosts. Ten institutions had the same president in every year of the sample, but only five institutions had the same provost in each year. Table 1 identifies the institutions, their Carnegie classications, and in which state they are found.

Notice that these institutions are spread across most of the Carnegie classifications. There are four Research I (R1) universities, two Doctoral I (D1) and II (D2) universities, eleven Master's I (M1) and two Master's II (M2) institutions, and two Baccalauerate I (B1) and II (B2) institutions. Research II is the only Carnegie classification not represented in the sample.

The variables in the analysis are defined in Table 2. Detailed information about the sources and construction of these variables can be found in the data appendix.

Table 3 shows the means of the key variables that appear in the system of equations, enrollment, tuition and fees, state government appropriation in 1,000's of dollars, and average faculty salary in real 1996 dollars for each of the 26 institutions in the sample from 1988 to 1996. W_{op} is expenditure on maintenance and operation of plant and equipment relative to the book value of buildings and equipment. W_{sup} is expenditure on auxiliary enterprises, which are defined as operations that furnish some service to students, faculty, and staff. Considerable variation exists across the institutions in the sample for all of these variables.

In 1988 the Maryland legislature formed the University of Maryland System, which was renamed the University System of Maryland in 1997. The USM is a collection of public institutions of higher education charged by the Maryland legislature with the goals of fostering the development of a consolidated university system, improving the quality of higher education, extending the benefits of higher education to all Marylanders and encouraging the economical use of the State's resources. Oversight of higher education in the state of Maryland is complicated and duplicative. Schools in the USM are overseen by the Maryland Board of Regents and by the Maryland Higher Education Commission (MHEC). The latter organization regulates all higher education in Maryland whether that education is academic or vocational. USM can be viewed as a consortium of public institutions of higher education pursuing a common set of goals and increasing mutual benefits. The USM collectively represents the member institutions before the Maryland legislature; individual institutions cannot directly lobby the state legislature for funding. In practice, this restriction on direct lobbying is not well-enforced, as UMCP was able to obtain direct funding from the state legislature in fiscal year 1997.

The member institutions in the USM represent a diverse collection of institutions of higher education. Among the eleven institutions in the sample are four historically black institutions (Coppin State, Bowie State, the University of Maryland Eastern Shore and Morgan State University), an institution that enrolls only juniors, seniors and graduate students, the University of Baltimore, and a comprehensive land-grant university, UM College Park. With the exception of Frostburg State University, these institutions are located in a relatively small geographic region with a high population density.

Nine USM member institutions are included in this data; the excluded USM institutions are the University of Maryland Biotechnology Institute, and the University of Maryland Center for Environmental Science, which are primarily research institutes, the University of Maryland at Baltimore, a free-standing graduate and professional school consisting of a medical school, a dental school and a law school, and the University of Maryland University College, an institution with nearly 10,000 part-time students and about 20 fulltime faculty that focuses primarily on continuing and distance education. At the time the USM was founded, two other public institutions of higher education, Morgan State University and St. Mary's College of Maryland, declined to join the USM. These two institutions still receive state support, although they are governed by separate boards of regents and lobby the state legislature for funding separately. Because they are public institutions of higher education in Maryland we have included these two schools in our sample.

The State Council of Higher Education for Virginia (SCHEV) regulates all public higher education in Virginia. The SCHEV was established in 1956. The mission of the SCHEV is "to promote development of an educationally and economically sound, vigorous, progressive, and coordinated system of higher education." The SCHEV makes higher education public policy recommendations to the Governor and General Assembly in areas like capital and operating budget planning, enrollment projections, institutional technology needs, and student financial aid and administers other educational programs.

The SCHEV is composed of 11 members who are appointed by the Governor for four-year terms. The Executive Director of SCHEV, who is appointed by the Council, manages the day-to-day operations of the state agency and its 44-member professional staff.

