

DIFFERENCES BETWEEN LARGE AND SMALL FIRMS
APPLICATION TO OIL LEASING POLICY

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"The law, in its impartial majesty,
forbids the rich as well as the poor
to sleep under bridges, to beg, or to
steal bread."

--Anatole France

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Introduction

There is widespread suspicion that many ostensibly neutral public policies--taxes, regulations, or other--are in fact biased to favor big business. If the suspicion is correct, then there must be systematic differences between larger and smaller firms, to which policies can be keyed. And if there are such differences, then the bias can also be reversed--to favor smaller firms, or at least not disadvantage them.

I will argue that larger and smaller firms* differ in their internal factor prices. Larger firms pay less for capital and more for labor; smaller firms pay more for capital and less for labor. This difference in factor prices in turn affects every aspect of different size firms' behavior. Larger firms do everything more capital-intensively. They prefer better educated employees. They select assets with a larger percentage gap between revenues and variable costs--that is, higher rent land and more automated factories. They also prefer assets yielding a less variable stream of income--that is, they will sacrifice yields for certainty.

As an example of how a knowledge of these differences can be applied to public policy, I will examine oil leasing. Current leasing policies--bonus bids, royalties, and profit shares--favor larger firms. Alternative policies of a rental variety--notably a change on the assessed value of reserves--would give an edge to smaller firms.

*One can rank firms by several variables. Fortune selects its top 1000 manufacturing firms by sales, but also gives rankings by total assets, equity, profits (net income), and employees. However, the rankings roughly correspond. Exxon and GM will be at or near the top by any of these criteria. Smaller firms will rank lower in every category, though the scatter will be larger. At the bottom, for the sake of completeness, one might put individual workers--conceived as firms with one employee, sales consisting of labor services sold, and assets consisting perhaps of a little human capital.

I. Origin of Differences Between Larger and Smaller Firms.

A. Failure of Market for Future Goods.

The differences between larger and smaller firms ultimately arise from what Ken Arrow has called the "failure of the market for future goods"

[Arrow, 2,8]. He offers two reasons for this failure:

a. Contracts cannot be enforced without cost. The greater the span of time the contract covers, the greater the cost.

To this I would add, it also costs something to make a contract.

b. Lenders are risk-averse. And so, I would add, are landlords, employers, and anyone else who yields some control over his assets in order to obtain future income.

Risk aversion is not in itself a cause of market failure. But lenders and others undertake contract costs to reduce risks--or fail to make contracts at all where costs are too high. So there is a direct tradeoff between risk and contract costs.

Both the cost and the risk of contracts arise from a basic fact of human nature: I am not my brother's keeper. People with whom I undertake contracts seek to maximize their own utility, not mine. The more I want them to serve my

interests, the more I must sacrifice to bribe or coerce them. The marginal cost to me will equal the marginal benefit long before their interests fully coincide with mine.

Contract costs and lenders' risk aversion show up most obviously in the official capital markets: the banking system, the stock and bond markets, etc.

For example, say I'm a banker. I must screen my customers, to make sure their proposals are sound, and/or are sufficiently covered by collateral. I give greater consideration to collateral, since it is easier to evaluate the quality of collateral than the quality of proposals. Then I may insist that my customers follow certain procedures, allow me to approve major decisions, and so forth.

Consequently, my customers lose the freedom to use their assets to their own best advantage--probably at some sacrifice in profits. (For example, lenders generally require real estate developers to adhere to standard designs, even though the developers might feel they could do better with something more innovative.)

Since the cost and risk is lowest, I give my biggest customers the lowest interest rates and the longest term loans. I may refuse to consider small customers at all, because the cost and/or risk of screening and monitoring them exceeds any possible yield I might get from a loan to them.

But contract costs and risk aversion show up elsewhere.

Say I own a shopping center, and rent stores to tenants. I turn over my asset to the tenants' control, in return for a claim to future income from them. This transaction costs me and my tenants something. For I must prescreen tenants, police them to make sure they don't damage the premises, harass them if they get behind on the rent, and so forth. The tenants lose the freedom to

operate their shops to their own best advantage. In particular, they must take a short-run view of things, for they may always lose their lease.

Like the banker, I discriminate among tenants. The biggest tenants get the longest leases at the lowest per square foot rental. The smallest tenants get the the shortest leases at the highest per square foot rates.

Or say I own a factory, and hire people to operate my equipment. I pay them wages and yield some control over the machinery in exchange for future income when I sell the goods the machines produce. I must screen employees, train them in the particulars of my equipment, and supervise them lest they goof off, steal, or damage the equipment. My employees in turn must bear the costs of job hunting and the disutility of taking orders from others.

Like the banker and the shopping center owner, I discriminate among employees. I offer better terms to those with more years of education, as there is a greater probability that they are more skilled. I may avoid hiring women and Blacks--not necessarily because I am prejudiced, but because white males are a priori better bets.

B. How the Failure of the Market for Future Goods Affects Different Size Firms.

Why should the failure of the market for future goods affect different size firms differently? Because the cost and risk of contracts rise with firm size.

On the one hand, the top manager of a large firm must make and supervise many more contracts than the manager of a small firm. The president of Safeway probably has ultimate responsibility for tens of thousands of contracts. Mom and Pop at the corner grocery have contracts with the delivery boy, the landlord, and a few suppliers.

However, there are only 24 hours in a day. And the larger an organization, the more spread out its activities geographically. Hence, the more contracts, the less time the top manager can devote to each. So the more contracts, the more scarce and valuable becomes the manager's time. In addition, as the manager's time becomes more valuable, his income rises. Income effect may then make him set a higher value on leisure, further limiting the time he spends per contract.

