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Capital and Capital Service Costs in 2700 US Colleges and Universities

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ABSTRACT

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Using data generated for a study of student subsidies (in WPEHE Discussion Paper No. 32), this paper reports on the distribution of capital stocks and the costs of capital services in 2700 colleges and universities in 1991. The $330 billion in physical capital estimated for these institutions imply that $40 billion in yearly capital service costs are incurred in US higher education, adding roughly 33% to reported current costs. While private Research-I Universities have the most capital per student ($143,557) and public Two-Year Colleges have the least ($14,540), a greater disparity in capital stocks appears when schools are differentiated by wealth -- their average subsidies per student. The top decile of private schools have over $150,000 of physical capital per student and the bottom decile of public schools have less than $10,000. The distortion of educational costs that results from omitting capital services range from roughly 25% for Research-I Universities, both public and private, to more than 40% for private Liberal Arts Colleges and public Comprehensive Universities. Clearly, capital service costs are large and unevenly distributed within higher education, creating serious distortions in any economic analysis that ignores them. The data are available as FoxPro files.

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CAPITAL AND CAPITAL SERVICE COSTS IN 2700 US COLLEGES AND UNIVERSITIES

Gordon C. Winston*
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Physical capital creates a problem for understanding the economics of higher education. It represents a centrally important economic input to the production process -- the essential services of buildings, equipment, and land -- but one for which we have only highly inadequate measures. In conventional collegiate financial reporting, in fact, there is no required recognition of capital services as the source of a cost of education even though it adds more than 33% to reported costs.[1] In total, US higher education uses roughly $360 billion of physical capital and the yearly costs of its capital services come to about $40 billion.

This paper has three modest objectives -- to report estimates of current values of the capital stocks used by 2,687 of the roughly 3,300 colleges and universities in the US in 1991, to give a broad sense of the distribution of physical capital and capital costs in higher education as reflected in that population, and to make these numbers available to

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1For a discussion of the sometimes-arcane reasons for this and the prospects for change, see Winston, NACUBO.

other students of higher education in the form of FoxPro or Excel files[2] These capital data, it should be noted at the outset, were generated as a byproduct of a larger study of student subsidies [Winston-Yen, 1995] but they are a byproduct that appear to be of considerable value in their own right.[3]

Since T.W. Schultz' 1960 study of US higher education [Schultz, 1960], economists have made efforts to fill in the missing information about physical capital use. A number of approaches have been used. O'Neill's influential 1971 study for the Carnegie Commission [O'Neill, 1971] used a "perpetual inventory method" borrowed from the national accounts in which reported investment flows for each year are adjusted for inflation and depreciation and added up over a long period of time to estimate the resulting capital stock. Bowen and Douglas used experts' estimates of capital requirements for a hypothetical representative institution [Bowen-Douglas, 197 1] while Bowen, alone [Bowen, 1980] based estimates on "the rental value of comparable land, buildings, and equipment in the private market economy." Duc Le To used replacement values for buildings reported in HEGIS data from the US Department of Education, a method similar to that used here though his objective was not to generate estimates for individual schools [To, 1987] But some have simply noted that capital costs "do not appear in the annual operating budget at all, and neither the totals nor their allocations

[2]Which can be got by contacting the author at gwinston@wiIliams.edu or Ethan Lewis at Ethan.G.Lewis@williams.edu.

[3] And more value will attach to the use of this same methodology to generate more complete data for all colleges and universities in a forthcoming study.

among the various final products [of the institutions] are readily available" and ignored them [James, 1978, p. 163].

The capital stock estimates used here are based on individual institutions' reports to the US Department of Education (IPEDS -- Integrated Postsecondary Educational Data System[4] -- Financial Survey) in 1991. The method of estimation is described in some detail in the Appendix, but, broadly, it used those reported capital stock figures to generate an estimate of current replacement value for buildings (B,), equipment (E,), and land (L,) for each school in the population -- as reported and analyzed in Sections I and II below -- and to estimate the yearly flow of capital service costs for each institution -- as described in Section III.

The 2687 schools reported on here represent that subset of the 3356 US colleges and universities that had positive student enrollments, more than 99 FTE students and 20% or more undergraduate enrollments as described in the IPEDS fall enrollment data for 199 1. These restrictions were imposed on the population because schools with fewer than one hundred students appeared to generate quite unreliable financial data and because schools with less than 20% undergraduate enrollment were dubiously relevant for a study of student subsidies. The first of these restrictions eliminated 409 schools and 104,572 FTE students (12.2% of the schools and 1.1% of the students in US higher education) while the second eliminated 10 schools and 18,103 students. For present

4 From CASPAR, ver. 4.4.

purposes, neither restriction is quite appropriate and each introduces, inevitably, some distortion in the picture of overall capital use that we will sketch out below.

I. The Distribution of the Capital Stock by Type and Control

While capital stock data based on the entire population of colleges and universities might reveal somewhat different patterns -- a possibility that will be examined in a later paper -- it is useful, nonetheless, to see what these somewhat limited data tell us about where the US educational capital is used and what it means for our understanding of educational costs. So this section looks at the distribution of capital stocks by institutional type and control, in the aggregate and as it is distributed among schools and among students.[5] The next section takes advantage of the newly available data on student subsidies to look at how that capital stock is distributed over the hierarchy of schools as defined by their ability to subsidize their students -- roughly by their wealth.[6]

Most broadly, Table 1 shows that $330 billion in total capital assets in these 2,687 institutions give the average school a capital stock of just under $123 million and equips

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5 Though it is important to keep in mind that these are figures for total institutional capital and not that portion of the educational capital stock allocated to instructional purposes.

6 Bradburd and Mann [1993] usefully describe the wealth equivalent of e.g. appropriations flows. It is in that sense that non-tuition resources measure wealth.

Table 1

The Capital Stock in US Higher Education

	Number of Institutions	Average Enrollment (FTE's)	Total Capital Stock	Fraction of Capital Stock	Average Capital Per School	Average Capital Per Student
	(1)	(2)	(3)	(4)	(5)	(6)
All Institutions	2,687	3,462	$330,224,409,385	100.0%	$122,897,063	$35,497
Public Institutions	1,386	5,128	$213,691,341,429	64.7%	$154,178,457	$30,068
Private Institutions	1,301	1,688	$116,533,067,956	35.3%	$89,571,920	$53,068

*The 2,687 US Institutions reporting in the Integrated Postsecondary Educational Data System with undergraduate enrollment $\geq$ 20% and $\geq$ 100 FTE.

the typical student (FTE) with $34,000 of buildings, equipment, and land. Those, of course, are 1991 dollars.

The next two lines of Table 1 divide that aggregate capital stock between public and private schools showing that roughly two-thirds of it is to be found in the public sector. There are a few more public than private schools in our population so the average public institution works with about eighty percent more capital -- at $154 million -- than does the average private institution -- with $90 million. But the last column of the table reverses the apparent dominance of the public institutions by recognizing the very different size of the typical college or university in the two sectors -- an average of 5,100 students in public institutions and only 1,700 in private ones -- so that the typical student in the private sector is equipped with over 75% more capital than the typical student in a public institution.

The broad picture, then, is that a $330 billion capital stock has been allocated largely to public institutions but that their average size is so much greater than that of private colleges and universities that the typical student is left with far less capital in the public than in the private sector.

