Models of Centralized and Decentralized Budgeting within Universities

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1. INTRODUCTION

In an attempt to make their operations more efficient, large organizations can divide into units that engage in various forms of competition with each other. This competition can occur within private firms or the public sector. For example, Tiebout's (1956) hypothesis asserts that competition for households among local governments leads to efficient public good provision. In recent years, some universities in the U.S. have implemented a decentralized budgeting process called responsibility center management (RCM), under which different academic units are induced to compete for students. In its purest form, RCM essentially allows these units to keep the revenue that they generate, out of which they must finance the costs of their operations and pay fees to finance certain "public goods," such as the library. However, tuition rates are set centrally, leaving units to compete for students by choosing the attributes of their educational services.[1] This system is similar to a form of Tiebout competition where taxes are centrally set and localities use their public expenditures policies to compete for households. It is unlikely to satisfy the conditions required for an efficient Tiebout equilibrium, but alternative methods of allocating resources can also be expected to exhibit inefficiencies.

The current paper compares the RCM method of decentralized budgeting with a form of centralized budgeting. In both cases, the issue is how to allocate resources across academic units, which are interpreted as schools or colleges within the university (rather than individual departments). In general, units can compete for several sources of revenue under RCM, including tuition revenue, alumni contributions, and research grants. In the case of a state university, units are also provided with a fixed share of the state appropriations, but most of my discussion will also apply to private universities. I focus on competition for tuition revenue, thereby treating as exogenous the other revenue sources.

[1] See Whalen (1991) for a detailed description of RCM, and also Cross's (1996) brief but informative description and history of the system, highlighting some of its fundamental problems. While emphasizing the relevance of economic theory for RCM, he notes the dearth of academic literature on RCM per se. Krause and Wilson (2000) provide one formal model, which is discussed briefly below. For the related issue of competition among different universities, see Epple et al. (2000) and Debande and Demeulemeester (2000).

A purported strength of RCM is its visibility and simplicity as a resource allocation mechanism. Units are compensated for supplying credit hours, but this compensation does not vary to accurately reflect differences in the costs of these credit hours. To capture this simplicity, I assume that units are provided with a fixed fee per credit hour, which is the same for all credit hours and does not vary with the types of students taking the credit hours.[2] They may also receive a fixed base allocation. In general, this allocation can differ across units, allowing the central administration to distribute resources across units while utilizing the fixed compensation rate to elicit competition among units. Later in the paper, I consider competition among units that differ in size, but to make my points most simply, the basic model assumes away asymmetries between units.

It would be easy to show that centralized budgeting is superior to RCM, simply by positing a central authority with the appropriate objectives, complete information, and the tools needed to take advantage of this information. However, this is not the position in which university administrators find themselves. Indeed, I am reminded of the comment by a former assistant dean that the position of department chair is preferable to anything in the dean's office, because department chairs have a greater ability to get things done. More generally, the importance of consensus building on a university campus is widely recognizing, suggesting severe limitations on the power of central administrations. Accordingly, I construct a model in which a sizable amount of bargaining power resides with the academic units, rather than with the central administration, or "center." The formal model assumes that the units present the center with proposed "budget schedules," which indicate how different levels of funding will be utilized. The center then compares the budget schedules of the different units and chooses how to allocate funds. It is the ability of the units to commit to these budget schedules that give them a sizable amount of influence. On the other hand, the units are still competing among themselves for funds, which serves to limit this influence.

[2] Actual RCM systems do allow some variation in compensation rates, such as between undergraduate and graduate students, across different professional schools, and between in-state and out-of-state students. As an extension of my basic model, I briefly discuss differences in compensation rates for in-state and out-of-state students at a public university.

Despite this rather inefficient form of centralized budgeting, I find that it provides more powerful incentives for units to deliver educational services than RCM. This result is proved in Section 3, after the model of RCM is discussed in Section 2. Section 4 discusses a variety of extensions to the model,[3] and Section 5 outlines an alternative view of RCM that may put it in a more favorable light . Section 6 concludes.

2. THE BASIC MODEL OF RCM

A simple model, or illustrative example, can be used to show how competition for students works. Consider a university composed of two units that compete for students. I initially assume that the total number of students is fixed. One can suppose that the admissions office has chosen how many students to admit, along with their attributes, and the units are competing for these students. In a later extension, the number of students is allowed to vary. But for now, a student's only decision is whether to enroll in unit A or unit B. Once a student chooses where to enroll, he or she completes a set of academic requirements and obtains a university degree. To avoid distinguishing between credit hours and students, I assume that these academic requirements include a fixed number of credit hours.

Consider the decision of where to enroll. In accordance with an RCM system, tuition is not a consideration in this decision, because these payments do not vary across units. Instead, students assess the relative attractiveness of the educational offerings and choose accordingly. A central feature of the model is that students differ in these assessments. In particular, an s-student is a student who places a value of $e_A + 1 - s$ on an education from unit A and $e_B + s$ on an education from unit B. The "preference level" s is an innate attribute of students that varies between 0 and 1 and measures the relative attractiveness of unit B over unit A.[4] In contrast, e_A and e_B are measures of educational quality, which

[3] Wilson (2001) provides a more extensive discussion of some of these points but does not provide a formal model that can be used to compare RCM with centralized provision of education

[4] For the arguments presented below, I use the approximation of a continuum of students, with s treated as a continuous variable.

are controlled by the two units, as discussed below.[5] Given these quality levels, students divide themselves across units, so that the "marginal student" possesses a preference level s^o that leaves him or her indifferent between units. In symbols,

$$e_A + 1 - s^o = e_B + s^o \qquad (1)$$

All students with preference levels below s^o prefer to enroll in unit A, while those with levels above s^o prefer B. For simplicity, I assume that students are uniformly distributed across preference levels, meaning that an equal number of students possess each preference level.[6]

The central administration, or "center," compensates units at a fixed rate per student, denoted r. The total amount of compensation provided in this way is assumed not to exceed the university's total budget. In symbols, $r(N_A + N_B)$ is no greater than R, where R is the total budget and N_i is unit i's enrollment level, with i representing A or B.[7] This assumption prevents the university from increasing incentives to attract students without bound, simply by raising the compensation rate and financing it with fixed "taxes" on the unit. The assumption accords with the practice of not distributing all tuition revenue in the form of compensation, but rather withholding some funds for discretionary use by the center. To focus on the incentives associated with competition for students, each unit is assumed to treat as fixed any additional revenue that is distributed to it from the center. Alternatively, fixed fees may be collected from the unit to pay for any costs that the unit imposes on the university as a whole (e.g., the university library).

