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NOTES ON THE ECONOMICS OF HIGHER EDUCATION

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[1]I am grateful to the Mellon Foundation for support, to Nuffield College for ideal working counditions and to Roland Benabou for instruction.
I apologise to my discussant Paul Courant and the other participants in NBER Education Meeting for the tardy appearance of this paper.

I Introduction

After 17 years as a full time academic administrator, I returned to the professoriat and started thinking systematically about two related questions:

1. What features account for the success of the US Higher education system and which of these are exportable?

2. How can we think about the efficiency of matching in education and other areas of the economy?

This paper is a progress report on these projects.

I.1 US Higher Education

It is generally agreed that the US higher education system is the best in the world.

I.1.1 Strengths

Henry Rosovsky[2] has argued that US research universities are the best in the world. My impression (getting hard evidence is on my to do list) is that the US excels on several fronts:

- Combining research and teaching in elite institutions. In France best students attend the écoles and the best researchers work at CNRS, other government think tanks, or in Universities where they have little interchange with undergraduates. In Germany the best researchers are in Universities where they seldom have contact with undergraduates and in places like the Max Plänck Institutes.

- Providing a good general education to students of all qualities; many students get a broad general education that prepares them for life in our rapidly changing society.

- Allowing second chances. While we have SATs and ACT exams and students from privileged high schools and educated families do better than those not so blessed, no exam or credential excludes US children from the best American education has to offer.

- Insulating colleges and universities from rapid political change. Many decry the conservatism of American education. Princeton's former Provost reveled in the following joke:

[2]The University: An Owner's Manual, Norton (1991).

Question: How many Princeton Professors does it take to change a light bulb?

Answer: *Change*?

However, American Universities change slowly and deliberately. They did adapt well to the many changes and challenges of the 20th century. The relatively slow pace of change stands in sharp contrast to the speed of change in Europe. Next fall, Norway will overhaul much of it system of higher education. It will adopt a 3 + 5 structure where the first degree is supposed to be general, providing the competence that a citizen of Europe needs and the five year degree is a specialized masters degree. The transition is in part a response to a declaration of European Union higher education ministers issued in Bologna in May 1999 [3], and in part a response to long felt desires for reform [4]. Still the change seems rushed. It may be that Norwegian higher education will adapt to this rapid pace of change as well as US institutions adapted to the GI bill and the great increase of research funding that followed the launch of Sputnik.

I.1.2 Exportable explanations for the success of US higher education

There are many possible explanations for the success of US higher education. It seems important for policy to try to identify forces that are exportable to other countries. Higher education is changing rapidly throughout the world. Since the US system seems so relatively successful it is worthwhile to identify important factors that account for its success. My working hypotheses emphasize the following factors, of which the first is probably not exportable):

Wealth. The endowments and are other capital assets of the best US universities exceed those of other countries by orders of magnitude. In 2001 Harvard's endowment exceeded $18 billion while the endowments and other assets of all UK institutions higher education was less than £ 7 billion in 2002[5]. Some US public universities are very rich. The

[3]Joint declaration of the European Ministers of Education Convened in Bologna on the 19th of June1999. See http://www.murst.it/convegni/bologna99/dichiarazione/english.htm

[4]See Per Nyborg, *The Quality Reform of Higher Education in NorwayA national reflection of the Bologna Process.* www.see-educoop.net/education_in/pdf/ q-reform-he-in-norway-oth-enl-t02.pdf and Kim Gunnar Helsvig CURRENT TRANSFORMATIONS IN NORWEGIAN HIGHER EDUCATION March 2002

[5]The UK figures are from Price Waterhouse and Coopers: **Higher Education Financial Yearbook**, (July 2002). One may ask if these figures properly reflect the values of vast land holdings of the older UK institutions. My best guess is that they do as the figures partly reflect the capitalized values of income streams. A skeptic might reply that simple compound interest on held since the 14th century should lead to greater valuations. One answer is that the value of real estate in the UK has not increased monotonically over the past five or six centuries but clearly more scrutiny of these figures is required.