Table 2 considers public and private sectors together to describe the allocation of the US capital stock by type of institution, using Carnegie classifications. It's useful to concentrate at first on the six types of institution that Carnegie identifies -- Research,

Table 2

The Capital Stock in US Higher Education

by Carngie Type

	Number of Institutions	Average Enrollment (FTE's)	Total Capital Stock	Fraction of Capital Stock	Average Capital Per School	Average Capital Per Student
	(1)	(2)	(3)	(4)	(5)	(f-5)
All Institutions	2,687	3,462	$330,224,409,385	**100.0%**	$122,897,063	$35,497
Research	101	19,413	$134,870,953,693	40.8%	$1,335,355,977	$68,788
Doctoral	105	10,022	$38,195,822,747	11.6%	$363,769,740	$36,296
Comprehensive	568	4,713	$72,314,493,221	21.9%	$127,314,249	$27,012
Liberal Arts	540	1,049	$27,550,626,282	8.3%	$51,019,678	$48,647
2-Year	1,077	2,563	$40,394,086,036	12.2%	$37506,115	$14,635
Specialized	296	967	$16,898,427,406	5.1%	$57,089,282	$59,021

*The **2,687** US Institutions reporting in the Integrated Postsecondary Educational Data System with undergraduate enrollment ≥ **20%** and 2100 FTE.

Doctoral, and Comprehensive Universities, Liberal Arts and Two-Year Colleges, and Specialized Institutions -- and initially ignore the further qualitative breakdown of these types into Carnegie levels I and II.

By any measure, Research Universities have the lion's share of the US educational capital. Which is hardly surprising. The 101 such institutions included in Table 2 have, in total, $135 billion or 41% of all the capital stock in US higher education[7] even though they represent only 4% of the schools. The average Research University, what's more, uses about $1.3 billion of physical capital and the typical student in the research universities is associated with the largest amount of capital, $69,000 per student. Once again, it is important to keep in mind that these are figures for total capital and not just that used in instruction or student residences or activities, so the average student in a Research University may be only remotely associated with much of that capital stock (or "What does the Linear Accelerator mean to a Stanford Sophomore majoring in Art History?').

For types of institutions other than Research Universities, the patterns of capital allocation are less consistent. So Comprehensive Universities have the second largest allocation of capital in the aggregate ($72 billion or 22%), but there are so many of them that they have less capital per school than the Doctoral Universities and they are so large that they have less capital per student than Doctoral Universities, Liberal Arts Colleges,

7 In strict accuracy, these figures describe only the subset of 'US higher education' represented by these 2,687 schools but that seems clear enough to allow this more relaxed representation.

or Specialized Institutions. The Two-Year Colleges are in a similar position with more than $40 billion or 12% of all capital -- putting them third in aggregate terms -- but since they divide that capital among so many schools and among so many students, both the average Two-Year school and the average student in Two-Year Colleges are least well equipped with capital stock. The opposite kind of story is told for Liberal Arts Colleges and Specialized Institutions. Liberal Arts colleges have only $27.6 billion of the aggregate capital stock -- 8% of it -- yet they are few enough in number and small enough in enrollment that they rank third in capital per student with 70% as much as the Research universities. And it becomes relevant, to repeat it once again, that we are reporting total institutional capital stock in each case so with their much greater concentration of activities on students, Liberal Arts Colleges quite likely have the largest amount of student-oriented capital. Doctoral Universities are second to Research Universities in capital-per-school, but again they are so large that they fall behind Research, Liberal Arts, and Specialized institutions in capital per student.

The Carnegie classification further divides Research, Doctoral, Comprehensive, and Liberal Arts institutions into quality rankings, I and II, on the basis of the number and variety of degrees awarded, the magnitude of research funding, and admissions selectivity. Adding that detail in Table 3 (and Figure 1) modifies the picture of capital allocation somewhat. Research-I universities clearly have the largest capital stocks in the aggregate, per school, and per student but a quite sharp division appears among Research Universities as Research-II schools have about two-thirds as much -- per school and per

Table 3

The Capital Stock in US Higher Education

by Carnegie Type and Quality

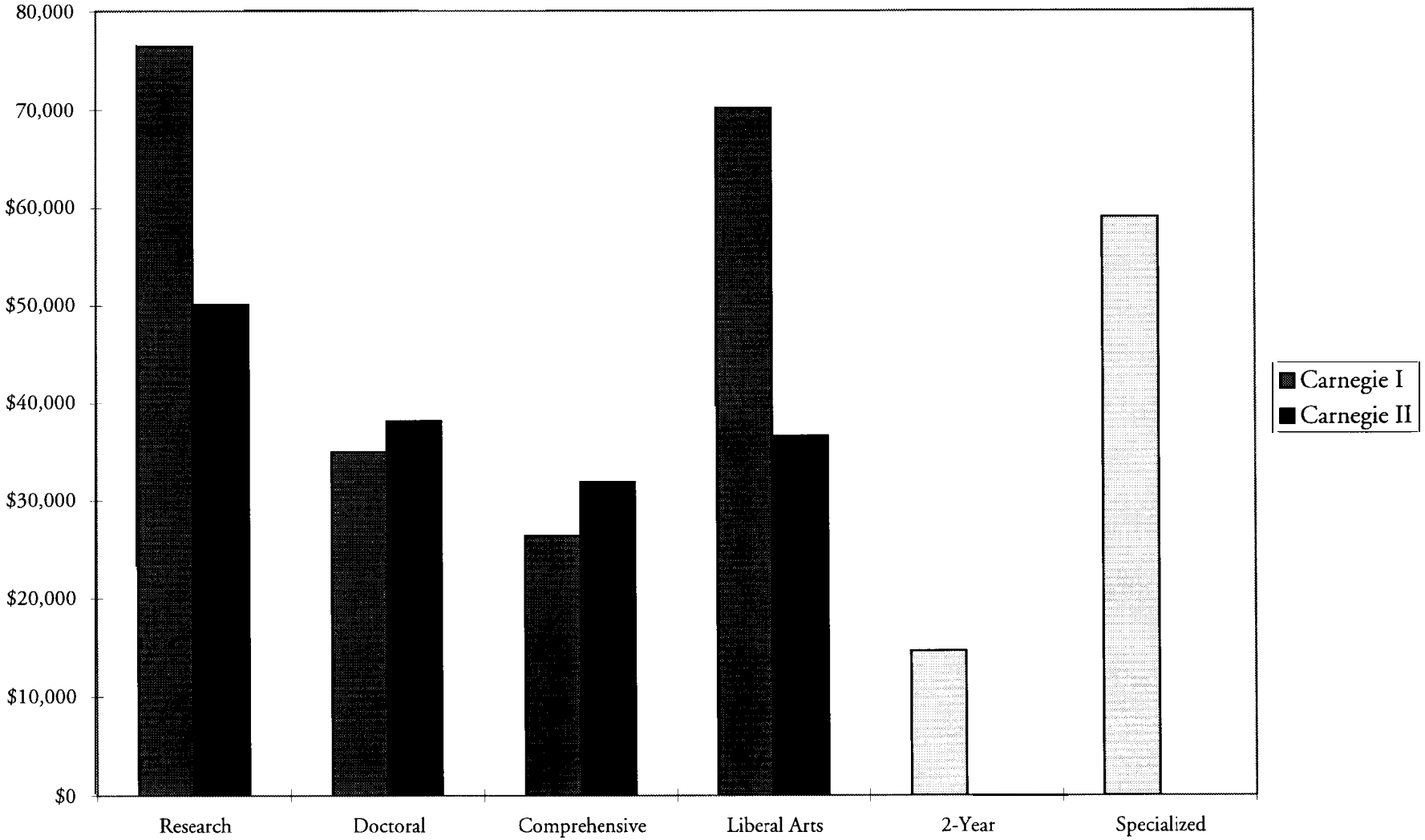
	Number of Institutions	Average Enrollment (FTE's)	Total Capital Stock	Fraction of Capital Stock	Average Capital Per School	Average Capital Per Student
	(1)	(2)	(3)	(4)	(5)	(6)
All Institutions	2,687	3,462	$330,224,409,385	**100.0%**	**$122,897,063**	$35,497
Research I	67	20,758	$106,300,778,168	32.2%	$1,586,578,779	$76,433
Research II	34	16,762	$28,570,175,525	8.7%	$840,299,280	$50,131
Doctoral I	48	12,859	$21,595,402,863	6.5%	$449,904,226	$34,988
Doctoral II	57	7,633	$16,600,419,883	5.0%	$291,235,437	$38,152
Comprehensive I	402	5,929	$62,937,397, 518	19.1%	$156,560,690	$26,407
Comprehensive II	166	1,770	$9,377,095,703	2.8%	$56,488,528	$31,923
Liberal Arts I	139	1,463	$14,267,183,592	4.3%	$102,641,609	$70,149
Liberal Arts II	401	905	$13,283,442,690	4.0%	$33,125,792	$36,599
2-Year	1,077	2,563	$40,394,086,036	12.2%	$37,506,115	$14,635
Specialized	296	967	$16,898,427,406	5.1%	$57,089,282	$59,021