[5] These variables can be interpreted as measuring the impact of education expenditures on the future earnings of students, along with other non-monetary benefits. By treating these quality levels as fixed, I am not explicitly modeling the production process by which students also contribute inputs to the production of their own education, an idea that Rothschild and White (1995) have emphasized.

[6] Actually, the results extend to a wide class of symmetric distribution functions (see footnote 17).

[7] Recall that $N_A + N_B$ is fixed in the current model.

With tuition rates fixed by the center, units are left to compete with each other by engaging in quality competition. I model this form of competition by using the concept of a Nash equilibrium, with the quality levels e_A and e_B serving as the strategy variables. A Nash equilibrium is reached when unit A is choosing its most preferred quality level, given the quality level chosen by unit B, and unit B is similarly optimizing its quality level, given A's quality level.

To determine what is optimal, a unit's objectives must be specified. On a university campus, objectives are far from straightforward, due to constraints on the ability of decision-makers within units (i.e., deans) to distribute excess revenue to themselves and other members of the unit. Such constraints may be beneficial, but I leave this issue to later discussion and simply assume for now that a unit's objective is to maximize the excess of revenue over the minimum costs needed to provide educational services. In short, units seek to maximize "profits." Revenue equals rN_i for unit i (i = A, B). Costs depend positively on both the quality level and the number of enrolled students, and these costs may be interpreted rather generally to include a monetary value of faculty effort. For the current model, I assume that the variable costs of educational services take the form $\alpha e_i N_i$, where $e_i N_i$ will be referred to as total educational services, and α is the minimum cost of a unit of services.[8] Subtracting these costs from revenue gives the profit expression that the unit seeks to maximize, $(r - \alpha e_i)N_i$. There may also be fixed costs or subsidies, which are independent of the number of students taught, but they do not influence a unit's decisions and can therefore be ignored.[9]

Consider the determination of the equilibrium quality levels. The only way in which a unit can attract an additional student is to raise its quality level. Thus, there are two components to the cost of the additional student incurred by the unit: the cost of providing all students with the required quality improvement, denoted $\alpha N_i \Delta e_i$, and the cost of servicing the additional student once he or she enrolls in

[8] Generalizations of this cost structure are later discussed.

[9] One interpretation of profits is payments above the minimum payments needed to induce the members of the unit to provide their labor services to the unit. In this case, $\alpha e_i N_i$ would include only these minimum payments. If the unit then also incurs various fixed costs, which are independent of N_i, we are implictly assuming here and in the next section that the excess of revenue over variable costs is sufficient to cover these fixed costs.

the unit, αe_i. The sum of these two costs is referred to as the "private marginal cost" of an additional student, $PMC_i = \alpha N_i \Delta e_i + \alpha e_i$. This marginal cost clearly increases as the unit attracts more students. In fact, it can be shown to rise at a constant rate with N_i.[10] To maximize profits, the unit increases quality to the point where the revenue from an addition student equals the marginal cost: $r = PMC_i$.

With both units behaving in this manner, an equilibrium is reached at the point where the total demand for students, summed across units, equals the supply. In Figure 1, the length of the horizontal axis gives the fixed supply, with unit A's demand measured from the left origin and B's from the right. For supply to equal demand, the two marginal cost curves must cross the horizontal marginal revenue line at the same point, denoted b in Figure 1. A single asterisk is used to identify the equilibrium values of variables. Given the symmetry between units, $N_A^* = N_B^*$ in equilibrium.

Now a critical observation is that each the private marginal cost lies above the "social marginal cost," $SMC_i = \alpha e_i$ for unit i, which measures the cost of providing the existing educational quality to another student. Thus, the average variable cost, αe_i, lies below r in equilibrium, as illustrated by the intersection of the social marginal cost curves in Figure 1. I refer to SMC_i as the social marginal cost because it excludes the quality improvement, $\alpha N_i \Delta e_i$, which represents a cost to the unit but is a benefit from the viewpoint of students. This discrepancy between the two cost concepts arises in equilibrium only because the units are imperfectly competitive. The alternative, perfect competition, would require the existence of many units on campus, or an infinitely elastic supply of students to the campus. Each unit would be able to attract as many students as desired by offering the quality level provided by other units to similar students. As a result, quality levels would be bid up to the point where each unit was indifferent about attracting additional students, or where $r = \alpha e_i$. If the center were optimally setting r (rather than rationing admission into the university), students would then enter the university until the

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[10] Since students are uniformly distributed across preference levels (s), the number of students is a linear function of e_i for unit i, which implies the PMC_i is a linear function of N_i. The social marginal cost curve introduced below also has this property.

marginal student's willingness to pay for education equaled the actual payment, r, and therefore equaled the cost of providing that education, αe_i. In other words, students would enter the university until marginal benefit equaled the social marginal cost, which is the classic condition for the efficient use of a facility. In the current case, r may fall short of this marginal benefit, due to rationing, but we have seen that the social marginal cost falls short of r. In other words, the marginal benefit exceeds the social marginal cost, implying that education is underprovided.[11]

The source of the imperfectness in competition is too few units chasing after too many types of students. In models of local government behavior, or "Tiebout models," households sort themselves across communities so that each community contains a single type of household and can therefore tailor its taxes and public expenditure programs to the particular preferences of this type. In the present case, many types of students enroll in the same unit, and the unit has "market power" because some of these types strictly prefer to be there rather than in another unit. This situation is somewhat exaggerated in the current model, because the units do not offer different educational programs to different types of students, but the model does capture the reality that educational programs can never be perfectly tailored to each student's abilities and preferences.