All fifteen public institutions of higher education in Virginia are included in our data. Like the institutions in Maryland, the four-year public institutions of higher education in Virginia are a diverse collection of schools. Among the public institutions of higher education in Virginia are three Research 1 institutions in the Carnegie classification system (the University of Virginia, Virginia Commonwealth and Virginia Tech), two Historically Black College and Universities (Norfolk State and Virginia State), a military academy (Virginia Military Institute) and a women's college (Mary Washington). These institutions are in diverse geographical areas that range from the Washington D.C suburbs to rural south western Virginia.

The political and regulatory environment faced by the colleges and universities in Maryland and Virginia during our sample is reflected in several variables. We will say more about this in section 3.3 below, but Table 4 provides a rough idea about the distinct political and regulatory administrations for each state in the sample. There is a noteworthy degree of similarity between the two systems. Volkwein and Malik (1997) rank Maryland 46th and Virginia 50th on their autonomy scale. In other words, colleges and universities in each state are, compared to institutions in other states, relatively constrained in their abilities to make independent decisions. In this regard, finding that presidents and provosts have independent effects on enrollment and faculty employment decisions in these two highly constrained situations suggests strong support for the bureaucratic model of universities.

3.2 Results and Discussion

Table 5 shows the results of estimating equations (13) and (14) using three-stage least squares. The top panel uses Full Time Equivalent (FTE) enrollment as the dependent variable (E) in the supply equation and the bottom panel uses total headcount enrollment as the dependent variable in the supply equation. FTE enrollment counts three part-time students as the equivalent of one full-time student. It is clear from the table that the results do not differ between headcount and FTE enrollment. The first two columns show the results for the institution-specific effects specification, the second two columns show the results for the provost-specific effects specification, and the final two columns show the results from the president-specific effects specification. The estimates of the various intercepts are discussed separately below.[15]

The first question we address is whether the institutions exhibit individuality in their enrollment and faculty demand behavior, as captured by institution-specific effects. The first two columns in the upper panel of Table 6 report the F-statistic, the P-valve and the degrees of freedom in the numerator and denominator, for the test of institution specific effects against a common intercept. Likewise, the third and fourth columns test for provost effects versus a common intercept, and the fifth and sixth test for president specific effects against a common intercept. In each case, the common intercept is rejected at any usual level of statistical significance.

The bottom panel of Table 6 reports the F-statistics, P-valve and degrees of freedom for president and provost specific effects against the institution specific effects model when the dependent variable is FTE enrollment. These tests reject the institution specific effects in favor of the provost effects in enrollment supply and in favor of president effects in faculty demand. Provost effects are not supported in faculty demand and president effects are not supported in enrollment supply. These results are different from those found by Coates and Humphreys (2001) where provost specific effects were significant, relative to institution specific effects, in both the enrollment supply and faculty demand equations, but president specific effects were not significant in either.

Note that regardless of the specification, the effect of an increase in the tuition and fees is to increase the quantity of enrollments supplied. In other words, the enrollment supply function is upward sloping at the public institutions of higher education in Maryland and Virginia. This is consistent with Coates and Humphreys (2001), which used only Maryland data. In addition, an increase in faculty salaries leads to a reduced quantity demanded of faculty in all specification but one. This downward sloping demand for faculty is also consistent with results in Coates and Humphreys (2001). Lump sum financing from the state government also has a positive and statistically significant effect

[15] We do not report the results from the "no fixed effects" specification; these results are available on request.

on both enrollment supply and faculty demand. Enrollment and faculty are, in other words, normal goods to the university, its president, and its provost.

Table 7 reports the price elasticity of enrollment supply, the elasticity of enrollment supply with respect to lump sum state support, the elasticity of faculty demand with respect to faculty salaries, and the lump sum support elasticity of faculty demand for each institution in our sample. These elasticities are evaluated, using estimated coefficients from the president-specific effects model at the institution specific means for the relevant variables. To get the elasticities for the provost specific effects model simply multiply the enrollment supply elasticity for tuition by 1.86, the ratio of the coefficient from the provost model to that from the president model, and multiply the elasticity of faculty demand with respect to salary by 3, the ratio of the coefficient from the provost effects model and the coefficient from the president effects model. Similarly, multiply the reported elasticities for lump sum funding in Table 7 by 1.12 for the faculty demand equations.[16]