*The 2,687 US Institutions reporting in the Integrated Postsecondaty Educational Data System with undergraduate enrollment >_ 20% anc≥100 FTE.

Figure 1

Capital Stock Per Student

by Carnegie Type and Quality



student -- as do Research-I institutions. The other notable feature is that students at Liberal Arts-I Colleges are very nearly as well endowed with capital as are those at Research-I Universities -- only 8% less -- at the same time that institutions' capital is certainly more directed toward student activities in the colleges than in the universities. Again, a sharp split is found between Liberal Arts I and II Colleges with the latter having roughly half as much capital stock per student as the former. All this is shown, too, in Figure 1.

Table 4 reports Carnegie type and public/private control dimensions, together, to show capital allocations by institutional type separately for public and private sectors.

The clear superiority of physical capital endowments at even the Research-I Universities looks rather different when we recognize this additional dimension of control: private Research-I Universities do work with a very large amount of physical capital -- and a very large amount per student -- but public Research-I Universities have far less. The figures for capital stock per student are $143,557 and $58,505, respectively -- public Research-I schools have a tad more than 40% of the capital per student found in private Research-I schools. Research-II Universities fare better in the public sector relative to their more highly-rated peers -- with a per-student capital allocation that is 77% that of Research-I institutions. In the private sector, Research-II schools have only 57% as much capital per student as Research-I institutions, though they still have nearly twice as much as the public Research-II Universities.

Tabld 4

The Capital Stock in US Higher Education

by Control, Carnegie Type and Quality

	Number of Institutions	Average Enrollment (FTE's)	Total Capital Stock	Fraction of Capital Stock"	Average Capital Per School	Average Capital Per Student	Average Capital/ Output Ratio	Average Capital/ Asset Ratio
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
All Institutions	2,687	3,462	$330,224,409,385	100.0%	$122,897,063	$35,497	2.20	92.1%
All Public	1,386	5,128	$213,691,341,429	64.7%	$154,178,457	$30,068	2.10	98.9%
All Private	1,301	1,688	$116,533,067,956	35.3%	$89,571,920	$53,068	2.31	84.8%
				Public Institutions				
Research I	43	25,526	$64,216,184,241	30.1%	$1,493,399,634	$58,505	1.93	93.7%
Research II	26	18,982	$22,271,488,895	10.4%	$856,595,727	$45,127	2.19	96.2%
Doctoral I	30	15,470	$15,351,549,171	7.2%	$511,718,306	$33,077	2.24	97.2%
Doctoral II	32	9,385	$11,173,158,337	5.2%	$349,161,198	$37,204	2.33	97.7%
Comprehensive I	275	6,933	$47,558,319,433	22.3%	$172,939,343	$24,946	2.32	99.0%
Comprehensive II	47	2,043	$3,085,101,414	1.4%	$65,640,456	$32,134	2.58	99.0%
Liberal Arts I	2	2,310	$415,139,039	0.2%	$207,569,520	$89,863	3.59	95.8%
Liberal Arts II	29	1,295	$1,148,124,397	0.5%	$39,590,496	$30,570	2.30	97.9%
2-Year	840	3,101	$37,878,208,279	17.7%	$45,093,105	$14,540	1.99	99.4%
Specialized	62	1,638	$10,594,068,224	5.0%	$170,872,068	$104,288	2.12	99.1%
				Private Institutions				
Research I	24	12,215	$42,084,593,927	36.1%	$1,753,524,747	$143,557	1.84	66.6%
Research II	8	9,548	$6,298,686,630	5.4%	$787,335,829	$82,459	1.94	69.3%
Doctoral I	18	8,506	$6,243,853,693	5.4%	$346,880,761	$40,779	1.83	77.0%
Doctoral II	25	5,392	$5,427,261,547	4.7%	$217,090,462	$40,265	2.07	76.0%
Comprehensive I	127	3,755	$15,379,078,085	13.2%	$121,095,103	$32,248	2.15	82.4%
Comprehensive II	119	1,662	$6,291,994,289	5.4%	$52,873,902	$31,820	2.31	83.8%
Liberal Arts I	137	1,451	$13,852,044,553	11.9%	$101,109,814	$69,69 1	2.73	66.1%
Liberal Arts II	372	875	$12,135,318,293	10.4%	$32,621,823	$37,295	2.59	85.9%
2-Year	237	654	$2,515,877,757	2.2%	$10,615,518	$16,239	1.94	92.7%
Specialized	234	789	$6,304,359,181	5.4%	$26,941,706	$34,128	2.22	91.8%

*The sample is the 2,687 IPEDS-reporting US Institutions with undergraduate enrollment ≥20% and ≥100 FTE.

**For public institutions, this column represents the fraction of the gross capital stock of all public institutions in the sample; For private institutions, this column represents the fraction of the gross capital stock of all private institutions in the sample

In private colleges, too, the gap between Liberal Arts-I and -11 is large: students in the second-tier private Liberal Arts schools have only 53% as much capital as those in the first-tier schools. It's not useful, note, to make much of the figures for public Liberal Arts-I schools since there are only two of them in the whole school population (Virginia Military Institute and SUNY Purchase).

Finally, the very different positions of public and private Specialized Institutions underlines the catch-all nature of that classification. The 62 public Special Institutions that give the average student $104,288 in capital are dominated by medical schools (42% of those that can be sub-classified) while the 234 private Specialized schools that give their students $34,128 of physical capital are dominated by religion (38%), art (23%), and business (16%).

In the last two columns of Table 4, two additional comparisons are made in which capital stocks are viewed, first, relative to institutional "output" and, second, relative to the institution's financial assets. The capital-output ratios reported there represent the value of an institution's capital stock relative to the value of its output as measured by total input costs over all activities.[8] Each entry describes the capital-output ratio of the average college or university of that type and control. The highest capital-output ratios are those of the private Liberal Arts Colleges, both I and II, while Research-I Universities in both public and private sectors are among the lowest. Since we know that Research

8 Net of financial aid costs but inclusive of capital costs. This conforms to the usual practice, in for-profit industries, of reporting capital-output ratios as the value of the capital stock per dollar of output which includes the value of capital services that are embedded in normal profits.