For future comparisons, it is useful to graphically depict the total discrepancy between revenue and the cost of providing quality to each student, $(r - \alpha e_i)N_i$, which is represented in Figure 1 by rectangle abde for unit A. In words, we subtract average cost from average revenue per student and multiply by the number of students. Another way to measure profits is to add together the profits obtained from each student as we incrementally increase the number of students from zero to the equilibrium level. The first student generates the highest profit, since the private marginal cost is lowest, whereas the last student generates no profit. Adding up profits in this way gives the area between the marginal revenue line and

[11] This argument does not distinguish between the private marginal benefit of education, which students use to make decisions, and the social marginal benefit of education. It is sometimes argued that education confers external benefits on the economy. This argument reinforces the argument that educational services are underprovided and provides a rationale for state universities. The importance of such external benefits is not clear, however.

the marginal cost line in Figure 1, which is triangle abc. I shall refer to these profits as "waste," since they represent revenue that is being "consumed" by the unit in a way that does not benefit students.

The excess of marginal revenue over social marginal cost has a second important implication: a unit always benefits if another student takes credit hours in it. By the unit's condition for an optimal number of students, this benefit equals the cost of generating additional credit hours:

$$r - \alpha e_i = \alpha N_i \Delta e_i \qquad (2)$$

Under the simplifying assumptions of the current model, this cost consists of raising quality. More generally, quality is multidimensional, and student decisions about where to enroll depend also on attributes of units for which there is not a common ranking from least preferred to most preferred from the viewpoints of students, e.g., curriculum issues or grading policies. Thus, units face multiple methods of generating additional credit hours, and they can be expected to continually explore new and cheaper methods and then exploit them to the point where they no longer have a cost advantage over the existing methods. This means, for example, that a unit's grade policies are optimized only when a change in these policies that attracts another student to the unit imposes a cost on the unit that equals the cost of attracting a student by some other method. Such costs might include reduced teaching effectiveness.

Other implications of (2) are discussed below. But first I compare RCM with centralized budgeting.

3. CENTRALIZED BUGETING

An alternative to RCM is to let the central administration allocate resources across units. As noted in the introduction, however, we should recognize the limitations faced by administrators, including informational asymmetries and the relatively non-hierarchical command structures of universities. In this section, I construct a model along these lines and show, nevertheless, that RCM is inferior to central control of the budget.

The model retains the assumptions from the previous section, except that units now engage in what might be called "political competition," rather than competition for students.[12] Simply stated, they attempt to convince the center that they deserve a sizable share of the budget. This convincing consists of essentially bidding for funds by offering to deliver educational services in return for a funding level. In particular, each unit provides the center with information on the relation between educational services and the funds it will need to provide these services. As before, these services are measured by the number of students taught multiplied by education quality, $E_i = e_i N_i$ for i = A, B. The level of funds provided to unit i, or its "budget," is b_i, and the unit's budget schedule is its proposed relation between b_i and E_i. An exact form of this relation is given below. I shall continue to let αE_i represent the minimum variable cost of E_i and for now ignore any fixed costs. More complicated cost structures are discussed at the end of this section.

In constructing its budget schedule, each unit is essentially attempting to manipulate the behavior of the center. I again use the concept of a Nash equilibrium to describe behavior, except that now the strategies are the entire budget schedules. As a Nash player, each unit is choosing the form of its budget schedule, given its beliefs about the other unit's budget schedule, and given its beliefs about the center's subsequent choice of a budget allocation, b_A and b_B. These funding levels add up to some given amount, R, which may be greater than tuition revenue, $r(N_A + N_B)$, if the university has other funding sources, but is not less. Once the center chooses its budget allocation and the units deliver their promised level of educational services, students divide themselves between the two units and quality levels adjust until the marginal student is indifferent about where to enroll, i.e., (1) is satisfied.[13]

As described here, political competition is being modeled as a type of principal-agent problem, known as a common agency problem. Each unit is a principal and the center is the agent, whose behavior

[12] See Masten (2000) for an extended discussion of political processes within universities.

[13] An alternative arrangement would be for the unit to specify only the quality levels that it would be willing to offer at different levels of funding from the center. It would need to predict how the center's choice of the quality level would affect the number of students it taught, given the behavior of the other unit. How this alternative arrangement might affect the results is left to future research.

the principals are attempting to influence.[14] To maintain consistency with the RCM model, I continue to assume that a unit's objective is to maximize profits, measured here by the excess of it funding level (b_i) over the cost of its educational services. On the other hand, the center is attempting to maximize the total well-being of students, measured by summing the individual student welfare levels, $e_A + 1 - s$ in unit A and $e_B + s$ in unit B. Thus, I am asking how well centralized budgeting can perform in delivering education to students, if this delivery is indeed the goal of the central administration. Centralized budgeting could obviously be made to look as bad as desired, simply by giving the center bad objectives. The current strategy is therefore to ask whether centralization can perform better than RCM in delivering educational services, if the center does have student welfare as its objective. A separate issue is then how to design incentives to induce the center to behave in a desirable way. The issue of other desirable objectives, including research activities, is addressed later. Note, finally, that my welfare comparison between RCM and centralized budgeting is using the students' own assessments of their welfare (e.g., a type-s student in unit B has welfare $e_B + s$). Thus, I am not viewing the center or units as being assigned the task of correcting the flawed choices made by students. The assertion that students don't know or do what is good for them provides an obvious argument against RCM, since an active central administration could exercise more control over student choices. The current paper provides a case against RCM even without this argument.