Consider the elasticity of enrollment supply with respect to tuition and fees. The evidence is that enrollment supply is highly inelastic for most institutions.[17] Only Virginia Military Institute has an estimated elasticity over 1, and only two other institutions (Clinch Valley and St. Mary's College) have elasticities above .5. Generally speaking, the stronger the research emphasis of the institution the smaller the supply price elasticity. For example, the highest elasticity among the four Research I institutions is 0.12 whereas for the four institutions with either a Bachelor's I or II classification the smallest elasticity value is 0.25. And for these latter institutions the other values are 0.67, 0.94, and 1.55. For institutions in the other classifications, the pattern of low elasticities associated with greater research intensivity in generally born out; Towson, Radford, James Madison, Norfolk State, and William and Mary are institutions not completely consistent with the general relationship.

[16] Conversion is possible for the enrollment supply as well, but the coefficient on G in the provost equation has the wrong sign and is not statistically significant.

[17] This conclusion holds for the provost specific effects estimates as well.

This relationship is, perhaps, even more strongly evident in the faculty demand elasticities. For the Research I institutions, except those that have medical schools (UVA and Virginia Commonwealth), these elasticities are much nearer to zero than those for the other classifications. These values indicate a demand for faculty that is very insensitive to faculty salaries. As the teaching emphasis of the institution increases, the elasticity of the demand for faculty rises. For example, at the four Bachelor's I and II institutions, the lowest elasticity is 0.51, higher than that at all but three of the other 22 institutions two of which are historically black and the third of which enrolls students only as juniors or higher.

The intuition of this increase in elasticity with increased teaching emphasis is straightforward. The faculty variable includes only tenure and tenure track faculty. There are few if any individuals who are available to work at universities as part time or non-tenure track researchers. Since there are few substitutes for tenured and tenure track researchers, demand for such faculty is highly inelastic. On the other hand, there are numerous substitutes for tenured and tenure track teaching faculty. These include graduate students, practitioners, retired faculty, and so on. Since there are numerous substitutes available for tenured and tenure-track teaching faculty, demand for tenure track teachers is highly sensitive to the price of such teachers. A fall in the faculty salary of tenured and tenure-track faculty induces substitution in favor of these individuals and away from part- timers, graduate students, practitioners, and so on.

Based on the president-specific effects equation, demand for faculty is quite inelastic, with most elasticities way below 0.50. However, based on the provost specific effects equation this conclusion does not stand. Since the coefficient on the faculty salary variable is three times larger in the provost equation than in the president equation, the elasticities on faculty demand from the provost equation are three times larger than those reported in Table 7. In other words, in the provost specific effects model, demand for faculty is highly elastic, at least at many of the schools with greater emphasis on teaching.

A 1% increase in lump sum funding generates less than a one-tenth percent increase in enrollment at most institutions, but an increase in faculty demand of 2% or more. Interestingly, the effect of the lump sum grant in enrollment is stronger, on average, for the Research I institutions than for other institutions. The range of these elasticities is from 0.05 to 0.13. It is also true that the elasticity of demand for faculty with respect to lump sum funding is greater, on average, the higher the research intensity of the institution. The range on these elasticities is from 1.21 to 3.18. However, the Historically Black Colleges and Universities (HBU) in Maryland also fall on the high end of this elasticity.

This seems an odd result. It may be explained, however, by two different phenomena. For the research institutions, increases in state lump funding that go into hiring faculty may be leveraging greater resources from outside granting agencies. For the HBU this large elasticity may be the result of relative under funding of these institutions over time. For example, if the HBU have traditionally hired relatively more part-time faculty or had relatively more students per class or relatively fewer course offerings than other institutions, then an increase in state support may be used to address these deficiencies. And if the salaries paid to faculty at these institutions are relatively low, then a given dollar increase in lump sum funding can support a larger increase in the number of faculty than at an institution paying larger faculty salaries. Moreover, since the HBU tend to be rather small, the proportionate increase in their faculty is more from a single hire than would be the proportionate increase in faculty at a larger institution.