Universities have the largest amounts of capital per student in both sectors (ignoring public Specialized schools), these low capital-output ratios appear to reflect the greater significance of non-student oriented activities in these schools, leaving us with little sense, from these numbers, of how well equipped are their students. The high capital-output ratios of the Liberal Arts I schools do, in contrast, reflect the use of capital in student-oriented activities.

The last column of Table 4 describes the relative importance of physical capital in total assets' with the predictable result that private institutions, with their greater reliance on endowment wealth, have a smaller fraction of their total assets in the form of physical capital than do public institutions. It is notable, though, that among public institutions, even Research-I Universities have the vast majority (93.7%) of their assets in a physical capital.[10] Overall, the average private institution has 84.8% of its assets in physical form while the average public institution has 98.9%. Among private institutions, Liberal Arts-I schools have the smallest share of their assets tied up in physical capital with 66.1% while Research-I and II Universities are close with 66.6% and 69.3%, respectively. private Two-Year Colleges look a lot like the public institutions with 92.7% of their assets in the form of physical capital.

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9 This is not the ratio of physical to financial wealth since neither asset figure is adjusted for liabilities -- in the form of accumulated deferred maintenance of physical assets or accumulated liabilities against financial assets [Winston, *Planning]*. Indeed, the financial assets here are only those reported as endowment and quasi-endowment in IPEDS so the (usually small) category of non-endowment financial assets is not included.

10 Though some caution is advised in taking reported endowment figures too seriously for public institutions since the use of "foundations" to conceal endowment wealth in these schools is widespread. [Warren, 1991]

II. The Distribution of the Capital Stock by Subsidy Ranking

The paper that spawned this report on physical capital generated estimates of the subsidies that colleges and universities offer their students -- as financial aid that lets a student's net price fall below the sticker price or, more typically, as a general subsidy got by setting the sticker price below the costs of the student's education [Winston-Yen, 1995]. It was hypothesized that these subsidies and the ability to award them -- which differ markedly among institutions -- describe an important hierarchy of colleges and universities with ramifications for their price, quality, size, and aid policies.

In Tables 5a and 5b, the value of physical capital is reported by the subsidy ranking of the 2,687 schools of this population. Average subsidies range from an average of $21,135 a year for students in the top decile of private colleges and universities down to $488 a year for those in the bottom decile of private institutions, with average subsidies granted by public institutions falling between those extremes.

The dominant fact about the relationship between student subsidies and the schools' use of capital is the clear and relentless decline in capital endowment with declining subsidies. Large capital stocks go with high subsidies -- in the aggregate, in the average school, and for the average student -- and small capital stocks go with low subsidies. So more generous capital services are one of the very concrete ways that

Table 5a

The Capital Stock in US Higher Education

By Subsidy Decile

	Average Enrollment (FTE's)	Average Subsidy Per Student	Total Capital Stock	Fraction of Capital Stock	Average Capital Per School	Average Capital Per Student	Average Capital/ output Ratio	Average Capital/ Asset Ratio
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
All Institutions	3,462	$7,55 **1**	$330,224,409,385	**100.0%**	$122,897,063	$35,497	**2.20**	92.1%
Decile 1	3,224	$20,801	$90,135,124,701	27.3%	$335,074,813	$103,925	**2.68**	83.2%
Decile 2	3,166	$10,594	$41,910,288,718	12.7%	$155,800,330	$49,204	**2.55**	88.5%
Decile 3	4,281	$8,680	$48,617,923,891	14.7%	$180,735,777	$42,219	**2.42**	92.2%
Decile 4	4,126	$7,627	$37,552,785,911	11.4%	$139,601,435	$33,838	**2.33**	93.5%
Decile 5	4,333	$6,760	$3 1,224,606,936	9.5%	$116,076,606	$26,79 1	**2.27**	93.7%
Decile 6	3,637	$6,010	$22,696,617,764	6.9%	$84,374,044	$23,201	**2.18**	94.3%
Decile 7	3,821	$5,300	$22,074,935,148	6.7%	$82,062,956	$21,476	**2.13**	93.9%
Decile 8	3,165	$4,591	$15,478,578,511	4.7%	$57,755,890	$18,250	**2.00**	94.1%
Decile 9	3,094	$3,646	$13,776,742,881	4.2%	$5 1,405,757	$16,613	**1.84**	93.2%
Decile 10	1,767	$1,457	$6,756,804,924	2.0%	$25,211,959	$14,271	**1.64**	94.1%

*The 2,687 US Institutions reporting in the Integrated Postsecondary Educational Data System with undergraduate enrollment ≥ 20% and ≥100 FTE. All Deciles have 268 or 269 institutions.

Table 5b

The Capital Stock in US Higher Education

By Public and Private Subsidy Decile

	Average Enrollment (FTE's)	Average Subsidy Per Student	Total Capital Stock	Fraction of Capital Stock"	Average Capital Per School	Average Capital Per Student	Average Capital/ Output Ratio	Average Capital/ Asset Ratio
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
All Institutions	3,462	$7,551	$330,224,409,385	100.0%	$122,897,063	$35,497	2.20	92.1%
All Publics†	5,128	$7,839	$213,691,341,429	64.7%	$154,178,457	$30,068	2.10	98.9%
All Privates†	1,688	$7,244	$116,533,067,956	35.3%	$89,571,920	$53,068	2.31	84.8%
				Public Institutions				
Decile 1	5,318	$20,149	$51,766,355,716	24.2%	$372,419,825	$70,026	2.41	98.2%
Decile 2	5,384	$9,811	$28,230,714,503	13.2%	$203,098,665	$37,723	2.28	99.0%
Decile 3	6,573	$4,981	$37,659,147,711	17.6%	$270,929,120	$41,220	2.29	98.0%
Decile 4	5,204	$5,314	$22,419,985,784	10.5%	$161,294,862	$30,997	2.25	99.2%
Decile 5	5,457	$4,429	$17,483,237,620	8.2%	$125,778,688	$23,050	2.07	99.4%
Decile 6	5,052	$4,499	$16,098,096,398	7.5%	$115,813,643	$22,924	2.15	99.2%
Decile 7	5,255	$3,846	$15,113,912,025	7.1%	$109,521,102	$20,842	2.06	98.6%
Decile 8	4,350	$3,391	$9,977,806,209	4.7%	$72,302,944	$16,622	2.05	99.2%
Decile 9	4,461	$2,598	$9,610,508,352	4.5%	$69,641,365	$15,610	1.85	99.2%
Decile 10	4,208	$1,601	$5,331,577,111	2.5%	$38,634,617	$9,182	1.63	99.1%
				Private Institutions				
Decile 1	2,420	$21,135	$47,632,240,094	40.9%	$366,401,847	$151,436	2.82	72.6%
Decile 2	1,224	$11,552	$12,177,757,540	10.5%	$93,675,058	$76,510	2.84	78.6%
Decile 3	1,068	$9,233	$7,915,880,826	6.8%	$60,891,391	$57,032	2.64	82.5%
Decile 4	1,849	$7,666	$12,557,562,211	10.8%	$96,596,632	$52,244	2.53	81.0%
Decile 5	1,422	$6,471	$7,633,386,841	6.6%	$58,718,360	$41,288	2.52	84.9%
Decile 6	1,711	$5,427	$7,764,441,838	6.7%	$59,726,476	$34,917	2.29	85.1%
Decile 7	1,679	$4,534	$7,024,381,332	6.0%	$54,033,703	$32,182	2.20	87.3%
Decile 8	2,175	$3,579	$7,056,477,330	6.1%	$54,280,595	$24,953	1.95	88.3%
Decile 9	1,743	$2,413	$4,336,227,338	3.7%	$33,355,595	$19,138	1.79	9 1.6%
Decile 10	1,589	$488	$2,434,712,605	2.1%	$18,585,592	$11,697	1.55	95.9%

*The sample is the 2,687 IPEDS-reporting US Institutions with undergraduate enrollment ≥20% and ≥100 FTE.