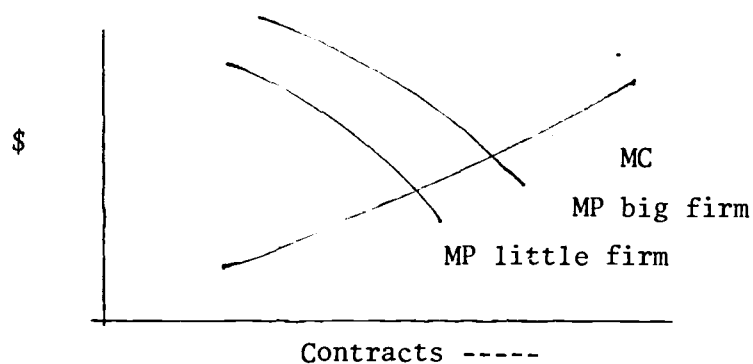
Of course the top manager can and does delegate a lot of contract making and supervising to subordinates. But then he must supervise contracts with them, and become more of an absentee manager, with the cost and risk that entails. Meanwhile, if the subordinates have a lot of contracts to supervise, their time becomes scarce and valuable, so they further delegate contracts, and so on . . .

As a result, the marginal cost of contracts rises with the number of contracts. This rising marginal cost shows up as an increasing scarcity and high value of managerial time--not only for the top manager, but all the way down the line.

On the other hand, the marginal product of making more contracts--or the marginal cost of not making more--rises with the relative assets of a firm. For the opportunity cost of course depends on what others would do with the firm's assets. For a given number of contracts, the greater a firm's assets relative to other firms' assets, the greater the advantage of making more contracts, or the greater the opportunity cost of not doing so. In other words, the marginal product curve for a larger firm lies above the marginal product curve for a smaller firm.

(To see why it is relative assets that matter, consider the following: Farmer Brown has 100 acres. If everyone else has 100 acres, Farmer Brown probably has little to gain by hiring others to work his land, or renting land to others. But if everyone else has ten acres, or no land at all, Farmer Brown does gain by making contracts.)

The manager of a firm makes contracts until marginal product equals marginal cost. Since the marginal product curve for a larger firm is higher than that of a smaller firm, the larger firm ends up with a higher marginal cost and marginal product. Contract costs are essentially managerial labor costs. So a higher marginal cost and marginal product of labor necessarily mean a lower marginal cost and marginal product of capital. And that means the larger firm gets a lower yield on its assets.



In brief, the cost and risk of contracts bottle up capital in larger firms, and bottle up labor in smaller ones. That leaves capital relatively cheap, and labor relatively expensive in big firms; and the opposite in little firms.

As a result, larger firms will do everything more capital intensively. Since the rational manager of course equates marginal cost to marginal product for innumerable variables, this greater capital intensity should show up in many ways. Table 1 lists some important measurable differences in capital

Table 1: Measurable Differences Between Large and Small Firms.

	<u>Large</u>	<u>Small</u>
Assets	High	Low
Sales	High	Low
Equity	High	Low
Net Income [Accounting Profit]	High	Low
Employees	High	Low
Sales/Assets	Low	High
Sales/Equity	Low	High
Sales/Employee	High	Low
Net I/Sales	High	Low
Net I/Equity - ROI	Low*	High*
Net I/Employee	High	Low
Assets/Employee	High	Low
Equity/Employee	High	Low
Equity/Assets (= $\frac{\text{Equity}}{\text{Equity} + \text{Debt}}$)	High	Low
Cost of Capital (bank, stock, bonds)	Low	High
Wages for "equivalent" employees and jobs	High	Low
Costs for "equivalent" operations	High	Low
"Quality" of inputs--employees, equipment, resources	High	Low
Land/capital improvements (and other measures of asset durability)	High	Low
Percentage variability of net income	Low	High
Innovation	Low	High
Market Power	High	Low
Economic rents	High	Low
Geographic preferences	Central	Marginal

*The actual data on ROI is ambiguous--see text.

intensity that should show up between larger and smaller firms. Some of these correspond to popular notions of differences between larger and smaller firms; others may come as a surprise.

C. Manifestations of Differences Between Larger and Smaller Firms--Greater Capital Intensity of Larger Firms.

An easy way to see how the differences between larger and smaller firms might arise is to follow the top manager of a large firm as he responds to relatively high contract costs, or, what is the same thing, relatively scarce managerial time. The same results can be derived from a larger firm's relatively low cost of capital.

1. Number of contracts. The most obvious way to reduce contract costs is to make fewer contracts, per dollar of assets, sales, or profits. And the most obvious contracts to lop off are little contracts--those for which it is most likely that marginal contract costs exceed marginal product. So bigger firms hire fewer employees per dollar of assets (sales, profits). Bigger banks make fewer loans per dollar of loans than little banks (and little banks make fewer loans per dollar than loan sharks).

2. Duration of contracts. A major share of contract costs come at the beginning of contracts--such as screening and training of employees. One way to reduce these costs is to make longer contracts. So managers of larger firms will make longer term investments, buy more durable assets, hire employees who will stay longer, carry larger inventories, and so on.

3. Managerial pay. Since the marginal product of his time is so high, the manager pays or imputes to himself a high hourly wage. He probably pays his subordinates a relatively high wage too, since the marginal product of their time is so high. If he doesn't pay them well--if he sets a high value on stinginess--he nonetheless imputes a high cost to them. For since he cannot supervise them as well as the manager of a smaller firm can, they will serve him relatively poorly.