Finally, consider the estimated coefficients on $W_{op,it}$ and $W_{ser,it}$. In the supply equations, each has the expected sign, though neither is consistently statistically significant across specifications reported in Table 5. In the faculty demand equation, $W_{ser,it}$ is significant and positive in each of the six specifications; $W_{op,it}$ is never significant and its sign flips.

3.3 Political and Regulatory Effects

Unlike Coates and Humphreys (2001), this paper includes controls for the political and regulatory environment. The model in section 2 indicated that the political landscape acts as a constraint on the behavior of the institution, both in determining the faculty employment and the student enrollment. However, theory was unable to unambiguously predict whether the political and regulatory environment results in higher enrollments and more faculty, less of each, or more of one and less of the other. In this section we present evidence on this issue.

As Table 4 indicates, Maryland had two and Virginia three governors during our sample period. In Maryland, there were four chairs of the Board of Regents and 2 Chancellors of the USM; Virginia had one Executive Director of the State Council of Higher Education for Virginia (SCHEV) and 6 Chairs of that body. To address the political and regulatory environment we create dummy variables indicating years when person i held position j. If each of these variables were included in the regression, then nothing would be estimable due to perfect multicollinearity. We estimate several different specifications of the regulatory environment to work around the collinearity problems.

First, we estimate specifications including all but one governor from each state. We do this for both the president and provost fixed effects models. The top panel of Table 8 shows the F-statistic, P-valve and degrees of freedom for testing the exclusion of the governor variables from the model. The clear implication is that the governor variables belong in the enrollment supply equation with the president specific effects, but do not belong in the provost specific effects equation or the faculty demand equations. We discuss these results below.

The second set of specifications introduces dummy variables for the higher education regulatory agencies. Virginia has only one such agency, but Maryland has two, MHEC and the Board of Regents. Inclusion of both Maryland regulatory groups in the equations results in collinearity problems, so we estimate the model twice, once with each type of Maryland regulator. The second and third panels of Table 8 report the F-statistics, P-values, and degrees of freedom for tests of the null hypothesis that these regulatory variables all have coefficients of zero. As is readily apparent, the null hypothesis can be rejected for the enrollment supply equations with the president specific effects, but cannot be rejected for the faculty demand equations.

Interestingly, one can reject, at the 10% level, the null hypothesis of no effects of the regulatory environment in a model with provost specific effects when the leadership of the Board of Regents characterizes that environment in Maryland. This is consistent with intuition because the Board of Regents has more direct oversight over the institutions in the sample than does MHEC, whose role includes developing state policy on all education beyond the secondary level. For example, MHEC assures that institutions in the state do not produce unnecessary duplication of programs, and regulates barber and cosmetology schools, programs that the University System of Maryland institutions have, to our knowledge, avoided adding to their curriculums so far.

The implication from these F-tests is that the political and regulatory environment explains variation in the enrollment supply of colleges and universities that president specific effects miss. The variation explained by regulatory effects is, however, already accounted for by provost specific effects, with the one exception noted above.[18] Since the provost specific effects model is favored over the president specific effects, and the political and regulatory effects are generally rejected in the provost effects model, this suggests that whatever effect the regulator variables capture is largely a proxy for the effects of the provosts.[19]

Consider now the actual estimated effects of the regulatory environment in the provost effects equation. Recall that for Maryland there are two governing bodies, MHEC and the Board of Regents,

[18] This result that politics matters is consistent with the work of Hoenack and Pierro (1990) who explicitly modeled demand for enrollment by the politicians.