**For public institutions, this column represents the fraction of the gross capital stock of all public institutions in the sample. For private institutions, this column represents the fraction of the gross capital stock of all private institutions in the sample.

†There are 1,386 public institutions and 1,301 private institutions in the sample. All public deciles contain 138 or 139 institutions, and all private deciles contain 130 or 131 institutions.

students are subsidized in the high-subsidy schools.[11] It is no accident that lavish physical plants are found at the high subsidy schools.

Winston and Yen determined that while average student subsidies are very similar in the public and private sectors ($7,839 and $7,244, respectively), they support very different price-cost-quality policies: public institutions on average charge a low price ($921) for a low-cost education ($8,760) while private institutions go the other way with both a higher price ($5,424) and a higher cost ($12,669). The ***proportion*** of his or her educational costs paid by the average student is always lower in public sector schools, over all the deciles. So in decile averages, the student in a highly subsidized public school pays 5.5 cents on the dollar of his educational costs while a student at the least subsidized public school pays 23.3 cents. But even the most highly subsidized student in a private school pays 24.7 cents on the dollar while in the least subsidized decile, he or she pays a full 9 1.6 cents.

Comparing the amount of capital used in public and private schools, arranged by size of student subsidy -- Table 5b -- the same kind of decline of capital use with declining subsidy appears in both sectors, but with less regularity than in the aggregated data in Table 5a. Still, lower subsidies go with less use of capital. But it is the skeweness of the capital allocation in the private sector -- and its moderation in the public sector --

11 Note that this is not a tautology. While the cost of capital services is (an important) part of the per-student cost that determines a student's subsidy -- subsidy is the difference between cost and net price, S = C - P, a given subsidy can go with high price and cost or with low price and cost. So Cooper Union grants a $26,656 subsidy by giving a $26,656 education at a zero price while Williams gives a similar $28,795 subsidy by charging $11,554 for an education that costs $40,349 to produce. [Winston-Yen, 1995].

that comes through most clearly in Table 5b. Fully 4 1% of all the capital stock in the private sector -- almost half -- is concentrated in those 10% of the schools that give the largest student subsidies. On average, those schools are equipped with more than $366 million in capital stock and, because they are also relatively small, their students enjoy the services of $15 1,000 of capital each.

The last two columns of Tables 5 show a strong decline in capital-output ratios with falling subsidies in the aggregate data indicating, once again, that those schools offering the largest subsidies to their students use the largest amount of capital relative to other inputs. While that decline is not so regular within each sector alone, it is nearly so. In the last column, the relative importance of physical capital as an asset is shown to increase with decreasing subsidies -- poorer schools don't have or use much wealth other than physical capital stocks. That pattern, too, carries over from aggregate to sectors, taken separately, but again with greater variation in the private than in the public sector.

III The Costs of Capital Services -- and The Distortion When Ignored

Everything to this point has been in terms of capital stocks and their distribution. There remains the important question of how seriously the omission of capital costs distorts our understanding of costs in higher education and how those distortions are, themselves, distributed among schools by type, control, and subsidy hierarchy. To that

end, we turn in this final section first to the data of Table 6 that reports the percent by which total yearly c ost[12] are increased when we recognize the costs of capital services.

The top three lines of Table 6 report annual current expenditures and capital service costs for all the institutions in our population and for public and private institutions separately. Two aspects of those data are remarkable:

- The distortion in measured educational costs due to the conventional omission of capital service costs is very large -- an accurate measure of the costs of higher education would, on average over all institutions, show them to be a full one-third higher than they are reported to be.[13]

- Despite than the sheer size of the distortion caused by the omission of capital costs, the distribution of that distortion by type and control does not appear to be very interesting. There are no significant differences either between public and private institutions or between quality levels, I and II, among Carnegie types. The only difference of note by type is the higher degree of cost distortion found in Liberal Arts Colleges, both public and private.

Table 7 is another matter. In it, the distortion of costs due to omission of capital service costs is reported over the range of institutions ranked by student subsidy decile --

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12 In Winston-Yen, only educational (instructional) costs were at issue but the percentage distortions reported in this section apply, too, to them since we calculated the division of capital costs between instruction and non-instructional uses to be the same as the division of non-capital costs.

13 It should be noted that the measure of current expenditures used in Table 6 leaves out mandatory transfers because -- as explained in the Appendix -- they are sometimes the vehicle for recognizing actual capital service costs. Were such transfers of considerable moment, we could not reasonably describe the expenditures in Table 6, then, "as conventionally reported." But in fact, mandatory transfers are a mere I .7% of total current expenditures, so it did not seem necessary to honor that distinction.

Table 6

Current Costs and the Distortions of Omitted Capital Services

by Carnegie Type and Quality

	Number of Institutions	Current Expenditures[1]	Annual Cost of Capital Services	Distortion for Average School
	(1)	(2)	(3)	(4)
All Institutions	2,687	$124,167,691,000	$35,994,279,948	33.4%
Public Institutions	1,386	$8 1,122,692,000	$23,300,542,536	31.2%
Private Instiutions	1,301	$43,044,999,000	$12,693,737,412	35.7%
		Public Institutions		
Research I	43	$27,143,263,000	$7,02 1,409,347	27.2%
Research II	26	$7,768,0 18,000	$2,43 1,230,897	32.0%
Doctoral I	30	$5,202,558,000	$1,676,887,682	32.8%
Doctoral II	32	$3,782,859,000	$1,215,578,783	34.9%
Comprehensive I	275	$16,235,421,000	$5,183,426,141	35.1%
Comprehensive II	47	$840,46 1,000	$337,494,280	41.4%
Liberal Arts I	2	$63,863,000	$44,744,287	66.1%
Liberal Arts II	29	$324,146,000	$125,710,503	35.8%
2-Year	840	$15,129,882,000	$4,105,985,695	28.8%
Specialized	62	$4,632,221,000	$1,158,074,921	34.4%
		Private Institutions		
Research I	24	$17,581,692,000	$4,574,988,998	26.2%
Research II	8	$2,879,706,000	$688,754,269	28.0%
Doctoral I	18	$2,781,554,000	$680,783,400	25.5%
Doctoral II	25	$2,170,120,000	$589,582,486	29.8%
Comprehensive I	127	$5,489,946,000	$1,673,343,776	31.6%
Comprehensive II	119	$1,972,612,000	$686,859,731	34.7%
Liberal Arts I	137	$3,495,335,000	$1,515,920,589	43.8%
Liberal Arts II	372	$3,254,042,000	$1,325,158,491	41.7%
2-Year	237	$999,189,000	$272,992,521	28.0%
Specialized	234	$2,420,803,000	$685,353,151	34.7%

[1] Includes E&G, Hospital, Auxilliary Enterprises and Independant operations; excludes scholarships, fellowships and mandatory transfers. (See appendix.)