4. Dealing with employees and other contractees. Since the manager of a larger firm cannot supervise so closely, the parties with whom the firm has contracts can more freely pursue their own interests at the expense of the firm. For example, employees may goof off or pad their expense accounts. Suppliers may be late, or deliver the wrong materials. The manager can cope with this problem in a number of ways.

a. He can accept the loss as inevitable.

b. He can institute control systems, such as elaborate accounting systems, at a cost of more paperwork, more computer time, more delays, etc.

c. He can make employees and others follow routine procedures. This makes it easier to monitor their performance. But this restriction also leads employees to forego profitable opportunities that come the firm's way. (Cyert and March describe this phenomenon in A Behavioral Theory of the Firm, [Cyert and March, p. 120]).

d. He can pay employees more, including fringe benefits, to buy their loyalty (and to make them stay with the firm longer, lowering contract costs).

e. He can allow employees more amenities--more luxurious offices, expense-paid "conferences" in Hawaii, or more congenial associates. The same goes for the top manager himself. For example, he may try to enhance his company's prestige (and his own) by landmark office buildings, glossy institutional ads in Fortune, or donations to public television. Such "goldplating" can in fact be regarded as an input or an output. As an input, it is part of what employees (including the top manager, if he isn't the owner) get away with when less well supervised. Or it is a bribe to them to perform better when less well supervised. As such it is an investment in employee performance that would be submarginal in a smaller firm (e.g., a small firm would regard the difference between a first class and coach plane ticket as submarginal). As an output, goldplating amounts to income effect. The higher the income of the top manager (owner or not) and employees, the larger the share of the firm's total output will appear in the form of manager and employee satisfaction. Either way, goldplating lowers yields on the firm's capital--by adding to costs for a given marketed output, or by subtracting from total output for a given input.

In practice, the manager will combine these approaches, so that marginal cost equals marginal product for each.

5. Selection of assets. The top manager of a larger firm will also respond to higher contract costs in the kind of assets he selects. As already mentioned, he prefers larger and more durable assets, since these allow him to make fewer contracts less often. But he also prefers assets for which variable costs are a lower percentage of gross revenues, that is, assets that yield a higher revenue flow for a given quantity of management time. What sorts of assets are these?

a. Employees. Firms can and do treat employees as assets. There is an initial investment in screening and training, after which an employee yields a service flow above wages--often for many years [Doeringer and Piore, p. 77].

The manager can economize on his time in many ways. He can select more skilled employees, and--since it is difficult to evaluate skill in advance--use more arbitrary criteria for screening. (Only white male Harvard MBAs need apply.) He may also put employees through longer and more intensive training at company expense. And, again, he will almost certainly pay employees better. For better pay enables him to select the cream of the crop of applicants and train them with less effort. Better pay also makes employees more loyal to the firm, and less likely to leave--reducing future recruitment and training costs. So the top manager's higher actual or imputed wage is in effect transmitted throughout the organization.

b. Physical assets.

i. The manager of a larger firm can economize on managerial time by greater mechanization. A more automated plant yields a greater output per employee. New equipment breaks down less often, and hence requires less management attention. Some of greater mechanization is just "goldplating"--such as fancy computers and other intriguing gadgets.

ii. He can economize on managerial time by using the same equipment less intensively--for example, by not running night shifts. This makes equipment last longer.

iii. He can economize on managerial time by replacing equipment less often. This may seem a contradiction to point (i) but in fact it is not. For both keeping equipment longer and buying the latest shiny new equipment when the time does come to replace--cut down on management time by lengthening the replacement cycle and reducing supervision during the cycle. In the same way, hiring better employees, and training and paying them better, also ultimately lowers management time by lowering turnover and reducing supervision per employee.

iv. Land as an asset requires no replacement and little supervision. So the manager of a larger firm will use a higher ratio of land to capital equipment. A large corporate farm, for example, will use a higher ratio of land to machinery, and a higher ratio of machinery to labor than will a small farmer.

v. The manager of a larger firm can economize on time by purchasing superior resource inputs--the best farmland, the highest grade, most accessible mineral deposits, prime office sites in the central business districts of the biggest cities, radio and TV licenses in the biggest cities, airline routes between the biggest cities, and so on. All these resources yield a high revenue flow at relatively low variable cost. In other words, they yield high economic rents--mostly Riccardian in this case.

vi. Finally, the manager of a larger firm can economize on managerial time by "purchasing" another kind of asset with high revenue at low variable cost: market power. Market power also yields economic rent--monopoly rent in this case. But from the manager's point of view, rent is rent, whether from superior resources or market power. And the two often go together: control of the best iron reserves yields U.S. Steel both Riccardian and monopoly rent.

c. Financial assets. If the manager of a large firm finds himself with more assets than he can cope with, he can always transfer them out of the firm in exchange for "financial" assets. For example, he may make loans to other companies, buy bonds, or certificates of deposit at a bank, stock in other companies, and so forth. Financial assets require relatively less management effort than physical assets, but they also yield less. Some firms, such as

banks, insurance companies, and pension funds, specialize in holding financial assets.

Financial assets, however, do not extract the large firm manager from the squeeze of scarce managerial time by enabling him to invest his capital with smaller, higher yielding firms. For if he has large sums to invest and little time to attend to the investments, he makes big, long-term loans to big companies, and buys big blocks of blue chip stock or triple A bonds.

The result is the familiar phenomenon of credit discrimination and rationing in the official capital markets, already mentioned above. Large firms can borrow for long terms at the "prime" rate of interest; smaller firms can borrow for shorter times at higher rates, and even smaller firms can't borrow at all. If they can get any credit at all, it is installment credit from suppliers--at "usurious" rates. Only very large firms can even issue stock or bonds, and the big blue chip firms can sell their stock and bonds at higher prices than less favored smaller firms. Hence the "two tier" stock market.

In short, credit discrimination and rationing in the official capital markets reflects the kind of investment discrimination that goes on within larger firms.