Universities Texas and California have endowments that exceed $9 and $4.5 billion. Ten other public universities have endowments that exceed $ 1 billion.

Competition. US higher education is competitive. While public institutions comprise the great majority of US institutions of higher education (75%? get some more numbers), private institutions dominate the elite. Public institutions belong to many different systems and compete vigorously among one another for grants, faculty, political support and the like. Competition for students is intensifying to as the following headline from the October 15th Washington Post demonstrates: *Colleges Use Discounts to Draw Best Mix Of Top Students, Paying Customers.* The story goes on to note that many colleges use tuition reductions to attract the best students, destroying the "need blind" admissions policy that some elite schools claim to follow[6]. A recent report from a think tank warned about the dangers of excessive competition among universities [7].

Legitimized hierarchy. Much US education is public, including many elite research universities and many non-elite teaching institutions. State support is crucial for all these institutions[8]. The best example of legitimated hierarchy is the "California Master Plan," largely devised by Clark Kerr[9] in the 1960's. Public higher education in California consists of three distinct systems: the University of California, the California State System and the Community College system. Each system has distinct roles and purposes. The University of California has nine doctoral granting campuses, it admits the top eighth of

None of these figures include the capitalized value of land and buildings that universities use in the production of research and education.

[6]I was reminded of the line from *Casablanca*, which reads in this context, "I am shocked, just shocked, to find that there is competition here."

For those who lament the demise of need blind admissions, it is worth pointing out that our present system very much resembles a merit scholarship system. Abler students get into better schools; all are subsidized (see the discussion of Winston's concept of surplus below). This is perhaps most clearly seen with the admissions of athletes in the IVY league. Athletic ability, unlike academic ability, has a very low correlation with income. Football players admitted to Princeton because they are football players get, in every reasonable sense of the term, athletic scholarships. A much higher percentage of the students in the IVY league get athletic scholarships than students in the Big 10.

[7]*MEETING THE COMPETITION*, A Report by Public Agenda for the Futures Project, October 2002. This project is housed at Brown University. The report notes the apprehension of many leaders of public universities that the private sector will "cherry pick" the most profitable and easy to satisfy students.

[8]This is true even when schools can legitimately argue that public support is minimal and seek freedom from legislative control in exchange for freedom to set their own prices and admission policies. The University of Michigan, parts of the University of California, and Oxford have all had bootless dreams (and occasional empty threats) of becoming private.

[9]I recommend his memoirs highly: Clark Kerr, Neil J. Smelser, *The Gold and the Blue: A Personal Memoir of the University of California, 1949-967: Volume 1, Academic Triumphs,* University of California Press; (2001)

qualified students in California. The University of California is the only public institution in California that can grant doctorates. While it does not get a single appropriation from the legislature, it has considerable freedom in allocating resources and each campus has considerable discretion in allocating its share of the budget. In return the state asks for coordinated planning (which limits program duplication) and tries (unsuccessfully) to limit competition between campuses for faculty.

The campuses of the California state system are oriented towards teaching. The top half of high school graduates can be admitted to the state system. Classes in the state system at the undergraduate level are smaller than at the University of California. The formula driven California budgeting system is less generous to state colleges which get lower capitation fees and are supposed to build cheaper buildings. While faculty at state colleges do research (some in cooperation with UC faculty) the state colleges cannot offer doctoral degrees.

The Community Colleges are local institutions, open to all high school graduates. They offer professional and academic tracks. Successful completion of a two year academic track permits transfer to University of California. (I think this is more useful politically than educationally. Community Colleges do not offer bachelor degrees.

The California plan has been an extraordinary success. A preponderance of America's great public universities are part of the US system, Berkeley and its medical school (UCSF), UCLA and UCSD. The system kept improving in difficult times. Ronald Reagan became governor of California in 1964, the same year that the Free Speech movement erupted. Political support for the University of California declined[10]. At that time UCLA was struggling to overcome its origins as a teacher's college and UCSD was less than five years old. Ronald Reagan and his successor Jerry Brown were notoriously unfriendly to the University of California. Many predicted the decline of the UC system through the crises of the Free Speech Movement, and sharp economic downturns in the 80's, 90's. Yet in the 1993 NRC rankings, Berkeley, UCSD, and UCLA were the three top rated public university systems. Many believe that UC will survive Grey Davis. At the same time the state system and the community college provide wide access to public higher education for all Californians.