Table 7

Current Costs and the Distortions of Omitted Capital Services

by Public, Private and All Institution Subsidy Deciles

	Number of Institutions	Average Subsidy Per Student	Current Expenditures[1]	Annual Cost of Capital Services	Distortion for Average School
	(1)	(2)	(3)	(4)	(5)
			All Institutions		
Decile 1	269	$20,801	$36,392,234,000	$9,828,336,618	46.9%
Decile 2	269	$10,594	$14,529,496,000	$4,571,786,757	40.3%
Decile 3	269	$8,680	$17,382,211,000	$5,308,642,335	37.6%
Decile 4	269	$7,627	$13,046,891,000	$4,097,553,685	35.2%
Decile 5	269	$6,760	$11,193,133,000	$3,402,099,729	34.1%
Decile 6	269	$6,010	$8,021,019,000	$2,469,105,373	32.2%
Decile 7	269	$5,300	$8,192,029,000	$2,407,550,753	31.1%
Decile 8	268	$4,591	$6,087,151,000	$1,683,915,820	28.6%
Decile 9	268	$3,646	$5,925,949,000	$1,492,488,381	25.4%
Decile 10	268	$1,457	$3,397,578,000	$732,800,497	22.3%
			Public Institutions		
Decile 1	139	$20,149	$21,542,407,000	$5,655,380,537	40.6%
Decile 2	139	$9,811	$10,326,764,000	$3,077,627,282	34.5%
Decile 3	139	$8,355	$13,635,171,000	$4,114,190,862	34.6%
Decile 4	139	$7,610	$7,779,364,000	$2,445,118,481	33.6%
Decile 5	139	$6,917	$6,195,608,000	$1,901,033,422	30.1%
Decile 6	139	$6,307	$5,461,892,000	$1,753,349,348	31.4%
Decile 7	138	$5,762	$5,731,556,000	$1,646,714,069	29.9%
Decile 8	138	$5,198	$3,761,558,000	$1,087,472,071	29.5%
Decile 9	138	$4,600	$4,064,387,000	$1,043,950,901	25.6%
Decile 10	138	$3,597	$2,623,985,000	$575,705,563	22.0%
			Private Institutions		
Decile 1	130	$21,135	$18,162,610,000	$5,181,501,177	50.5%
Decile 2	130	$11,552	$3,908,373,000	$1,332,269,278	46.8%
Decile 3	130	$9,233	$2,407,554,000	$865,246,940	42.2%
Decile 4	130	$7,666	$4,707,720,000	$1,371,893,742	39.3%
Decile 5	130	$6,471	$2,436,637,000	$831,148,495	39.1%
Decile 6	130	$5,427	$2,775,219,000	$846,011,594	34.0%
Decile 7	130	$4,534	$2,557,711,000	$765,539,023	32.2%
Decile 8	130	$3,579	$2,806,621,000	$766,194,832	27.4%
Decile 9	130	$2,413	$1,873,690,000	$470,369,628	24.9%
Decile 10	131	$488	$1,408,864,000	$263,562,703	20.7%

[1] Includes E&G, Hospital, Auxilliary Enterprises and Independent operations; excludes scholarships, fellowships and mandatory transfers. (See the appendix.)

by the degree to which they offer subsidies to their average student as described above. This is a measure of their non-tuition resources, hence it is roughly a measure of institutional 'wealth.'

Two facts stand out:

- There is, quite reasonably, far more distortion of reported costs in wealthy schools than in poorer ones -- those with the largest capital stocks will most seriously understate their true costs by ignoring them.[14] This does not follow trivially from the size of their capital stocks since what is reported here depends on the size of their capital stocks relative to their other ***spending. So*** Table 7 suggests that capital service inputs become ***relatively*** less important for poorer schools.[15] And the regularity of declining distortion over the ten deciles is notable.

- private institutions show more distortion from the omission of capital costs than do public ones. While those differences in distortion were not very dramatic as reported over all public (3 1.2%) and all private (35.7%) institutions in Table 6, they become clearer in Table 7 when schools of comparable wealth can be compared so that the concentration of that distortion in the wealthiest schools is revealed. In the top decile, distortion due to omitted capital costs is 25% higher in private than in public schools (9.9 percentage points) while in the bottom decile, it is 6% lower (1.3 percentage points). And the transition between them is quite smooth.

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14 Subsidy (as cost-price) is clearly not independent of capital service costs but only if all else were held constant would this relationship reduce to tautology.

15 As does Table 5 in showing declining capital-output ratios by subsidy decile.

IV. Conclusions

The capital stock used in US higher education is simply very large and very unevenly distributed among colleges and universities by public and private control, by Carnegie classification and, most markedly, by schools' wealth. By almost any measure, the private Research Universities and Liberal Arts-I Colleges are best endowed with physical capital -- the average student at a public Two-Year College has access to less than 1/10th as much capital as the average student at a private Research-I University. And from the poorest ten percent of public institutions to the richest ten percent of private schools, capital per student increases by more than 16 times.

Without estimates of the value of the capital stocks and costs of the capital services used, we simply don't know how much it costs to produce US higher education each year. And these data suggest that absent such estimates, we're typically way off the mark. It's also important that even when we've known that the distortions were serious, we've had inadequate information on how those distortions are distributed within higher education -- for which kinds of schools does it matter very much and for which does it matter relatively little that we neglect capital costs? On the basis of these data, we can answer those and similar questions.

And data like those presented here, built up from individual institutions, allows us to aggregate over institutions in different ways. Here, the aggregations have been by Carnegie type, by public and private control, and by wealth as reflected in student

subsidies, but other purposes might be served by geographical aggregation or size or other dimension. One caveat, however. It is not advisable to put much faith in the numbers for any individual institution considered in isolation. Quite valid results can be reported for groups of schools even if individual observations are off the mark so long as they are inaccurate in unbiased ways. So we make far more confident claims for the validity of the kinds of aggregate results reported here than for those from any single college or university.

Finally, these data should give college trustees and administrators a useful sense of how seriously their managerial and governance decisions may be distorted by the neglect the costs of capital services. On the one hand, they fly nearly blind in the portfolio decisions they make whenever they alter the allocation of their wealth between physical and financial assets -- whenever they build a building -- when they have neither accurate an measure of the value of their physical assets nor, importantly, even a hint of the value of the capital services those assets contribute to the enterprise. On the other hand, their neglect of the costs of physical capital services must guarantee internal misallocation of their scarce resources and make the delegation of decisions to others further down in the organization virtually impossible since those decisions can't realistically reflect the costs of capital.

Some $360 billion of buildings, equipment, and land is inadequately accounted for in US higher education, leading to a distortion in cost estimates of about $40 billion a year. While private Research-I Universities have the most capital per student ($143,557) and public Two-Year Colleges have the least ($14,540), a greater disparity in capital

stocks appears when schools are ranked by wealth -- their average student subsidies. The top decile of private schools have over $150,000 of physical capital per student and the bottom decile of public schools have less than $10,000. The distortion of educational costs that results from omitting capital services range from roughly 25% for Research-I Universities, both public and private, to more than 40% for private Liberal Arts Colleges and public Comprehensive Universities. Capital service costs are large and unevenly distributed within higher education, creating serious problems for any analysis that ignores them.