6. Behavior toward risk. The manager of a larger firm acts more risk averse--relatively--than the manager of a smaller firm. That is, he makes a greater sacrifice of returns on the firm's capital to maintain

a given percentage variability of the firm's net income. (He may take larger absolute risks than the manager of a smaller firm.) [Arrow, 1; Pratt].

The larger firm manager's greater relative risk aversion is a necessary corollary of his higher contract costs. For he undertakes greater contract costs because he faces a greater risk of losing control of his organization. There is a direct tradeoff between contract costs and risk. Most of the responses to higher contract costs described above--reducing yields on capital--are equally risk averse behavior. For example, it saves management time to buy the best mineral reserves, and hire the best employees (and then constrain them to routine procedures)--and it also reduces risk. More durable assets (e.g., a new apartment building vs. an old tenement) are generally safer assets as well.

Another way to see the same point is that the large firm manager copes with risk in a more capital-intensive way--just as he does everything else more capital intensively. He copes with risk by anticipating it. He makes an investment in certainty, at a sacrifice in yields, of course. The small firm manager copes with risk more labor-intensively--by reacting after the unexpected occurs, instead of anticipating it. It is the difference between a knight in armour and a foot soldier. The knight guards against injury with armour; while the foot soldier runs away.

But what about the familiar argument that larger firms can pool risk better. Therefore, they can take on high-yielding investments

that--considered independently--are very risky, but are not risky when pooled with the firm's other assets. As a result, the argument goes, larger firms can take greater risks and get higher yields on their capital.

Larger firms of course are more diversified than smaller ones. But that does not prove they have a risk pooling advantage. If diversification to reduce income variability costs them yields on their capital, then it only proves that their management is more risk-averse.

Investments most likely to offer a risk pooling advantage are those which are both easy to evaluate and yet uncorrelated. One thinks of routine insurance policies and bank loans, or vehicles in a fleet. Larger firms may well get some risk pooling advantage in such investments.

However, if larger firms have higher contract costs and risk of employee foul-up (a risk that is surely highly correlated from one part of the firm to another)--this clearly limits their risk pooling advantage. For example, if big banks make big loans, and little banks make little loans, the big banks gain no pooling advantage. And the controls that top management put on subordinates to keep them from injuring the firm surely discourage them from taking risks that might benefit the firm.

So far, I have argued that the manager of a larger firm acts more risk averse because he faces a greater risk of losing control of his organization. However, the manager may also have a greater personal preference for certainty, or the

"quiet life." This greater preference may be an income effect--especially if the top manager is the owner. If the top manager is not the owner, he may feel constrained to greater caution by the stockholders--just as he in turn constrains his subordinates.

Some Evidence on Differences

There is an enormous mass of comparative data on different size firms. Most of it supports the differences predicted in Table 1. For example, Table 2, derived from the 1974 Fortune top 1000 manufacturing firms, accords with Table 1 on every point except return on investment. Rather than reviewing all this data, I will just briefly discuss the evidence on three points that may seem most controversial:

1. Rates of pay and employee quality;
2. Return on investment (and investment quality);
3. Behavior towards risk.

1. Wages and quality of employees (skill and social desirability) rise with the size of organizations.

Many economists and non-economists assume that large employers "exploit" their workers. That is, they use their monopsony power to depress wages.

Yet studies of different size firms suggest the opposite--though such evidence must be interpreted cautiously, since if larger firms do everything more capital intensively, job categories won't be strictly comparable. But

Table 2
Fortune 1,000 for 1974, Fortune May-June 1975

	Top 1, Exxon	No. 2, GM	Top 10	Top 50	Top 500	Bottom 500	Bottom 50
Sales	42,061,336	31,549,546	210,307	409,666	833,956,699	80,948,036	4,662,839
Assets	31,332,440	20,468,100	155,460	304,660	628,636,981	59,829,223	3,171,762
Net Income	3,142,192	950,069	12,018	22,811	43,619,745	3,742,877	138,779
Equity	15,723,954	12,530,597	80,662	154,539	309,507,418	29,469,258	1,546,809
Employees	133,000	734,000	2,678,841	5,952,393	15,255,946	1,993,976	129,275
Sales/Assets	1.342	1.541	1.358	1.345	1.327	1.353	1.470
Sales/Equity	2.675	2.518	2.607	2.651	2.694	2.747	3.014
Sales/Employee	\$316,248	\$42,984	\$78,544	\$68,824	\$54,664	\$40,596	\$36,069
Net I/Sales	7.47%	3.01%	5.72%	5.57%	5.23%	4.62%	2.98%
Net I/Equity	20.0%	7.58%	14.9%	14.76%	14.09%	12.70%	8.97%
Net I/Employee	\$23,626	\$1,294	\$4,491	\$3,832	\$2,859	\$1,877	\$1,074
Assets/Employee	\$235,579	\$27,886	\$57,826	\$51,182	\$41,206	\$30,005	\$24,535
Equity/Employee	\$118,226	\$17,072	\$30,112	\$25,963	\$20,288	\$14,779	\$11,965
Equity/Assets	.502	.612	.519	.507	.492	.493	.488
% of all sales	3.33%	1.62%	16.6%	32.4%	66.0%	6.4%	0.37%
% of all profit	5.19%	1.57%	19.8%	52.3%	72.0%	6.2%	0.23

wages for apparently equivalent work rise substantially with size of establishment and industry concentration [Lester, pp. 57-58; Weiss, pp. 103-104]. Fringe benefits rise even more rapidly [Lester]. So does stability of employment [Ferguson, p. 44]. Unions have little to do with these size differentials, as they predate unionization, and unions in fact calibrate their demands to firm size [Lester].