Common agency problems have been extensively studied and found to possess a critical property, which in this case concerns the budget schedules: they satisfy a condition that may called "local truthfulness." In particular, the additional funding that a unit demands for a small increase in its educational services from the equilibrium level leaves the unit indifferent about this increase. Since α is the cost of a unit of services, it follows that the budget schedules require the payment of α in return for another unit of services.

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[14] See Berheim and Whinston (1986a, 1986b) for the theory of common agency, and see Grossman and Helpman (2001) for applications to special-interest politics.

The common-agency literature has argued that reasonable strategies possess an even stronger property, "global truthfulness."[15] In the present case, this means that large changes in a unit's educational services result in budget changes that also leave the unit as well off as before. In symbols, the budget schedules take the form:

$$b_A = \alpha E_A + K_A \qquad \text{and} \qquad b_B = \alpha E_B + K_B, \tag{3}$$

where K_A and K_B represent the levels by which the budgets exceed the minimum expenditures needed to fund educational services. For a terminology that is consistent with the RCM model, I refer to these quantities as the levels of "waste." With this simplified form of the budget schedules, the two units compete for funds by reducing their levels of waste. The question then is, does this competition result in higher or lower levels of waste than exist under RCM.

The waste levels are not competed to zero. Under the current setup, each unit has the option of offering no educational services, in which case the center will provide it with no budget and rely instead on the rival unit to provide all educational services. Less extreme options could be considered, but my strategy here is to demonstrate that centralized budgeting is preferable to RCM even when units possess more bargaining power than would commonly be the case. For the current case, unit A will choose its budget schedule so that the center chooses the desired amount of educational services for the desired budget, denoted E_A^{**} and b_A^{**}, and b_A^{**} is set sufficiently high to leave the center indifferent between this choice and the alternative of providing unit B with the entire budget. Under the budget schedules given by (3), if all students did move to unit B, then the center could induce B to continue to provide the equilibrium quality level by raising its budget by $\Delta b_B = \alpha e_A^{**} N_A^*$, where N_A^* is again A's (and B's) equilibrium enrollment level. This amount would also be A's budget if it received no waste (i.e., if K_A equaled zero in (3)). But now students who preferred unit A are forced to enroll in B, implying that B

[15] See Grossman and Helpman (2001, Chapter 8, esp. pp. 268-270). They refer to schedules satisfying the global truthfulness property as "compensating schedules."

would need additional funds to raise its quality enough to keep total student welfare from falling. These additional funds are the excess of funding over $\alpha e_A^{**} N_A^{*}$ that the center is willing to provide unit A. Consequently, they represent A's waste.

This waste level is now identified in Figure 2, where once again the equilibrium quality level, e_A^{**}, is determined by the intersection of the two social marginal cost curves (B's waste is similar). To calculate this waste, consider reducing e_A from e_A^{**} to a level, e_A^{***}, at which point all students have migrated to unit B. For any small reduction in e_A, denoted Δe_A (a negative number), those students who move to unit B experience a negligible welfare loss, since they were about as happy with e_B^{**} in unit B as with the initial e_A in unit A. But those students left behind do lose welfare. Summed across all of these students, the total welfare loss is $N_A \Delta e_A$. To offset this welfare loss, e_B would need to rise by an offsetting amount, at a cost equal to $-\alpha N_A \Delta e_A$. In Figure 2, this amount may be measured using A's social marginal cost curve. In particular, we measure N_A by the horizontal distance from the vertical axis to the social marginal cost curve at the initial αe_A, and we multiply this N_A by $-\alpha \Delta e_A$. Adding up these cost changes as e_A is reduced in small increments from e_A^{**} to e_A^{***} gives the area to the left of the social marginal cost curve, between these two quality levels.[16] Thus, unit A's waste is measured by triangle xyz in Figure 2.

The critical observation here is that waste is now measured using the area to the left of the social marginal cost curve, rather than the private marginal cost curve. In Figure 1, the latter curve is seen to have the steeper slope. Changing the equilibrium quality level alters the height of the social marginal cost curve, but the slope can be shown to stay unchanged.[17] Consequently, waste must be higher under RCM.

How the equilibrium quality levels differ obviously depends on the relative levels of funding under the two budgeting systems. Recall that the total tuition revenue that units compete over under

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[16] In terms of calculus, we integrate the cost reductions to obtain this area.

[17] If we dropped the assumption of a uniform distribution of students across preference levels, then the social marginal cost curves would no longer be linear, but their slopes at any given enrollment level would still not depend on the equilibrium quality level.

RCM is no greater than the total size of the university's budget. To make RCM as favorable as possible, let us allow this tuition revenue to exhaust the entire budget, which is what is up for grabs under centralized budgeting. Each unit gets half of this budget, which equals area $abN_A{*}O_A$ in Figures 1 and 2. In this case, the equilibrium quality levels cannot be identical between the two budget systems. If they were identical, the lower level of waste under centralized budgeting would fail to exhaust the entire budget. Consequently, the equilibrium quality level must be higher under centralized budgeting, making students better off.

In Figure 2, unit A spends $\alpha e_A{**}N_A{*}$ on educational services, leaving the amount given by rectangle abyz to be wasted. In other words, the area of this rectangle equals the area of the waste triangle, xyz.

Some intuition about this result can be gained by drawing parallels to the theory price discrimination. As noted earlier, the reason for inefficiencies in this model is imperfect competition. In particular, quality levels are set below the levels that perfectly-competitive units would choose. Similarly, imperfectly-competitive private firms that sell a good at a single unit price usually supply an inefficiently low level of this good, in an attempt to drive up the price. It is well-known, however, that this inefficiency could be eliminated if these firms were able to perfectly price discriminate, selling each unit of the good at a different price, namely, the maximum price that consumers are willing to pay for each unit. In this case, supply would be expanded to the point where the price of the next unit equals the cost of the next unit, which is the necessary efficiency condition.