APPENDIX

This appendix will provide more detail on the way the capital stock figures used in this study were generated from the IPEDS data. With the exception of the identification of the instructional cost component of total current costs, it is the same as that used in Winston-Yen [1995]

In the IPEDS financial survey of 1991, each school was asked to report book and replacement values of the buildings and equipment used in their educational activities[16] as well as the book value of the land used.[17] In our earlier study of institutions' student subsidies, the objective was to estimate current replacement values of buildings, equipment, and land in order to estimate the costs of the yearly capital service flows used in instruction in each institution. To that end, it was necessary only to separate the sum of building and equipment values from the value of land[18] so the values of buildings and equipment were not estimated separately for all institutions.

The primary difficulty presented by these IPEDS physical capital data was, most simply, that not all schools reported all five of the measures of capital stock requested (book value of land and book and replacement values of buildings and equipment), nor even the three measures essential to these data (replacement values of land, buildings, and equipment). Indeed, had all schools reported to IPEDS as requested, no estimation -- but only aggregation -- would have been needed. A secondary difficulty was, of course, occasionally flaky numbers.

Capital Stock Estimates -- The Method

Broadly, for each school for which the replacement value of capital -- or any of its components -- was not reported, we filled in the missing value on the basis of the relationships revealed by those schools that did report. And while the CASPAR IPEDS data suffer from an ambiguity that makes it impossible to distinguish between a zero value (no capital) and a blank (no information), we took advantage of the fact that it's hard to imagine the production of higher education without the use of some physical capital, to justify the interpretation of all such zero-blank entries as blanks that needed to be filled in.

The goal of the subsidy study [Winston-Yen, 1995] was simply to derive reasonable estimates of the value of the capital services that are used in instruction in each institution in order that subsidy calculations -- the cost of the average student's

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16 i.e., excluding those held for investment purposes but including those used by the institution but owned by another institution or agency -- a consideration that is of the frequent importance for public colleges and universities, as in the SUNY system where much physical capital is provided by another state agency without explicit charge.

17 So IPEDS asked schools to report, for all of the capital used in their activities: book values of buildings (B_b), equipment (E_b), and land (Lb), along with replacement values for buildings (B,) and equipment (E,).

18 Since, as noted below, we did not depreciate land or land improvements while land incurred an opportunity cost in full. Schultz does this, too [Schultz, 1960].

education less the net price he pays -- would adequately reflect all costs. In this paper, in contrast, we report on **all capital** stocks and all capital service costs, and not just those used in instruction.

Capital Service Costs

From the replacement values of a school's buildings (B,), equipment (E,), and land (L,), calculation of the yearly cost of capital services is straightforward: a defensible estimate of yearly real economic depreciation, d, is joined with a defensible estimate of the opportunity cost of capital, r, to generate a yearly rental rate, $(d+r)P_kK$, where P_k is the current replacement price of a capital stock of size K making P_kK the replacement value of that capital stock. For depreciation, we used 2.5%, near the middle of the range suggested by campus physical planners (see Dunn [1989] or Probasco [1991])[19], and for opportunity cost, the long term Federal bond rate, which was 8.55% in 1991. We assigned a zero value to the depreciation of land (so we ignored depreciation of land improvements) and expressed land in current replacement values. The rental rate we used, then, was $d(B_r+E_r) + r(B_r+E_r+L_r)$ or $(d+r)(B_r+E_r) + rL_r$.

Missing Data

The first broad step involved filling in the blanks -- getting replacement values for all components of the capital stock for each school -- while the second involved estimating the yearly cost of their capital service flows. The generation of a complete set of replacement values followed a sequence of steps:

1 - 1,929 schools reported both book (B_b) and replacement values (B,) for buildings.

2 - 404 schools reported the book value of buildings (B_b) but not their replacement value (B,). To estimate the latter, we used the 1,929 reported values to generate the coefficient, $B_r = 2.138B_b$ to fill in missing building replacement values.

3 - 1,763 schools reported both book (E_b) and replacement values (E,) for equipment.

4 - For the 620 schools that reported a book value of equipment but not its replacement value, we used the 1,763 reported values to fill in the blanks. The coefficient was $E_r = 1.364E_b$.

5 - There were then 2,331 schools with reported or estimated replacement value of buildings (B,) and equipment (E,).

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19 Alternative approaches can come much the same thing. Attributing different depreciation rates to buildings and equipment [O'Neil, 1973] or to a wider variety of capital types [Probosco, 1991] might be desirable but would much exceed the limits of these data.

6 - For 11 schools that reported the value of buildings but not that of equipment, we used reported and estimated replacement values of buildings and equipment to establish the coefficient, $E_r = 0.323B_r$.[20]

7 - 290 schools did not report either book or replacement values for either buildings or equipment. To fill in these blanks, we estimated a capital-output ratio from the 2,342 schools for which we now had either reported or estimated capital values. We used as output, Q, Adjusted E&G plus Auxiliary and Hospital and Independent Operation expenditures (less all Scholarships and Fellowships and Transfers, Mandatory and Non-mandatory). The result was a capital estimate, $K_r = B_r + E_r = 2.202Q$.

8 - This coefficient was used, too, to estimate the replacement value of the capital stock for those 55 schools that reported the value of equipment but not buildings.[21]

9 - For the 424 schools that did not report a book value of land, we estimated it on the basis of the relationship between reported and estimated building and equipment replacement values and the book value of land so $L_b = 0.028(B_r + E,)$.

10 - IPEDS asked schools to report the book values of land so we estimated its replacement value as 2.138 of reported book value, using the coefficient that our data had produced between replacement and book value of buildings. This assumes that land has appreciated with inflation at the same rate, on average, as buildings.

Yearly Capital Service Costs

The result of these steps is a set of reported estimates of current replacement values for buildings, equipment, and land for each of the 2,687 schools in our population. These are discussed in Sections I and II above. From these data, the yearly costs of total capital services for each school, i, were estimated as, for the ith school, $.025(B_i + E_i) + .0855(B_i + E_i + L_i)$. These capital cost data are reported in Section III above. In the subsidy study, these total capital service costs for each institution were then allocated to instruction in proportion to the role of instructional costs in total current costs, Instructional $costs_i/(E\&G_i + Auxiliary_i + Hospital_i$ + Independent Operationsi - Scholarships & Fellowshipsi - Mandatory and Non-Mandatory Transfersi). In the data reported here, no such desegregation is reported.

Capital Ownership, Double Counting. and Deferred Maintenance

Since IPEDS appropriately asks schools to report the value of all of the buildings, equipment, and land used in their activities, we were able to generate a measure of the

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20 Note that this coefficient is substantially larger than Brinkman's reported in Due-Le T[o1987].

21 The alternative of simply using the relationship in step 6 above was dismissed as amplifying, unacceptably, any noise in reported equipment values -- going in the other direction, from building to equipment values, such noise is damped.

total yearly cost of capital services for each institution. But there is the potential for overstating capital costs for two reasons. Our method will (a) double count to the extent that all or part of these capital service costs are already included in reported current costs and (b) overstate capital costs to the extent that replacement values overstate the current value of the capital stock by ignoring accumulated deferred maintenance, thereby overstating opportunity cost. The first of these, note, affects only the estimation of capital service costs while the second affects the estimation of the value of capital stocks.

One source of potential double counting was eliminated when we subtracted from E&G (and Auxiliary and Hospital and Independent Operations expenditures) the Mandatory Transfers that are sometimes a device for reflecting capital services in current costs. Our procedure, in effect, replaces a highly idiosyncratic, even quixotic, recognition of capital costs with a systematic one.[22] As noted in the text, Mandatory Transfers represented only 1.7% of current costs in these data so that correction was appropriate, but not large.