[19] One possibility is that the provost effects are actually just capturing institution-specific time trends. But if this is the case, we cannot distinguish it from the provost specific effects. Plots of enrollment against time reveal likely trends for many campuses, some upward, some downward, a few that are U-or inverted-U shaped, and some that have no apparent trend. Inclusion of a linear and a quadratic time trend in the model produces no effects on the other variable and the terms are themselves not statistically significant.

and they cannot both be included in the same regression because of collinearity problems. The regulatory coefficients in the enrollment supply equation with MHEC as the Maryland regulatory variable indicate that of the six Chairmen of the SCHEV, Virginia's higher education regulatory commission, the fourth and fifth presided over significantly lower enrollments than the others, and the third Chair of MHEC presided over significantly larger enrollments than the first and second. In other words, if the role of the state regulatory board is to push enrollments down from the excessive levels associated with the utility maximizing bureaucrat, then 2 of the six were successful in Virginia, while those in Maryland were ineffectual.[20] If, instead, the analysis uses the Board of Regents as the regulatory agency in Maryland, then one regulator in Maryland actually exacerbated the over enrollment problem. Changing the Maryland regulator has no effects on the estimates for Virginia.

Interestingly, that same political and regulatory environment has no effect on faculty demand in either the provost or president effects equations. As a faculty member, I appreciate the political environment not impinging on faculty employment. Universities and colleges are, according to this result, not subject to micro-management by politicians on the hiring side. As a taxpayer, on the other hand, the evidence that the regulatory variables do not affect faculty demand means that colleges and universities are able to hire more than the efficient (profit-maximizing) number of faculty, something that creation of regulatory boards seeks to avoid.

Consider the specific estimates from the provost effects equations. Regardless of whether the Maryland regulator is MHEC or the Board of Regents, the only significant regulator coefficient is for the second Chairman of the SCHEV. This coefficient is positive and equal to about 15.5, indicating that demand for faculty is higher at the Virginia colleges and universities by about 15 and a half tenured and tenure-track faculty under this individuals leadership than under the leadership of other SCHEV chairs.

[20] Of course, it is entirely possible that this downward pressure exerted by the regulators goes too far, producing sub-optimal supply in place of supra optimal enrollments. Whether this is what happens cannot be determined in the current context.

In the president effects equations, the second and third chair of SCHEV have significant and negative effects on faculty demand whether the model uses the MHEC or Board of Regents variables for Maryland. These effects are about 12 to 13 fewer faculty than under the other chairs. No Maryland regulator is individually statistically significant and neither are the regulators as a group under any specification.

4 Summing Up

Although the provision of higher education is an important function of state government, relatively little attention has been given to this subject by economists. In this paper we explore the influence that administrators, regulators, and elected officials have on the supply of enrollments in higher education. We develop a Niskanen-style model of bureaucratic behavior in which college or university administrators are treated as utility maximizing agents who choose the level of inputs and outputs of an institution subject to constraint. The effects of individual higher education policy makers are also included in this model. The model predicts that the preferences of individual administrators will affect enrollment supply and faculty demand at an institution.

We test the predictions of this model using a panel of data from 26 public colleges and universities in Maryland and Virginia over the period 1988 to 1996. The results are very similar to those reported by Coates and Humphreys (2001) using only data from Maryland, showing that these earlier results hold in an expanded setting and suggesting that they may hold generally in other settings.

The simultaneous estimation of the two equation system shows that individual presidents and provosts have a significant effect on the supply of enrollments and demand for faculty; these president- and provost-specific effects were statistically distinct from unobservable institution-specific effects. We also find that different regulatory regimes, measured by the heads of various regulatory agencies and the governor, generally have no effect on either enrollment supply or faculty demand. However, specific regulators do affect enrollment supply and faculty demand, but the estimated impact is about equally likely to be to raise as to reduce the quantities relative to those chosen by unconstrained Niskanen-style bureaucrats.

Although enrollment demand in higher education has received the lion's share of economists' attention, our results indicate that the supply side of this market is affected by the preferences of individual administrators and other higher education policy makers. Our results have important implications for the design and assessment of higher education policy. The preferences of individual administrators may not lead to a supply of enrollments identical to the socially optimal level. The same may be true of the preferences of state bureaucrats who regulate higher education. Those concerned with the issue of public higher education should bear in mind that factors other than the level of state appropriation to institutions of higher education can have important effects on enrollment at these institutions.