The Wisconsin story is different. The University of Wisconsin at Madison was founded in 1849. By the early mid-century Wisconsin was one of the preeminent American Universities and clearly with Michigan one of the two best public universities in the country. Madison merged with Milwaukee in 1956.Parkside and Green Bay became part of the University of Wisconsin in 1968. A gaggle of teacher's colleges and two year colleges were merged into one University of Wisconsin System in the early '70s.

[10]Ronald Reagan dismissed Clark Kerr as President of the UC system in 1967. Kerr stated that he left the Presidency as he began it, "fired with enthusiasm."

The University of Wisconsin System is one centralized system - with reasonably uniform formulae for allocating resources across the different parts of the system. It has proved hard to provide for a research university. While Clark Kerr set his sights on becoming better than Madison when he became Chancellor of Berkeley in 1952, by the early 90's three UC campuses and the University of Michigan had surpassed Madison.

Potted history is hypothesis not proof. It is easy to argue that the relative success of California and Michigan has everything to do with relative wealth and history (no strong competing private colleges as in the Northeast) and nothing to do with the idea of legitimated hierarchy. I am searching for ways to put this notion to more rigorous tests than trial by anecdote.

Diversity of revenues. Most of the better US universities have many sources of funding: Endowment earnings, state support[11], research support from private, federal,and other government sources, gifts from foundations,warm hearted alumni, coolly calculating businesses, business revenues, and patent revenues. In contrast, I believe, foreign universities are much more dependent on one or two sources of revenue. At Oxford, for example, the main sources of revenue are research grants, state reimbursements for teaching and research awarded on judgments of quality[12], endowment earnings, tuition from different classes of students[13]. I suspect that sources of revenue in other elite foreign universities are less diverse. This is not an original idea[14]. I am sure I can compare the US and the UK and am looking for other data sources.

[11] This is most important for public institutions. However, many private institutions get public funding. Princeton used to get funds from the New Jersey legislature. After Princeton hired a controversial professor, Peter Singer, the legislation funding all New Jersey institutions was changed so that it no longer applied to institutions with endowments greater than $1 billion.

[12] The rapid introduction of revenues based on quality in England and other countries is an example of rapid institutional change. These systems have serious incentive implications. Whether our experience with these institutions will remind us of our experience with hospitals is a question that may launch a thousand papers

[13] At Oxford the biggest difference is between students from the UK who pay £1100 and foreign students who pay what the traffic will bear.

[14] Cite Bowen and others

I.2 "Stylized Facts" about American higher education: a possible competitive explanation

Remarkable diversity characterizes the US education system. Figures 1, 2, and 3 document the diversity of student quality, wealth, and faculty salaries[15]. Gordon Winston[16] has argued that the most important fact about American higher education is the fact that students are subsidized. They pay much less in tuition than schools spend on them[17]. Furthermore, the more students pay the more surplus or subsidy they get. His Table 1, reproduced below, summarizes some of his findings; further data (his Table 2) shows that on average abler students go to more heavily subsidized schools.

I.2.1 Stylized Facts

We can write down Winston's findings as a list of "stylized facts."

1. Schools vary greatly in the expenditures per student – teachers, libraries, buildings, labs, computers, therapists.
2. All schools subsidize students.
3. Subsidy is higher at richer schools – this may just be a definition of "richer".
4. Average tuition paid is higher at richer schools.
5. Ability is higher at richer schools.

It is an interesting, if old-fashioned, exercise to write down a simple economic theory – one that assumes profit maximization on the part of schools and rational choice on the part of students – that is consistent with these observations.

I.2.2 A neoclassical "explanation" of increasing subsidy.

Suppose that the educational production function is as in Rothschild and White [18] with the addition of capital or resources as an additional input into the human capital process.