One study finds high wages for unskilled workers associated with high wages for semi-skilled and skilled workers, and with four earmarks of capital intensity: high value added per wage earner hour; high value product per wage earner hour; payrolls a low percentage of income from sales; and net after tax income a high percentage of sales [Slichter, p. 83]. Since establishment wage structures tend to be low or high in all categories [Doeringer and Piore, p. 78], this suggests that a high wage structure goes along with capital intensity--as predicted.

If larger firms pay higher wages for "equivalent" work, then necessarily they get higher quality employees, if only because higher wages allow them to be more choosy. (And vice versa: if they are more choosy about employees, they must pay higher wages.) And a number of studies do show that quality of workers--education, race, sex, social background, etc.--rise with organization size and industrial concentration [Weiss, p. 108; Becker, p. ; Alchian and Kessel, p. 170].

As mentioned above, it is possible to regard a firm's inputs as yielding both the firm's marketed output, and satisfaction to members of the firm [Alchian and Kessel, p. 163]. So if the costliness of inputs--"goldplating"--rises with firm size, that is also evidence that employee compensation rises with firm size. It is precisely this phenomenon that the "behavioral" literature on the firm describes and seeks to explain [Williamson, Cyert and March].

For example, Cyert and March develop the concept of "organizational slack." Slack consists of extra costs that rise during flush times, as managers build up extra staff, undertake pet projects, go in for "frills" like corporate gymnasiums. During lean times, corporations can save costs by trimming off slack [Cyert and March, p. 36].

Cyert and March examine and simulate with a computer the price and cost behavior of American Can Co. and Continental Can Co. over a 20-year period. The series starts with the founding of Continental Can as a small competitor to former monopolist American Can. Continental starts with much lower unit costs than American. But as Continental grows, gradually overtaking and passing American, its unit costs also overtake and pass those of American [Cyert and March, pp. 94-95].

I should emphasize at this point that a rise in wages and costliness of other inputs with firm size does not mean that payroll and other costs rise as a proportion of sales. On the contrary: as Table 2 shows, costs decline as a proportion of sales. So larger firms more than make up for the rise in wages by hiring fewer employees per dollar of sales--again, a mark of greater capital intensity.

2. Return on investment declines with increasing firm size.

It may surprise most people, economists included, to suggest that the big corporations get a relatively low return on investment. That is, they are less "profitable" than smaller corporations. But how can that be? Many are oligopolists, and most are obviously rolling in money. And most of the data on ROI is inconclusive, or actually shows an increase in ROI with firm size. For example,

see the data on the Fortune 1000, in Table 2.

The problem with the data on ROI is that the larger a firm, the more its assets tend to be understated. Partly, this results from accounting conventions. Land acquired 50 years ago is carried on the books at cost; bigger firms are generally older. For example, coal analysts estimate that the Pittston Company's net worth is about \$2.5 billion, instead of the \$496 million on the books [Forbes, October 15, 1976, p. 52]. Larger firms are more likely to employ devices like sale-leaseback, which turn an actual purchase of assets into a tax-deductible cost. And then they use plain old expensing of capital investments, which has the same effect. Probably most important, assets like a share in a cartel, or influence with Congress, won't show up on the books at all. Clearly, those who try to test the hypothesis that firms with market power attain a higher ROI actually mean to test the extent to which such "intangible" assets add to the apparent return on ordinary assets.

However, there is plenty of indirect evidence that ROI declines with increasing firm size.

The clearest evidence is that larger firms pay less for borrowed capital. As noted above, smaller firms must pay higher rates for shorter term borrowings--when they can borrow at all--while larger firms can borrow for longer terms at lower rates--if they even choose to borrow. Blue chip firms get more for their stock and bonds than smaller firms; even smaller firms can't go to the stock and bond markets at all. Since firms will invest capital until marginal product (ROI) equals marginal cost, the gap in ROI between larger and smaller firms must be at least as large as the gap in credit rates.

The big blue chip firms in fact pride themselves on their high price-earnings ratios, which allow them to borrow so cheaply. Since murder will out, the price of a firm's stock is surely a better indicator of the value of its equity than book value. That makes the price-earnings ratio a better measure of true ROI than reported ROI. For example, a high price-earnings ratio like 30 would correspond to an ROI of 1/30th or .033 percent (plus something for appreciation).

But that leaves the question of why investors will bid up the price of blue chip stock until the rate of return gets so low. The answer is obvious: blue chip stock is safer. There are two immediate reasons why: (a) The return on blue chip stock is less variable; and (b) blue chip companies are less leveraged. Table 2 on the Fortune 1000 shows equity to asset ratios rising with increasing firm size; the rise would be greater but for the rising understatement of assets.

The unmistakable greater capital intensity of larger firms also suggests a lower return on investment. For example, as the Fortune data in Table 2 shows, assets/employees and output/employee rise with firm size.

Profits as a percentage of sales rise with firm size. Accounting profits, or net income, are equivalent to interest on a firm's assets, plus or minus random fluctuation (economic profits or losses). Higher profits as a percentage of sales therefore show greater capital intensity. As mentioned, higher profits also mean lower costs as a percentage of sales, and hence a lower share to labor--despite higher wages.

Capital turnover--sales/assets--declines with increasing firm size, as Table 2 shows. (The Fortune data is doubly biased against showing this decline, first by the rising understatement of assets with increasing firm size, and

second by the fact that the Fortune 1000 are ranked by sales.) Capital turnover measures the rate at which a firm's assets are replaced, or "turned over," with interest. The slower the turnover, the greater the capital intensity.

A measure that is approximately the inverse of capital turnover is reserve-to-output ratios for mining companies. For example, for the top 11 steel companies ranked by sales in 1963, reserve-to-output ratios ranged from 18.8 years for Kaiser with .6 percent of reserves, to 63.6 years for U. S. Steel, with 65 percent of reserves [Martin, p. 124]. Since reserve-to-output ratios are measured in years, the rise clearly shows the longer time horizon of larger firms--another earmark of capital intensity.