A Data Description

The data used in this paper were taken from the Integrated Postsecondary Education Data System (IPEDS) which is collected and published by the U.S. Department of Education; before 1986, this survey was called the Higher Education General Infor-mation Survey (HEGIS). The data used in this paper were taken from two of the six surveys that make up IPEDS: the Fall Enrollment Survey and the Finances Survey. Each of these surveys is conducted annually; all postsecondary institutions in the United States and outlying areas that are eligible for Title IV federal financial aid programs are surveyed. Enrollment and Finance data are available for academic year 1988-1989 through 1996-1997.

Fall enrollment is the most commonly used measure of access to higher education. The IPEDS fall enrollment data is based on reported enrollment for the first week of October in the fall semester or quarter. There are many possible measures of enrollment. In this paper, we use both total (or headcount) enrollment and FTE enrollment as measures of the number of students attending an institution of higher education. Using a broad measure of enrollment has several advantages over narrower measures like full-time undergraduate enrollment. Universities have different missions, and administrators have different goals. Full-time undergraduate enrollment would not reflect the impact of an administrator attempting to increase graduate enrollment or the impact of an administrator attempting to increase undergraduate offerings to working adults who enroll in one or two courses per semester. Broad measures of enrollment, like total headcount, should reflect a wide variety of changes in enrollment policies.

However, institutions with many part-time students will have large headcount enrollments and very different needs in terms of capital, faculty and other infrastructure than institutions with large numbers of 18-24 year old full-time students. In order to control for these differences, we estimate the empirical model using FTE enrollment as the dependent variable.

A considerable amount of institution-specific budget data are available in the IPEDS Finances Survey. We used data from the Finances Survey to construct the output price measure as well as measures of the costs of student services like dorms, dining halls, and intercollegiate athletics, the cost of operation and maintenance of buildings and equipment, and the state government appropriation variables which were used in this analysis. TF_{it}, our measure of the price of enrollments, is defined as total revenues from tuition and fees divided by total enrollment. Public universities price discriminate in many different ways. In-state students, out-of-state students, full-time students, part-time students, undergraduates, and graduate students are all charged different tuition. Differing need-based and merit-based financial aid packages further differentiate charges to students. Because of this, we chose to use an ex post measure of the price of enrollments. This variable will reflect the effect of differences in the composition of the student body on revenues earned by the university. G_{it} is revenue from state government appropriations. W_{op} is expenditure on maintenance and operation of plant and equipment relative to the book value of buildings and equipment. W_{sup} is expenditure on auxiliary enterprises, which are defined as operations that furnish some service to students, faculty, and staff. Examples of auxiliary enterprises are residence halls, food services, student health services, intercollegiate athletics and student unions. W_{fac} measures the average faculty salary. This variable was constructed by dividing the total salary outlay for all contract categories on each campus by the total number of faculty employed in each contract category.

All variables expressed in dollars were deflated using the Higher Education Price Index (HEPI) published annually in the Handbook of Educational Statistics. Deflating with the Consumer Price Index had little effect on the empirical results.

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Table 1 Institutions of Higher Education in Sample

UNITID	Name	Affiliation	Carnegie
161873	University of Baltimore	UM System	M1
162007	Bowie State	UM System	M1
162283	Coppin State	UM System	M1
162584	Frostburg State	UM System	M1
163268	UM Baltimore County	UM System	D2
163286	UM College Park	UM System	R1
163338	UM Eastern Shore	UM System	M2
163453	Morgan State	Public Independent	M1
163851	Salsbury State	UM System	M1
163912	St. Mary's College	Public Independent	B1
164076	Towson University	UM System	M1
231712	Christopher Newport University	VA Public	B2
233897	Clinch Valley College	VA Public	B2
231624	College of William and Mary	VA Public	D1
232186	George Mason University	VA Public	D2
232423	James Madison University	VA Public	M1
232566	Longwood College	VA Public	M2
232681	Mary Washington College	VA Public	M2
232937	Norfolk State University	VA Public	M1
232982	Old Dominion University	VA Public	D1
233277	Radford University	VA Public	M1
234076	University of Virginia	VA Public	R1
234030	Virginia Commonwealth University	VA Public	R1
234085	Virginia Military Institute	VA Public	B1
233921	Virginia Polytechnic Institute and State University	VA Public	R1
234155	Virginia State University	VA Public	M1