Under centralized budgeting, something like perfect price discrimination is also occurring. At the margin, unit A (and B) is offering to "sell" another increment of educational services to the center in return for additional funds equal to the true cost of these services (see the budget schedules given by (3)). In other words, unit A is earning no profits at the margin. However, its total profits are indeed positive, because it is effectively collecting a fixed fee from the center (again see (3)). The fee is capturing the surplus benefit that students receive from enrolling in A rather than B, which is created by their relatively

high preference for A (low s). But with educational services efficiently priced at the margin, quality is higher under centralized budgeting than under RCM. In the latter case, the unit is compensated at a fixed rate for teaching another student, but not for increasing the educational quality at which existing students are taught. This leads to lower quality than under centralized budgeting, making all students worse off. The units are actually better off in terms of profits, because the lack of incentives to increase quality leads to less competition, enabling them to keep more revenue.

Consider finally the assumption of a linear cost function, αE_i. Adding unit-specific fixed costs would effectively give the center more bargaining power in this model, because an added advantage to eliminating a unit would be the elimination of the fixed cost involved in operating it. In this case, centralized budgeting would become even more advantageous. For the time period to which the model is meant to apply, however, it may be more reasonable to assume that such costs are sunk, that is, they cannot be eliminated. Alternatively, RCM could be made preferable to centralized budgeting simply by positing capacity constraints on the production of education, whereby the center would encounter much higher educational costs per student if it moved a sizable number of students out of one unit and into a rival unit. However, the relevance of such capacity constraints in this context is debatable. If RCM is exercised over a long enough time period, then such constraints become less important. In addition, they depend on how various types of infrastructure in the university are allocated between units. We could consider an RCM system where the units effectively rent buildings from the center, in which case one unit's buildings can expand relative to the other unit's buildings as it competes students away from the other unit. While it would certainly be useful to explore alternative cost structures, the one used for the current analysis seems like a useful benchmark case.

4. EXTENSIONS

This section discusses a number of ways in which the analysis can be extended, beginning with relatively straightforward extensions and progressing to more ambitious extensions. A message that emerges is that the benefits of centralization survive and, in some cases, are enhanced. I also indicate

instances where additional research is needed to sort out the relative merits of RCM and centralized budgeting.

A. A Variable Student Population

Suppose now that the total student population is variable. One way to model this extension is to assume that students are indexed not just by the preference level, s, but also by an "outside opportunity," v. In other words, all students with a given s possess a range of possible outside opportunities, described by an interval of v's, the location of which may vary with s.[18] Given quality levels e_A and e_B, s determines the unit in which all type-s students within the university choose to enroll, whereas a type-s student's v determines whether this particular student enters the university. If, for example, type-s students enroll in unit B, then these students must have v's where $e_B + s$ is at least as high as v. Otherwise, they would prefer opportunities outside the university to enrolling in unit B. Note that the distribution of the v's and s's across students may reflect admission requirements set by a central administration. In other words, there may exist students where $e_B + s$ is greater than v, but these students are not included in the set of students under consideration, because they are denied entrance. For the model, these admission requirements are treated as exogenous, as are the tuition fees paid by students. Given these exogenous variables, increases in quality levels e_A and e_B increase the attractiveness of the university to students, thereby raising enrollments. Note that higher quality levels would allow admission levels to be tightened, producing another equilibrium where the student population is unchanged but the existing students are left better off. If units anticipated this tightening, however, then we would be back to the model with a fixed student population. So the basic difference in models is that units do not anticipate an offsetting tightening of admission requirements. Given this variable student

[18] Unless we imposed the appropriate symmetry on the joint distribution of s and v, units would not choose the same quality levels in equilibrium. For this subsection, assume that units do behave identically. Subsection 4.C considers asymmetric units.

population, measures of student welfare should now include not only actual students, but also potential students.

With this setup, it is now easy to extend the previous analysis. We can again construct private and social marginal cost curves, as depicted in Figure 1, except that the length of the horizontal axis now represents the university's total population only when both units are pursuing their equilibrium strategies. If unit A reduces its quality level, for example, more students will choose to enroll in unit B, and more will choose not to enroll in either A or B. This variability in population levels tends to flatten these curves, because a smaller rise in quality is required to increase a unit's student enrollment by one unit, given that the enrollment change comes not only at the expense of the other unit, but also from outside the university. But their relation and uses remain the same. As previously argued, the welfare loss from a small reduction in e_A is again measured by the lost welfare of those students left behind in unit A. By replicating the previous arguments, we once again find that centralized budgeting is superior to RCM.

Another issue raised by this extension is whether the university should seek to attract particular types of students, perhaps with differential tuition levels, and what implications this goal has for RCM.[19] For example, state legislatures typically behave as though in-state students contribute more to state welfare than do out-of-state students.[20] Such preferences, along with the practice of charging relatively high tuition rates to out-of-state students suggest that the RCM system should be modified in a way that provides differential compensation rates to units for these two groups of students. But Wilson (2001) argues that it is not clear how these compensation rates should differ, suggesting that attempts to improve upon the simplest RCM systems can quickly require the kind of information that reduces its purported informational advantages. Due to this lack of information, the prices attached to different activities under

[19] In other words, there is a difference between the social and private marginal benefit of education, and this difference varies across different groups of students. The previous analysis has assumed away such differences, and in the current subsection, I have also assumed that v is both the social and private opportunity cost of education for a type-v student.

[20] Groen and White (2000) investigate the relative preferences of state governments and universities for in-state and out-of-state students

any feasible RCM-type system are likely to produce large inefficiencies in university behavior.[21] Note, however, that the unequal treatment of different types of students in my model of centralized budgeting would require that units offer the center a vector of educational services in return for funding, with each element denoting the services going to a particular type of student. This extension also raises complications that deserve further research, including potential differences in the relative preferences of the unit and center for teaching different types of students.