[15] In his presidential address to the Soceity of Labor Economists, Ron Ehrenberg noted both the dynamics of ineqaulity in wealth and salaries and their relationship. See Studying Ourselves: The Academic Labor Market CHERI Working Paper # 23. See http://www.ilr.cornell.edu/cheri/work.html

[16] Winston, G. C. (1999). "Subsidies, hierarchy and peers: The awkward economics of higher education." Journal of Economic Perspectives 13(1): 13-36.

[17] Winston uses the much and correctly maligned IPEDS data. The differences he finds are sufficently striking that one can only doubt what they mean, not what they say in gross outline.

[18] Rothschild, M. and L. J. White (1995). "The Analytics of the Pricing of Higher-Education and Other Services in Which the Customers Are Inputs." Journal of Political Economy 103(3): 573-586

Also suppose for simplicity that there is only one kind of student and one kind of human capital then

$$Y = F(R, H, S) \tag{1}$$

In (1) F is a constant returns to scale production function that gives the amount of short run resources required, in addition to fixed resources, R, and students, S, to produce human capital, H. Since the production function is homogenous of degree one it is natural for required inputs, Y, to be negative. Y is essentially short term Marshallian profits. Suppose that all schools have the same technology but differ in their fixed resources, R. Since R is fixed we are doing classical short run Marshallian analysis.

When different schools have different levels of fixed resources we can ask how to allocate a total of $\mathbf{S}$ students to schools so as to maximize the total amount of human capital and short run profits produced by the education industry. Formally this amounts to maximizing

$$\sum_n (H^n - Y^n) \tag{2}$$

subject to the constraints

$$Y^n = F(R^n, H^n, S^n) \text{ and } \sum_n S^n = \mathbf{S}$$

The analysis of (Rothschild and White 1995) applies here virtually unchanged. The optimal allocation can be decentralized. At the optimal allocation schools charge students prices or tuition, $p = \frac{H}{S} - w$ where $w = -F_S$, the net cost of educating one student, and at the optimum $F_H = 1$ because human capital is measured in monetary units. Since the production function is constant returns to scale, Euler's theorem states that

$$Y = F_R + F_H H + F_S S = F_R + H - w_S S$$

Use the optimality conditions to get a formula for surplus or profits of each school:

$$\Pi = pS - Y - H. \tag{3}$$

This equation states that the school gets tuition, distributes human capital and uses net resources (which will be negative). Equation (3) reduces to

$$\Pi = F_S - Y = -(F_R R + H)$$

To get subsidy on a per student basis, divide profits, resources and human capital by S, use Euler's theorem again and get

$$\pi(r) = -(f_r(r,h)r + h \tag{4}$$

where $f(r,h) = F(r,h,1)$, $\pi = \frac{\Pi}{S}$, $r = \frac{R}{S}$ and $h = \frac{H}{S}$. Note that is essentially Winston's "surplus per student." We can treat r as a variable and analyze subsidy per capita as a function of resources per capita at the equilibrium allocation. This exercise does not assume or require that there exist schools at all levels of resources per student. It only asks how, at equilibrium, things vary with resources per student. Differentiate (4) and note that

$$\pi' = (f_r + rf_{rr}) > 0$$

To interpret recall that f_r is the marginal effect of resources on other resources needed to produce human capital and is positive. Diminishing returns implies that $f_{rr} > 0$. The absolute value of f_r is a decreasing function of r.

Consider a Cobb-Douglas example:

$$f(r,h) = r^{-\beta}h^a;\ f_r = -\beta h^\alpha r^{-(\beta+1)},\ f_{rr} = (\beta(\beta+1)h^\alpha r^{-(\beta+2)}$$

In this model we can write tuition as a function of subsidy per student.

$$p(r) = h - \mathbf{D}_3F(r,h,1) = -f + f_r r \tag{5}$$

In equation (5) the$\mathbf{D}_3F(x,y,z)$ is the partial derivative of $F(x,y,z)$ with respect to its third argument evaluated at the point (x,y,z). Differentiating (5) we see that

$$p' = f_{rr}r > 0$$

Thus, this model is consistent with the stylized facts of (Winston 1999) that subsidy and price per student are increasing functions of resources per student.