3. Risk aversion rises with increasing firm size.

In equilibrium, if larger firms pay higher wages they can get better employees, and if they want better employees, they must pay more. The same goes for investment quality. If larger firms will accept a lower yield on their capital, they can pick better--safer--investments; if they want safer investments, they must sacrifice yields.

Richard Caves devotes a lengthy article to documenting "an important and oft ignored aspect of the large firm's behavior: that a significant portion of the potential profits latent in its position of market power is taken in the form of avoiding uncertainty, with important allocative effects on the economy" [Caves, p. 284]. This is an income effect. I have argued that there is another more fundamental reason why managers of large firms should act more risk averse: they run a greater risk of losing control of their organization. But the evidence is the same. (Incidentally, market power is not necessary for greater risk

aversion; greater assets of any sort will do.)

Here is some evidence from Caves and elsewhere:

- a. The variability of (accounting) profits declines with increasing firm size. Aggregate profits of small firms vary much more over the business cycle than those of large ones. Since small firms as a group are at least as diversified as big ones, this suggests that the lower profit variability of large firms does not arise primarily from an advantage in risk pooling.
- b. As mentioned, the ratio of equity to total assets rises with increasing firm size. That means large firms have a less risky capital structure.
- c. Oligopolists tend to hold prices rigid to avoid the risk of an outbreak of competition. They also hold market shares stable over long time periods.
- d. The evidence that large firms pay more, offer more stable employment, and select higher "quality" employees, also demonstrates greater management risk aversion.
- e. Mergers, diversification, vertical integration. There is evidence that large firms may diversify to the extent of a serious sacrifice in yields [Caves]. For example, Sampson argues that this happened when ITT diversified from its lucrative telecommunications monopolies [Sampson, p. 76]. Vertical integration may also bring a sacrifice in yields [Caves, p. 295]. For example, Vernon describes the resource and market matching strategies of the international oligopolists: for each new resource one firm acquires, or market one firm enters, its rivals do likewise, often at

enormous cost [Vernon, pp. 29ff]. In fact, it is the nature of oligopolists to build up excess capacity as insurance against actions of rivals.

f. There is abundant evidence that while big firms may spend a lot of money on research and development, most major innovations still come from single inventors or smaller firms, and smaller firms adopt new techniques faster than do larger ones.

g. There is also impressionistic evidence for the greater risk aversion of large firms: small firms dominate risky industries. For example, large corporations don't fare too well in most lines of agriculture. Despite high capital requirements, small firms dominate real estate.

h. Finally, there is the evidence of geographic preferences. For example, Sternleib and Burchell found that, contrary to popular impression, slumlords are not much better off than their tenants--slum property is too risky and labor intensive an investment for the well-to-do. (Interestingly enough, it is the better off--though not well off--slum property owners who most often neglect and abandon--in accord with the prediction that larger firms use property less intensively [Sternleib and Burchell, p. 69]). In a study of oil leasing, Norgaard found (what is common knowledge in the industry) that the majors paid premiums for the best tracts, leaving the poorer, riskier tracts to smaller companies [Norgaard, personal communication].

II. Application to Public Policy: The Example of Mineral Leasing.

If large and small firms differ as described, then seemingly neutral public policies affect large and small firms differently. For example, minimum wage laws and Social Security taxes hit small firms harder by disproportionately raising the cost of relatively unskilled labor. Maximum interest--"usury"--laws also hit small firms harder.

I will briefly show how a knowledge of the differences between large and small firms can be applied to mineral leasing policy. This is quite an important policy question, given the billions of dollars of publicly owned oil coming up for lease in the near future.

These are--or ought to be--some of the major objectives in the leasing of publicly owned minerals or other resources.

1. To promote competition--which means as many firms as possible should have a reasonable chance of winning leases. Among its many virtues, competition brings higher bids, by reducing game playing.
2. To maximize public collection of economic rents.*
3. To encourage "efficient"*** development of resources. That means not encouraging lessees to "highgrade" or take the best resources while

* The economic rent of a resource is the income it yields net of all costs. This income is capitalized into the present value of the lease. To the firm that buys the lease, however, this net income is not economic rent at all, but merely interest on its investment in the lease.

** I put "efficient" in quotes, because efficiency has meaning only in reference to a set of factor prices. If large firms have low capital costs and high labor costs, and small firms have the opposite, any choice of factor prices to measure efficiency from a social perspective is necessarily arbitrary.

leaving behind resources that are supramarginal from a social point of view. It also means not encouraging premature development--"looting"--or postmature development--excessive delay due to speculative holding, or stockpiling by oligopolists. Finally, it means encouraging compact rather than scattered development, to minimize the costs of public infrastructure and environmental damage.

4. To permit easy and fair administration.

There are four basic approaches to leasing: (1) lump sum "bonus" bidding; (2) royalty or percentage of output; (3) profit-sharing; and (4) rental. The first three are widely used, singly or in combination. The fourth isn't much used. There is an excellent, lengthy discussion of the pros and cons, ins and outs of each of these approaches in Oil and Gas Leasing Policy, Alternatives for Alaska in 1977, by Mason Gaffney. Gaffney adds to rental approaches what he calls an "assessed value change" or AVC. This is a high percentage change on the assessed value of resources, similar to a property tax. Gaffney faults the bonus, royalty, and profit-sharing approaches on the first three criteria, and royal and profit-sharing on administrability as well. The AVC comes out ahead on the first three criteria, and probably second only to the bonus system in administrability.

I will briefly examine the four approaches in terms of how they affect different size firms.