B. Restrictions on the Behavior of Units

One common attribute of RCM is that few restrictions are placed on the behavior of units, at least relative to centralized budgeting systems. But this relative lack of restrictions can clearly lead to additional waste. One way to understand such restrictions is that they limit the ability of a unit to engage in expenditures that have little or no relation to the provision of educational services. In this case, additional educational services now benefit the unit by allowing it to more easily undertake wasteful activities.. In other words, educational services lower the "cost" of waste to the unit. In an attempt to circumvent behavioral restrictions and increase waste, the unit may therefore increase quality levels beyond their levels in the absence of restrictions. To the extent that RCM removes such restrictions, it may encourage additional waste.

Of course, a problem with this conclusion is that attempts by the university to eliminate waste run the danger of inadvertently restricting activities designed to improve the delivery of educational services. Indeed, an argument for RCM is that the center lacks the information needed to directly control the behavior of units in desirable ways. The form of political competition described above might be subject to restrictions on how the units can spend their funds, but the removal of some of these restrictions might be welfare-improving. It would be useful to investigate how to design restrictions on the behavior of

[21] See, for example, Ehrenberg's (2000) revealing discussion of Cornell University's experience in this regard.

units, given the informational asymmetries between the center and units. Once again, agency theory is likely to be useful.

C. Asymmetric Units

Allowing units to differ in size introduces another potential source of inefficiency into the basic model of RCM. Size differences can be introduced by assuming that more students are located at each preference level s below .5 than at values of s above .5. Then unit A will possess more students than unit B in equilibrium. Moreover, unit A has an incentive to set its quality level below the one chosen by B. Raising its quality level to attract more students carries a greater cost, because the number of initial students that must be provided with this higher quality is higher. This difference in equilibrium qualities is another source of inefficiency, because it distorts a student's decision about where to enroll. Since tuition rates do not vary across units, an inefficiently large number of students choose unit B. To see this, hold quality levels fixed, and move a small number of students from unit B to unit A. Since the marginal student is indifferent between units (as described by condition (1)), this move does not affect the movers' welfare levels. However, it does lower the total cost of educating students on campus, since more students are being educated in the low-quality unit, namely, unit A. This cost saving could then be devoted to either making the units better off (more "waste") or making the student better off (higher quality levels).

Thus, we can expect too many students to enroll in small units within a university, with too few remaining in large units. This result parallels the conclusion from the public economic literature that small countries have an advantage when they compete with large countries for internationally mobile capital: they face stronger incentives to lower their taxation of capital, making them relatively attractive to investors. See, in particular, Wilson (1991) and Bucovetsky (1991).

A surprising result is that there is no similar tendency for quality levels to differ under the centralized budgeting system discussed above. Under the budget functions given by equation (3), the cost of another unit of educational services is α, regardless of whether this unit is obtained from A or B. With

these services having equal value to students, the center has no incentive to tolerate any inequality in quality levels. Hence, they are equalized. For this reason, the superiority of centralized budgeting extends to the case of asymmetric units.

Another issue is how size affects the internal workings of units. The basic model treats units as though they are controlled by a set of decision-makers with a single objective. But this assumption becomes less reasonable as unit size increases. With increased unit size, there exist greater opportunities to support money-losing activities through cross-subsidies within the unit. Academic departments recognize such opportunities and may therefore devote resources to trying to obtain subsidies, rather than trying to increase credit hours. In other words, the departments of larger units are more immune to the incentive effects of RCM. This is an additional reason for why large departments compete less vigorously for students.

It is not clear whether similar disadvantages of largeness carry over to centralized budgeting. In fact, one might argue that an increase in size raises the effective bargaining power of a unit, by making it more indispensable to the functioning of the university. The conjecture here is that small units should view RCM more favorably than large units, but this issue deserves further investigation.[22]

D. Heterogeneous Students

Recall that under RCM, each unit benefits from the entry of another student and, in equilibrium, sets this benefit equal to the cost of obtaining the student (see condition (2)). In the basic model, students differ according to a single preference parameter, s. As extended above, the model can also encompass a variable population, with students possessing different opportunities outside the university. But students differ in many other ways, including abilities and educational preferences over the courses and programs offered within a unit. This diversity creates two complications. First, the cost of providing a credit hour may depend on which student takes the credit hour, giving units incentives to compete more vigorously

[22] Of course, counterexamples to this conjecture can be found by comparing units offering fields of study which differ in their tendency to garner support from central administrators.

for low-cost students. Second, units will naturally place more weight on the preferences of the students who are more mobile across units, as represented by their responsiveness to changes in a unit's expenditures on different educational activities. In both cases, the unequal treatment of different types of students is unlikely to coincide with reasonable objectives for the university. If the more mobile students are also the relatively less-able students (e.g., less-able students lack strong preferences about their choice of majors), then an RCM system could erode academic standards.

Krause and Wilson (2000) present a model of RCM that focuses on this unequal treatment of different types of students. In particular, units offer different fields of study, and students possess different preferences for these fields. In their efforts to compete for students, units put the most resources into those fields they offer that are most similar between the units (e.g., "business economics" and "arts-and-sciences economics"), since these fields matter the most for attracting students. As a result, resources are misallocated across fields, causing students to misallocate themselves across fields. In other words, an inefficiently large number of students choose those fields that are most similar between units, since this is where the educational resources are going.

This competition may also affect the fields that are offered. If some fields are too similar between units, then competition for students may bid up the resources devoted to them to the point where the units are not compensated enough to cover the full costs of operating these fields (including fixed costs). If units anticipate this form of "ruinness competition," then they may respond by eliminating these fields (e.g., no economics departments), or funding them at minimal levels to meet accreditation requirements. Once again, resources are clearly misallocated across fields within a unit.

There does not seem to be similar incentives for units to misallocate resources under centralized budgeting. If we incorporate Krause and Wilson's internal structure of units into the current model of centralized budgeting, then the budget proposals presented to the center would need to include not just the total supply of educational services, but also the allocation of these services with the units. But if units

care only about the maximization of some measure of total profits, then neither the units nor the center should have an incentive to try to force a deviation from the efficient internal allocation.