Table 2 Variable Descriptions

Variable	Description
E	Total Fall Headcount Enrollment
FTE	Total Fall Full-time-equivalent Enrollment
F	Total Number of Faculty
TF	Price of Enrollment (from Tuition and Fees)
G	Lump-Sum State Appropriation
W_{op}	Cost of Operating and Maintaining Academic Buildings/Equipment
W_{ser}	Cost of Operating Dorms, Dining Halls, other Student Services
W_{fac}	Average Faculty Salary
$HSGRAD$	Number of High School Graduates in each state
$RATFCC$	Average Tuition and Fees at Public Community Colleges

Table 3 Summary Statistics

School	State	E	FTE	TF	G	W_{fac}	F
University of Baltimore	MD	5431	3391	2908	19876	64596	168
Bowie State	MD	4668	3139	2198	16526	45246	130
Coppin State	MD	3049	2293	1998	14457	47341	107
Frostburg State	MD	5253	4515	2650	21010	46644	238
UMBC	MD	10285	7999	3217	48647	53763	360
UMCP	MD	33629	27912	4245	253070	64350	1352
UMES	MD	2541	2288	3215	16829	43556	115
Morgan State	MD	5365	4703	2943	35474	50490	226
Salsbury State	MD	5881	4866	2671	20953	45280	241
Towson	MD	14952	11625	2739	50830	50020	480
Christopher Newport	VA	4760	3470	2683	11547	55345	153
Clinch Valley College	VA	1573	1239	2554	5957	57036	55
William and Mary	VA	7625	6958	5541	35560	69975	467
George Mason	VA	21350	14573	4006	62743	86157	660
James Madison	VA	11633	10652	3147	36258	64046	505
Longwood College	VA	3287	3010	2899	12450	54795	154
Mary Washington	VA	3688	3190	3740	11781	54960	165
Norfolk State	VA	8349	7231	2820	25939	58586	301
Old Dominion	VA	16652	12363	3814	55958	69739	620
Radford	VA	9098	8373	2409	29593	63019	378
University of Virginia	VA	21300	18426	6688	132169	131545	979
Virginia Commonwealth	VA	21528	16181	4641	125331	130761	780
Virginia Military	VA	1253	1253	5995	10748	67481	96
Virginia Tech	VA	25671	23377	5180	189357	74957	1466
Virginia State	VA	4105	3473	3745	17605	55292	180

Table 4 Political and Regulatory Environment

Variable	State	Number in Sample
Governor	MD	2
Governor	VA	3
Chair, Board of Regents	MD	4
Chancellor, UM System	MD	2
Chairman, MD Higher Ed. Committee	MD	4
Executive Dir., Council on Higher Ed.	VA	1
Chairman, Council on Higher Ed.	VA	6

Table 5 Empirical Results - Estimation of Equations 13 and 14

			FTE Enrollment			
Fixed Effect:	Institution		Provost		President	
Variable	E Supply	F Demand	E Supply	F Demand	E Supply	F Demand
TF	0.283*	0.010*	0.602*	0.038*	0.323*	0.069*
	(0.071)	(0.003)	(0.077)	(0.004)	(0.078)	(0.029)
G	0.011*	0.013*	-0.011	0.019*	0.014*	0.017*
	(0.004)	(0.001)	(0.055)	(0.003)	(0.004)	(0.001)
W_{op}	-0.379	-0.005	-0.521*	0.002	-0.471*	-0.002
	(0.245)	(0.009)	(0.223)	(0.012)	(0.245)	(0.009)
W_{ser}	0.017*	0.009*	0.008	0.004**	-0.007	0.008*
	(0.008)	(0.003)	(0.008)	(0.002)	(0.008)	(0.002)
W_{fac}	-0.002	-0.012*	0.016*	-0.042**	-0.047	-0.014*
	(0.005)	(0.002)	(0.005)	(0.025)	(0.053)	(0.002)
N	208	208	208	208	208	208
			Headcount Enrollment			
Fixed Effect:	Institution		Provost		President	
Variable	E Supply	F Demand	E Supply	F Demand	E Supply	F Demand
TF	0.388*	0.013*	0.778*	0.043*	0.360*	0.084*
	(0.117)	(0.004)	(0.113)	(0.004)	(0.119)	(0.035)
G	0.020*	0.018*	-0.013*	0.018*	0.012*	0.011*
	(0.005)	(0.002)	(0.066)	(0.003)	(0.005)	(0.001)
W_{op}	-0.105	0.019	-0.463	0.01	-0.416	-0.097
	(0.359)	(0.011)	(0.296)	(0.011)	(0.318)	(0.940)
W_{ser}	0.016*	0.013*	0.036	0.008*	-0.009	0.008*
	(0.013)	(0.004)	(0.101)	(0.003)	(0.011)	(0.003)
W_{fac}	-0.022*	0.018	-0.020*	-0.042**	-0.042	-0.014*
	(0.01)	(0.02)	(0.01)	(0.03)	(0.07)	(0.00)
N	208	208	208	208	208	208