If the bidding for natural resources (or other investment opportunities) is fairly competitive, then the firm to which the resource is worth most will win the bidding. (This isn't true where there are so few bidders that game playing replaces competitive bidding.) So what determines how much a resource

is worth to a firm?

The present value of an investment can be written in generalized discounted cash flow form:

$$(1) \quad V_0 = \int_0^{\infty} \frac{R(t) - C(t)}{e^{r(t)t}} dt$$

$R(t)$ and $C(t)$ are expected future revenues and costs as a function of time. $r(t)$ is the firm's discount rate, which is also a function of time. $r(t)$ can be broken into $r_0 + \delta(\sigma)$, where r_0 is the firm's "riskless" discount rate, and $\delta(\sigma)$ is a risk premium. $\sigma(t)$ is the standard deviation of $R(t) - C(t)$. (One might choose some other measure of risk--it doesn't really matter.) The more risky the investment, the higher will be $\sigma(t)/(R(t)-C(t))$ and so the higher $\delta(\sigma)$.

The present value of the investment at any time τ now and into the future can be written:

$$(2) \quad V(\tau) = \int_{\tau}^{\infty} \frac{R(t) - C(t)}{e^{r(t)[t-\tau]}} dt$$

Income at any time τ , that is, interest on the value of the investment, equals $V(\tau)r(\tau)$. This is equal to cash flow plus appreciation or minus depreciation, or cash flow plus the rate of change in lease value at τ .

$$(3) \quad V(\tau)r(\tau) = R(\tau) - C(\tau) + \frac{dV(\tau)}{d\tau}$$

How will a given investment--say, a lease on a piece of potential oil land--appear to a large and to a small firm?

1. $R(t)$ revenue will be larger for the small firm--at least in the near future for a depreciating asset.

2. $C(t)$ cost will be lower for the small firm--unless the investment requires heavy future capital outlays on which the firm will have high interest payments.

3. So, in general, $R(t) - C(t)$ will be higher for the small firm.

4. r , the discount rate for a riskless investment, will be higher for the small firm.

5. $\delta(\sigma(t))$, the risk premium, will be smaller for the small firm--the small firm either perceives a lower σ , or discounts less for risk, or both--it doesn't matter. Of course there is a tradeoff between $C(t)$ and $\sigma(t)$ --a firm can reduce risk by increasing costs, and vice versa. But since C lowers the numerator, while $\delta(\sigma)$ increases the denominator, both change the present value formula in the same direction.

If the small firm has a higher discount rate for riskless investments but a lower risk premium, then for a sufficiently risky investment the small firm will apply the same total discount rate as the large firm.

This is sufficient information to tell us which investments small firms will purchase, and which large ones will purchase--including investments in oil land.

A. Bonus bidding. Bonus bidding is the most widely used system in the United States. Under bonus bidding, an oil lease simply goes to the firm to which the lease has the highest present value--barring game playing, of course. So

present value determines which leases small firms win, and which large firms win.

Small firms will win marginal oil fields--those for which C is a large percentage of R. For such fields, slightly lower costs or higher revenues will have a large percentage effect on present value. Expected R-C may even be negative for a large firm, making the oil field worthless to it.

Small firms will also win riskier oil fields on which their lower discount for risk compensates for their higher riskless discount. Since marginal fields are generally riskier, a preference for marginal fields cannot be distinguished from a preference for riskier fields.*

Large firms will win low cost/high revenue fields--which are also less risky. For here their lower discount rate for riskless investment overcomes their high cost and risk premium disadvantages.

Two other factors besides the quality of oil territory help determine who wins the bids: parcel size, and timing of leasing.

(a) Parcel size. Capital costs to a firm rise with borrowing. So the difference in capital costs to a large and small firm--and hence the difference in discount rate--risk with parcel size. All else being equal, the larger the parcels, the greater the bidding advantage of large firms.

(b) Timing. All else being equal, the more distant in the future the pay-off from an oil lease--so the more capital must be sunk before production--

* Defining riskiness as standard deviation divided by expected value

$$\text{Riskiness} = \frac{\sigma_{R-C}}{R-C} = \frac{\sqrt{\sigma_R^2 + \sigma_C^2 - 2\sigma_R\sigma_C}}{R-C}$$

For given σ_R and σ_C , the closer C is to R, the greater the riskiness, and the more marginal the field.

the greater the bidding advantage of large firms. For a delay raises the amount and duration of borrowing for small firms, raising their discount rate, and increasing their costs with heavy interest payments. The timing factor shows up, for example, in differences in bidding between Atlantic and Pacific offshore leases--where the majors completely dominate, and leases in the relatively shallow, well-explored Gulf of Mexico, where small oil firms win a fair number of bids.

Bonus bidding has advantages: It is cheap and easy to administer; it is popular with the oil lobby; and it does not distort decisions at the margin after leasing. (It profoundly affects decisions by determining who gets the leases.)

On the other hand, bonus bidding gives the maximum advantage on all but the worst territory to large firms--an advantage compounded by the government's tendency to lease large tracts with minimal preliminary exploration. As a result, there are often so few bidders that game-playing replaces competitive bidding--and the majors end up acquiring most of the best oil fields for a song. For example, the State of Alaska auctioned off the Prudhoe Bay fields, now worth an estimated \$10 billion, for \$6 million.

By determining who wins the bids, bonus bidding also determines how the leases will be developed. Large firms, with their low discount rate, will develop the best fields too slowly, or simply hoard them. Meanwhile, small firms, with their high discount rate, will develop the worst fields too fast--making a lot of environmental mess for very little oil.

B. Royalties.

Royalties are a share of the value of output. They are also widely used, in the United States and elsewhere, sometimes in combination with bonus bids.