I.3 Caveats

This model has many flaws: It takes resources as given. It assumes only one type of student and one type of product, neglecting research, prestige, and consumption while in college. A complete dynamic model would include all these things. In a formal sense this is not much of a problem. Many of these problems can be solved by notation. Allowing

inputs and outputs to be vectors we can deal with time and uncertainty in the standard Arrow-Debreu way. It doesn't take much to assume that the technology is convex and the existence of an optimum that can be decentralized follows from general results on duality. I doubt that many economists interested in education will find this general observation of much interest. In particular offers no insights into the question of how universities acquire resources. The market for what the model calls resources, if it can be described as a market, is an important questions; if nothing else, this model makes clear, at least to me, how important.

More generally,. I think the result does pose a question: "How far can we go using a competitive model to explain higher education?" I think we can go father than most people believe. Many have observed that universities and schools are monopolies have both too much and too little power to be modeled competitively. They have too much power because they are monopolists who don't really have to compete for students; they have too little power because there is no satisfactory answer to the question "Whose in charge?" While one of my colleagues called Larry Summers the Ariel Sharon of higher education, no one has (yet) accused him of being Sandy Weil[19].

II Matching

Academics devote a lot of time to rearranging deck chairs way behind the extensive margin. We spend much effort deciding who will go to what college and less to deciding who will go to college at all. Referees for journals often see papers they have rejected appearing, unchanged, in other journals. Alan Krueger and Stephen Wu's study predicting placement of graduate students in economics programs[20] began life as an attempt to check the efficacy of the admissions practices of one graduate program. The authors noted that most students who applied to the program in question did go to other graduate programs. Thus it was possible to correct for sample selection bias by looking at the job placements of most students who applied to University X . Note that this strategy eliminates bias only if the treatment effect of matriculating in different graduate programs has no effect on placement. This raises the question of what the admissions committees of all these programs were doing. Surely having better students profits the faculty, but is there any social return to this effort?

Education provides an interesting context in which to think about the social value of matching or sorting. Consider two examples:

[19] See Martin S. Feldstein's comment on Rothschild and White, NBER conference volume

[20] Alan B. Krueger and Stephen Wu,"Forecasting Job Placements of Economics Graduate Students," . Journal of Economic Education, Vol. 31, No. 1,Winter 2000, pp. 81-94

Technology matters and is a choice Suppose colleges produces human capital from inputs of student ability and other resources. To fix ideas let that

$$y_i = R_i^a (G(s_{i1}, ..., s_{iN})^{(1-a)}$$

where y_i is output of human capital per capita, R_i is the amount of other resources used per capita, s_{in} is the ability of the n^{th} student attending college i, and $0 < a < 1$. The efficiency problem is to allocate students and resources to colleges so as to maximize total output of human capital. I simplify by assuming both that exactly N students attend each college and that there are K colleges. This is an inessential simplification. The optimal allocation depends on the educational technology. Consider the following three cases:

$$G(s_1, ..., s_N) = Min(s_1, ...s_N) \quad \text{(MIN)}$$

$$G(s_1, ..., s_N) = \sum s_n \quad \text{(SUM)}$$

$$G(x_1, ..., s_N) = Max(s_1, ...s_N) \quad \text{(MAX)}$$

In each case it is easy to characterize the optimal allocation. If the production function is MIN, then students should be allocated so that most able N students go to the best college, the next N most able students go to the next best college, and so on. Resources are allocated so as to make the labels, best, next best, etc. descriptive of the allocation of resources. The best college gets a lot of resources, the next best less and so on. If the production function is MAX, the best student goes to the best college, the next best to the second best, and so on until the K^{th} best student goes to the worst college. It doesn't matter how the other $N(K-1)$ are allocated to colleges. Allocations of resources are qualitatively similar to the MIN case but the differences in resources allocation are less pronounced. The SUM case is in between. Students should be allocated to most nearly equalize the sum of ability at each college. Since total ability is nearly equal at each college, other resources should be allocated almost equally to each college. This characterizes efficiency. It is worth making two further points about this example:

1. Technology is a choice variable. A college chooses the MIN technology when it offers small seminars for select students. It chooses the MAX technology when it trains the best students to teach other students.