But variations in the ownership of the capital stock -- hence in the source of the capital service flows -- would also produce double counting under our procedures. Our method is wholly appropriate for a school that owns its capital stock outright (whether or not it is used as collateral on indebtedness). Once Mandatory transfers are got rid of, no other part of the current accounts will include the costs of owned capital. But to the extent that a school *rents* its capital services, those rental charges will show up in current spending but *not* identified as rental payments so that we could avoid counting them twice. Finally, when capital services are provided, as such, by another agency, our method *won't* distort the measure of total capital costs. We doubt that double counting of costs in the presence of rented capital is of practical moment, but we can't be sure. [Winston, NACUBO]

The potential for overstating the true value of resources tied up in a capital stock -- hence the opportunity cost of that capital -- by using replacement values without an adjustment for accumulated deferred maintenance is best seen by analogy with the value of an institution's financial capital.[23] Conventionally, assets represent the gross value of financial holdings. Financial wealth, or "net worth," recognizes any offset to those financial assets in the form of financial liabilities. So *net* worth is assets less liabilities. A school (or firm or family) with $100 million in assets and $40 million in outstanding debt has a net worth of $60 million. To ignore debt and act as if all assets were unencumbered would be highly misleading. The same relationships hold with respect to physical capital, only here the value of 'assets' is the replacement value of the plant and equipment while the 'liabilities' are accumulated deferred maintenance. Their difference is 'net physical worth,' the measure of wealth held in the form of physical capital. So a school that owns land, buildings, and equipment with a replacement value of $100

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22 Whether these transfers will or won't acknowledge capital costs in excess of legally obligated debt service is entirely at the discretion of the institution, therefore the subject of considerable inconsistency.

23 See Winston, *Planning*

million on which it has accumulated $40 million in deferred maintenance has a net physical worth of only $60 million.[24]

The opportunity cost of owning physical capital recognizes the yearly cost incurred because resources are tied up in a physical form that yields no explicit return rather than in the financial form that does. If a school has accumulated no deferred maintenance, the replacement value of its physical capital is the appropriate base for reckoning its opportunity cost. This is the opportunity cost we've used. But when a school defers maintenance spending, it effectively 'liquidates' or converts that portion of its physical wealth, releasing it for other uses including investment in financial assets. So it eliminates, to the extent of accumulated deferred maintenance, some of the opportunity cost of holding its physical capital. If the school above with its $100 million capital stock incurs $2.5 million of real depreciation each year and spends that much to offset it, deferred maintenance is zero and (ignoring inflation) the capital stock is worth $100 million at the end of the year as it was at the beginning. An opportunity cost is incurred by the full $100 million in resources -- all of them are tied up in physical capital at the end of the year just as they were at the beginning. But if, instead, nothing is spent on maintenance during the year and the full $2.5 million of maintenance is deferred, only an average of $98.75 million of resources (($100+$97.5)/2) will incur an opportunity cost -- the $2.5 million not spent on maintenance by the end of the year can be spent, inter alia, on financial assets that do earn a return. After, say, ten (inflation-free) years of deferring all maintenance, a quarter of the replacement value of the capital stock will have been thereby 'liquidated' so an opportunity cost will be incurred only by the remaining $75 million -- the 'net physical worth' -- even though replacement value remains unchanged at $100 million.

There is, of course, simply no way to estimate the accumulated deferred maintenance for the individual schools of this study -- indeed, it is a difficult and often controversial task to estimate it for a single institution. So it must remain a source of potential overstatement of the value of the capital stock and of capital costs.

Dirty Data

Aside from missing numbers (and zeros), the IPEDS capital data include some numbers that are, for one reason or another, simply unbelievable. Some of these are errors in magnitudes of 10 to 1,000,000 resulting, clearly, from misplaced decimal points. Others are values that embedded economically implausible relationships. Chief among these are schools with reported current replacement value of buildings smaller than their reported book value -- an extremely unlikely relationship in a world of durable buildings in an environment of rising construction costs. (A stock of equipment, in contrast, might conceivably carry a lower replacement than book value if it were dominated by information processing equipment for which costs have fallen over time -- so this logic and its implied adjustment were not applied to equipment estimates.)

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[24] In a set of stable competitive markets with perfect information, net physical worth would describe the market price of the capital stock.

In these cases, outliers were identified by examining extreme values of, for instance, replacement/book value relationships. Using IPEDS in the CASPAR CD-ROM format has the considerable virtue of providing data for all the years of the survey which allowed the simple and often fruitful check of a flaky looking number against its value for the same institution in adjacent years. So we were often able to correct a number for 1991 on the basis of its value reported for 1990 or 1992. When that comparison revealed an error as a simple multiple of 10 to 1,000,000, the corrections carried considerable conviction. In all of these, we focused on comparative *replacement* values -- the goal of our estimates -- and worried less about accurately reported book values, which served as on a route to the replacement values.

When the sources of error were less obvious, we simply treated the outlier as a blank and estimated its value as if none had been reported. These are included in the counts reported above.

CITATIONS

Bowen, Howard R., and Gordon K. Douglass. Efficiencv in liberal education. New York: McGraw-Hill; 197 1.

Bowen, Howard R. The costs of higher education. San Francisco: Jossey-Bass; 1980.

Bradburd, Ralph M. and Duncan P. Mann, "Wealth in Higher Education Institutions," Journal of Higher Education, (July/August, 1993).

Dunn, John A., Jr. Financial planning guidelines for facilities renewal and adaptation. Ann Arbor: The Society for College and University Planning; 1989.

James, Estelle, "Product Mix and Cost Disaggregation: A Reinterpretation of the Economics of Higher Education," The Journal of Human Resources, Vol. XIII, No. 2, 1978.

National Science Foundation. Computer Aided Science Policy Analysis & Research (CASPAR) Database System Ver. 4.4. Quantum Research Corporation (QRC), Bethesda, Maryland.

O'Neill, June A., Resource use in higher education: trends in output and inputs, 1930 to 1967. Berkeley: The Carnegie Commission on Higher Education; 1971.

Probasco, Jack. "Crumbling campuses: What are the real costs?" The NACUBO Business Officer, vol. 25, no. 5 (November, 1991): 48-51.

Schulz, Theodore W. "Capital formation by education." Journal of Political Economy, vol. 68, no. 6 (December, 1960): 571-583.

To, Due-Le. Estimating the cost of a bachelor's degree: An institutional cost analysis. Washington DC: Office of Educational Research and Improvement, U.S. Department of Education; 1987.

Warren, Thomas Hartwell. "Endowments at Public Universities and Related Foundations: A Growing Force?" Thesis (B.A.), Williams College, Department of Economics, 1992.

Winston, Gordon C., and Ivan C. Yen, "Costs, Prices, Subsidies, and Aid in U.S. Higher Education," Discussion Paper No. 32, The Williams Project on the Economics of Higher Education, July, 1995.

Winston, Gordon C. "New dangers in old traditions: The reporting of economic performance in colleges and universities." Change, vol. 25, no. 1 (January/February, 1993): 18-23.

Winston, Gordon C. “The Capital Cost Conundrum," The NACUBO Business Officer, (June, 1993), pp. 22-27.

Winston, Gordon C., “The Necessary Revolution in Financial Accounting,” Planning for Higher Education, Vol. 20, No. 4, (Summer, 1992), pp. 1-16.