On the other hand, the absence of competition for students as an incentive device gives departments within units more freedom to pursue their separate objectives. In other words, the assumption that units possess a single well-defined objective becomes even more questionable, and competition among departments can lead to types of inefficiencies that might not be present under RCM. More work needs to be done on the decision-making within units under centralized budgeting.

E. Externalities

The only source of inefficiency in the basic model of RCM is the lack of perfect competition among units. But the units that constitute a university typically exhibit interconnections that give rise to externalities, where the choices made by one unit imposes costs or benefits on other units, in ways that are not efficiently priced under an RCM system. One example is reputation effects. A unit's reputation with the potential employers of its students depends in part on the reputation of the entire university, which is based on the collective reputations of all units.[23] Thus, efforts by one unit to improve the quality of its academic programs are likely to benefit other units. For example, students in Business may find it easier to obtain high-quality jobs if Arts and Science offers rigorous, high-quality programs. The existence of positive externalities of this type may lead to "free-riding" whereby a unit under-invests in its academic programs because it is able to rely on high-quality academic programs elsewhere on campus to mask the deterioration in its own programs, at least for a period of time.

This reasoning presumes that individuals located outside the university are imperfectly informed about educational activities inside the university. The students themselves may also lack important information about the quality and types of educational programs offered by various units in a university. Such informational asymmetries are another potential source of inefficiency. For example, a unit might

[23] Similarly, Garvin (1980) models the "prestige" of a university as depending on the prestige of each of the individual departments within the university

engage in extensive marketing activities to induce students from high schools to enroll in its programs, although some of these students might be better suited for other units. Once the students are on campus, the unit might design its degree requirements to make it difficult for its students to change majors at a later date.

Under centralized budgeting, the central administration would presumably attempt to internalize such externalities. In this respect, centralized budgeting appears to have a distinct advantage over RCM, but informational asymmetries remain a problem.

F. Majors vs. Non-Majors

One major source of externalities under RCM is the ability of students to take courses in different units within the university. In particular, students major in one unit while taking distribution requirements in other units. In this case, the academic programs offered by different units become interdependent, leading to a host of welfare-reducing externalities not captured by the basic model developed above. For example, a unit may design the curriculum of its courses to cater more to the students majoring within the unit, at the expense of students majoring elsewhere, if doing so tends to increase total credit hours within the unit by generating more majors.

The ability of units to independently control the programs taken by their majors provides another source of inefficient competition among units. In particular, credit hours can be increased by forcing majors to take more credit hours within the unit, if doing so does not substantially reduce the attractiveness of the major. This behavior is similar to the use of "tied sales" by private firms. In particular, a firm can increase profits by packaging goods together and selling them at a single price, so that a customer is induced to buy more than desired. Similarly, an academic unit can confront a student with the choice of majoring in the unit and taking most of his or her courses there, or not majoring in the unit. Limiting choices in this way is a means of raising profits.

Other forms of RCM might be used to counteract these problems. One possibility is the University of Michigan system, where each academic unit is compensated for the number of students that major within the unit, rather than credit hours.[24] In this case, however, units have an incentive to send their majors to other units. A mixed compensation system, based both on credit hours and number of majors, might be a solution.

A common problem with centralized budgeting is that units typically face insufficient incentives to teach any students. As we saw, however, central administrators can restore these incentives by rewarding units that teach a lot of students with large budgets, but not in the form of a flat rate per student. In a sense, the menu-auction approach described above represents a nonlinear pricing scheme that seems to improve upon RCM. This interpretation is pursued further in the final section of this paper.

G. Research

One complaint about RCM is that it places too much emphasis on teaching relative to research. This concern is perhaps overdone, for several reasons. We have shown that RCM generates more "wasteful" profits for units than a centralized budgeting system. As discussed above, however, the center can seek to place restrictions on these profits, and one potential use is for research. To the extent that RCM frees up additional resources, it has the potential to increase research activities.[25] In addition, those forms of research that are complementary to teaching may be particularly encouraged by RCM.

Note also that a full RCM system rewards units not only for generating credit hours, but also for other activities that raise revenue, including research grants and alumni contributions. A common complaint about centralized budgeting is that it reduces research incentives by distributing a portion of research grants away from the units that generate them. By eliminating this cross-subsidization, RCM can encourage research.

[24] See Courant and Knepp (2001).

[25] Rey (2001) develops a formal model that captures this possibility.

Still, if we do view RCM as encouraging both research and teaching, then it is not completely clear how much one of these activities is encouraged relative to the other. There is at least some cause for concern that research gets shortchanged. This is another issue that deserves further research.

5. AN INFORMATION-BASED APPROACH TO RCM

The formal model of centralized budgeting that I have presented does not explicitly deal with informational asymmetries. Units know each other's strategies, consisting of budget schedules, and the only role for the center is to choose among budget schedules. However, the setup of the model is motivated by the center's lack of information about the internal functioning of units. If the center did possess complete information, then it could regulate the behavior of the units in a way that eliminated wasteful expenditures (assuming it had the incentive to do so, which is also an important issue). The surprising result of this study has been the finding that student welfare is higher despite the center's inability to directly influence the internal workings of units.

An alternative view of centralization is that the center obtains information from the units and bases its budget decisions on this information. The problem here is that many of the messages that units might wish to send to the center are difficult to verify (e.g., the relative importance of faculty recruiting in different fields). Moreover, individual units and the center clearly possess different preferences about the allocation of resources within the university, giving the units incentives to lie.

There is a sizable literature on this type of information transmission problem. See, in particular, Crawford and Sobel (1982) and Grossman and Helpman's (2001) applications of their work to special interest politics. In Grossman and Helpman, a special interest group sends a message to a policymaker about the "state of the world", and the policymaker uses this information to choose its policy. Since the truthfulness of the message cannot be directly verified, these messages will be truthful only if it is in the interest of the special interest group to make them truthful. One of the main results from this model is that truthfulness is possible, but only for messages that are coarse to the extent that they reveal a range of possible states, but not the specific state. Moreover, these truthful messages necessarily become less

informative (i.e., more coarse) as the difference between the preferences of the special interest group and policymaker grow.