2. Technology has strong distributional effects Suppose we care about equality of in-

come in the very general sense set out by Atkinson in 1970[21]; that is we agree that an increase in inequality is something all those who dislike inequality would disapprove of; an increase in inequality decreases the value of all quasi-concave social welfare functions. Assume that income is determined by human capital and that colleges distribute human capital on a per capita basis. It follows then that the MIN regime is the worst regime and SUM the best; MAX is in the middle.

Tracking by ability can be inefficient. Suppose that each school produces human capital with the production function:

$$H = Min[R, \prod_{i=1}^{n} s_i^{\frac{1}{n}}]$$

where R is the resources that school$i$ has and s_i is the ability level of student i at the school. Consider a system has two schools and four students. The capital endowments of the two schools are 3 and 2 and there are two students with ability 10 and 2 students with ability 1. Then if the two able students go to the well-endowed school, total output is $Min[3, 10] + Min[2, 1] = 4$. If the students are mixed then total output is $Min[3, v\sqrt{10}] + Min[2, \sqrt{10}] = 5$ since $\sqrt{10} = 3.162\,3 > 3$.[22]

[21] "Measurement of Inequality." Journal of Economic Theory 2(3): 244-263

[22] Roland Benabou taught how to think this way about matching. His papers, Equity and Efficiency in Human Capital Investment: The Local Connection," Review of Economic Studies, 62 (1996), 237—264 and "Heterogeneity, Stratification and Growth: Macroeconomic Implications of Community Structure and School Finance," American Economic Review, 86 (1996), 584—609 have more general analyses.

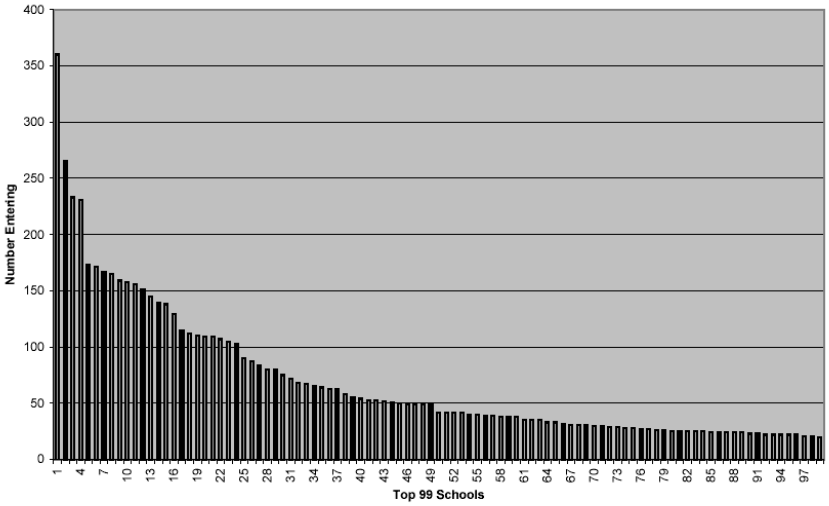

Figure 1:

III Tables and Figures

Figure 1: Number of National Merit Scholars Matriculating at 99 Schools Fall 2001