Table 6 F-tests on Fixed Effects Specifications

H_a	Institution-specific		Provost-specific		President-specific	
	E Supply	F Demand	E Supply	F Demand	E Supply	F Demand
	Dependent Variable: FTE Enrollment					
H_o: None	225.9	1174.8	151.6	218.9	153.1	384
P-value	0	0	0	0	0	0
Degrees of Freedom	26,196	26,196	63,146	63,146	46,196	46,196
H_o: Institution	-	-	1.4	1.26	0.61	1.33
P-value	-	-	0.05	0.13	0.97	0.1
Degrees of Freedom	-	-	63,146	63,146	14,146	46,146

Table 7 Estimated Elasticities (President-Specific Effects)

Institution	Enrollment Supply		Faculty Demand	
University of Baltimore	0.28	0.08	-0.54	2.01
Bowie State	0.23	0.07	-0.49	2.16
Coppin State	0.28	0.09	-0.62	2.30
Frostburg State	0.19	0.07	-0.27	1.50
UMBC	0.13	0.09	-0.21	2.30
UMCP	0.05	0.13	-0.07	3.18
UMES	0.45	0.10	-0.53	2.49
Morgan State	0.20	0.11	-0.31	2.67
Salsbury State	0.18	0.06	-0.26	1.48
St. Mary's College	0.94	0.11	-0.67	2.03
Towson	0.08	0.06	-0.15	1.80
Christopher Newport	0.25	0.05	-0.51	1.28
Clinch Valley College	0.67	0.07	-1.52	1.84
William and Mary	0.26	0.07	-0.21	1.29
George Mason	0.09	0.06	-0.18	1.62
James Madison	0.10	0.05	-0.18	1.22
Longwood College	0.31	0.06	-0.50	1.37
Mary Washington	0.38	0.05	-0.47	1.21
Norfolk State	0.13	0.05	-0.27	1.46
Old Dominion	0.10	0.06	-0.16	1.53
Radford	0.09	0.05	-0.23	1.33
University of Virginia	0.12	0.10	-0.19	2.30
Virginia Commonwealth	0.09	0.11	-0.23	2.73
Virginia Military	1.55	0.12	-0.98	1.90
Virginia Tech	0.07	0.11	-0.07	2.20
Virginia State	0.35	0.07	-0.43	1.66

Table 8 F-tests on Political Variables

H_a	Provost-specific		President-specific	
	E Supply	F Demand	E Supply	F Demand
	Dependent Variable: FTE Enrollment			
H_o: No Governors	0.62	0.64	5.71	0.68
P-value	0.60	0.59	0.00	0.57
Degrees of Freedom	3,142	3,142	3,159	3,159
H_o: No Regulators 1	1.33	0.20	3.07	1.19
P-value	0.25	0.98	0.01	0.31
Degrees of Freedom	6,139	6,139	6,156	6,156
H_o: No Regulators 2	2.07	0.02	3.67	1.09
P-value	0.06	1.00	0.00	0.37
Degrees of Freedom	6,139	6,139	6,156	6,156