This framework suggests a possible role for RCM: to bring the preferences of the center and units closer together, thereby facilitating the transmission of information. The presumed benefit of RCM is that it forces units to place greater weight on the delivery of educational services to students. In so doing, it might better enable units to communicate information to the center that can then be used by the center for allocating resources that are not part of RCM. This reasoning suggests a mixed system, whereby units compete for students in an effort to receive some funds from the center, but the center exercises discretion over other funds. Perhaps some mixture of RCM and centralized budgeting is preferable to either extreme. It would be useful to develop formal models of various mixed systems, recognizing the importance of informational asymmetries on a university campus.

6. FINAL REMARKS

In this paper, I have provided an argument for why centralized budgeting is superior in RCM, even though my depiction of centralized budgeting has severely limited the power of the central administration. My explanation for this result has rested on the crude way in which RCM compensates units for teaching students, with a fixed fee for each student (or credit hour). In effect, I have argued that this scheme still does not provide sufficient incentives to raise educational quality.

One approach to this problem would be to implement a more complex compensation scheme. In particular, we might consider schemes that do not treat all credit hours identically. In the basic model, a nonlinear compensation scheme under which the compensation rate rose as more students were taught could provide more powerful incentives to raise quality, without raising total compensation costs. But this solution has problems. First, it eliminates the simplicity of RCM, raising issues about whether there exists sufficient information to design the required degree of nonlinearity. Second, such a scheme is likely to introduce problems not present in the basic model, particularly the tendency of RCM to create incentives for units to pay too much attention to the preferences of the most mobile students. It seems

unlikely that an RCM system could be designed that would adequately substitute for the active involvement of central administrators in resource allocation decisions on a university campus.

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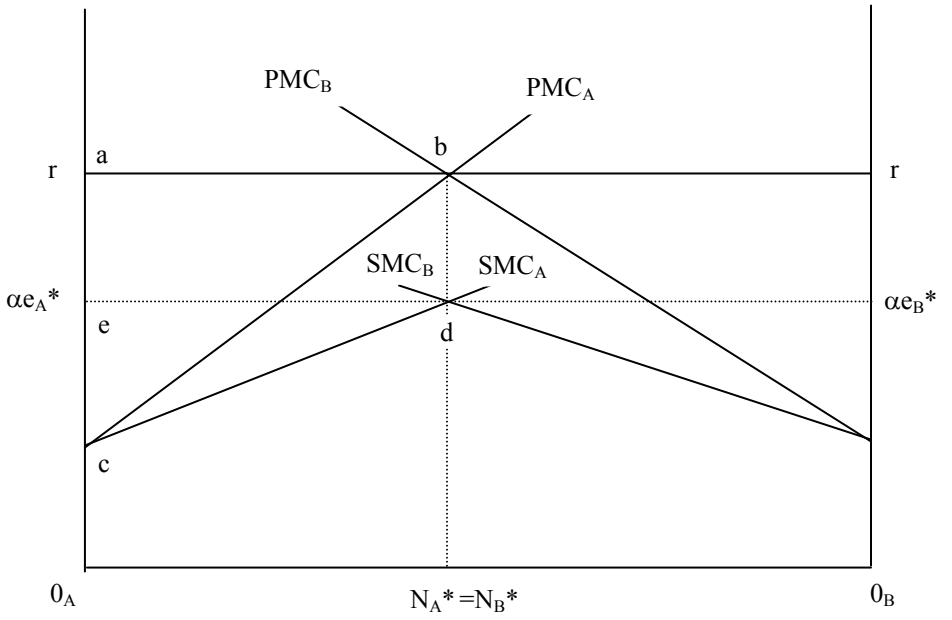

Figure 1

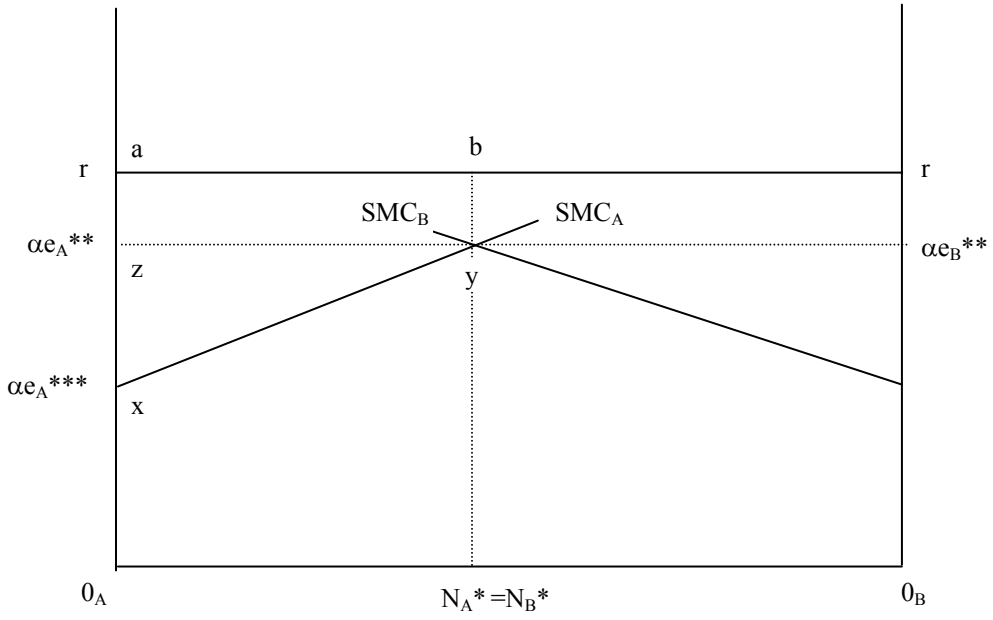

Figure 2