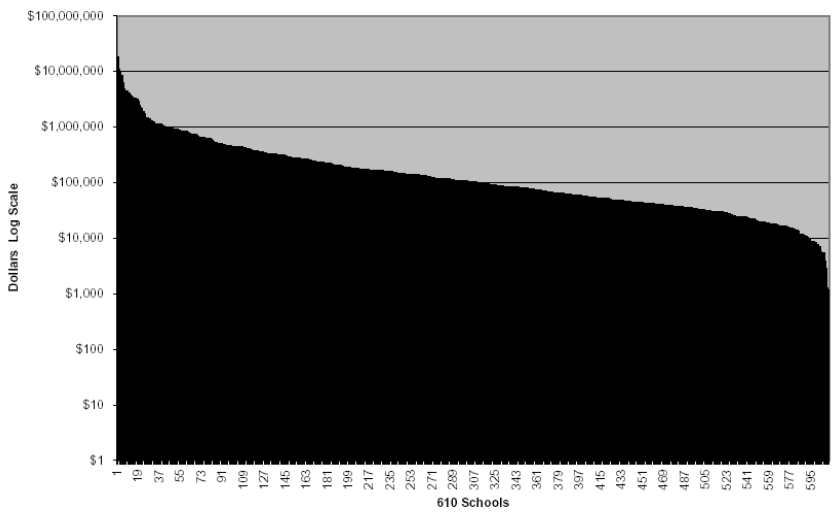

Figure 2:

Figure 2: Distribution of Endowments 610 Schools, June 2001

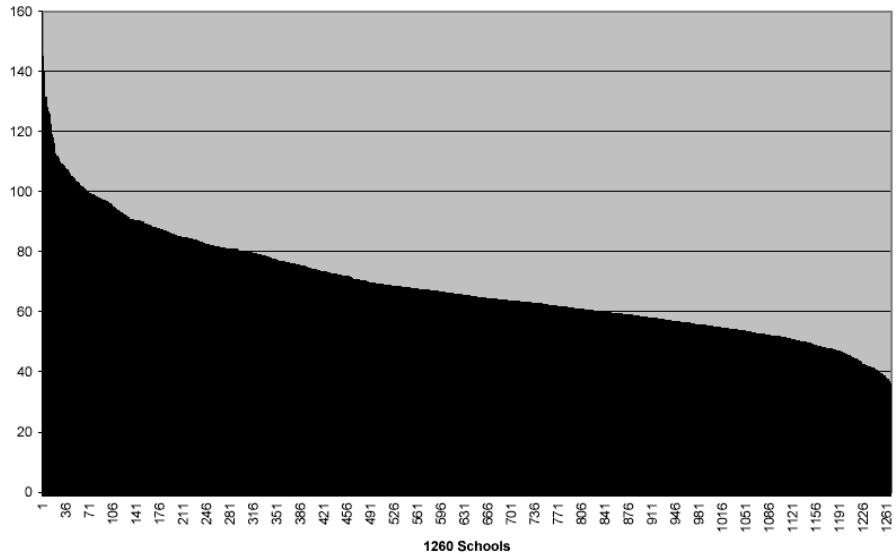

Figure 3:

Figure 3: Average Full Professor Academic Year Salaries $K in 2002-03

Table 1
Costs, Prices, Subsidies, and Hierarchy, 1995

Ranked by Dollar Value of Subsidy	*Enrollments*	*Average Student Subsidy*	*Costs: Educational "E&G&K"*	*Price: Net Tuition & Fees*	*Price/Cost Ratio*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*
	FTE	$	$	$	%
All Institutions	3,500	8,200	12,000	3,800	31.5%
Public	5,100	8,700	9,900	1,200	12.4%
Private	1,700	7,700	14,200	6,500	45.9%
Decile 1	3,300	22,800	28,500	5,700	20.1%
Decile 2	3,800	11,100	14,900	3,800	25.4%
Decile 3	4,300	9,300	12,300	3,000	24.4%
Decile 4	4,500	8,200	11,000	2,800	25.6%
Decile 5	3,700	7,300	9,900	2,600	26.6%
Decile 6	3,900	6,500	9,400	2,900	30.8%
Decile 7	3,500	5,800	8,700	2,900	33.1%
Decile 8	3,500	5,100	8,400	3,300	39.5%
Decile 9	2,900	4,100	8,700	4,600	52.5%
Decile 10	1,600	1,800	7,900	6,100	77.4%

Source: Winston-Yen, 1995 (updated); based on US Department of Education IPEDS data. Includes 2739 institutions, of which 1420 are public and 1319 are private. All dollar amounts are per FTE student averaged over institutions. Col. 3: Educational costs include the share of E&G spending devoted to instruction plus the rental rate for physical capital. Col. 4: Tuition and fees net of grant aid.

Figure 4:

Table 1: Winston's Data on Costs and Subsidies