The effect of a royalty on the present value of an oil lease can be written:

$$V = \int_0^{\infty} \frac{R(1-S) - C}{e^{rt}} dt$$

where S is the share of output. Royalties have many obvious and thoroughly discussed drawbacks (see Gaffney). They encourage highgrading--skimming the best deposits, delayed start-up, and premature shutdown. They sterilize marginal deposits while failing to collect much of the rent from premium deposits. They are costly to administer, the more so if some effort is made to compensate for the perverse incentives by charging higher royalties for better deposits.

Royalties have an alleged advantage in allowing the government to share risk with firms--to the benefit of smaller firms which are supposedly more risk averse than larger ones. Since I am arguing that large firms are in fact more risk averse than smaller ones--such risk sharing isn't necessarily an advantage. Besides, there are better ways to share risk.

As between larger and smaller firms: Royalties are in one way an improvement on bonus payment, as they do not require the upfront payments that put smaller firms at such a disadvantage. On the other hand, royalties render many marginal deposits submarginal, and smaller firms specialize in marginal deposits. Royalties also delay production--again a disadvantage to smaller

firms with their higher capital costs.

C. Profit sharing.*

Profit sharing is used, for example, with the THUMS consortium pumping oil from State of California land off Long Beach.

The basic idea of profit sharing seems to be that the public shares not only the net income attributable to the resource--the economic rent--but also the income attributable to the lessee's investment in developing the resource. That is, the public shares in interest on both the lease price and the lessee's capital improvements. However, I will ignore the share of interest on improvements except to note that it will reduce the value of the lease--and in practice, most of this interest gets exempted anyway.

Theoretically, a share of profits at rate s , at time τ , on a lease of value $V(\tau)$ (defined in equation 2) equals

$$(4) \quad s V(\tau) r(\tau) = s \left[R(\tau) - C(\tau) + \frac{dV(\tau)}{d\tau} \right]$$

where $\frac{dV(\tau)}{d\tau}$ is depreciation or appreciation.

A profit scheme reduces the present value of the lease to

$$V' = (1 - s) \int_0^{\infty} \frac{R(t) - C(t)}{e^{rt}} dt - s \int_0^{\infty} \frac{\frac{dV(t)}{dt}}{e^{rt}} dt$$

or

$$V' = (1 - s) V + s \int_0^{\infty} \frac{|dep|}{e^{rt}} dt - s \int_0^{\infty} \frac{|app|}{e^{rt}} dt$$

* Accounting profit equals economic net income-- Vr --plus or minus random fluctuations. (Random fluctuations are often termed economic profits and losses.)

where V is the original value of the lease.

A profit share reduces the present value of a lease to $(1 - s)$, its former value, plus something if the asset is chiefly depreciating, and minus something if it is appreciating. So a profit share theoretically hits an appreciating asset harder.

Profits as reported in practice omit unrealized depreciation, and allow excessive and premature deduction of depreciation (depletion for minerals). A profit share on a lease would also theoretically take a share of profit attributable to the firm's capital improvements. In practice these can be depreciated too fast or outright deducted--"expensed." So in practice, a profit share of s will leave a present value $(1 - s)$ times the former present value, plus something.

Profit sharing is clearly an improvement on royalties, as the deductibility of costs removes much of the incentive to highgrading. However, the omission of unrealized appreciation makes payment contingent on production. As with royalties, this gives firms an incentive to delay production.

The worst problem with profit sharing is that it gives firms a powerful incentive to pad costs, especially at the high rates necessary to collect any substantial part of the rents. This makes for very expensive and arbitrary administration, particularly when firms own many leases among which they can assign costs.

As between large and small firms, it is not clear how much an improvement profit-sharing is over bonus bidding. Profit sharing does reduce the present value of leases, so small firms can use a lower discount rate--increasing their bid relative to that of large firms. On the other hand, profit sharing

reduces the present value of leases for large and small firms in roughly the same proportion--something less than $(1 - s)$. To put it another way, since a large firm will earn a lower profit on the same lease, it will pay a lower absolute profit share than will a small firm, giving the small firm no advantage. Finally, the omission of appreciation in practice benefits large firms more than small, since appreciation is worth more to firms with low discount rates.

Profit-sharing does share risk with the government. But again, this is more to the benefit of larger firms--especially as they can trade risk for deductible costs.

D. Rental.

Although they might seem a reasonable option, rental approaches are not generally used in resource leasing.

The value of a lease to a firm under a rental approach can be written:

$$V = \int_0^{\infty} \frac{R(t) - C(t) - w(t)}{e^{rt}} dt$$

where $w(t)$ is a rental payment as a function of time. It may be a payment that is fixed in advance, or one that is periodically readjusted to the value of the resource, like the assessed value change. In any case, the payment does not depend on the individual lease holder's revenues and costs--a large and small firm face the identical dollar payments.

Since it does not vary with individual revenues and costs, a rental clearly lacks most of the disincentive effects of royalties and profit shares. It is

also relatively cheap and easy to administer, since it does not require the government to audit companies' books.

A rental with payments set in advance has some disadvantages: it may render submarginal some poorer deposits and not collect enough rent from some better deposits. And it may encourage overhasty exploitation of deposits--a sort of loot and run approach to get as much as possible and clear out before payments come due or the government terminates the lease.

A rental set in advance puts virtually all the risk on the lessee. In fact, it magnifies the risk by leveraging it, in the same way that a heavy mortgage does. In addition, there is the risk that the payment will exceed the present value of the lease--forcing the lessee to abandon the lease, (or the government to evict)--losing the value of his improvements. Such a rental in fact makes the lessee act like the proverbial short-sighted tenant farmer, neither adequately maintaining the landlord's property, nor making sufficient improvements.

Gaffney's assessed value charge--a charge at a high percentage on the assessed value of reserves--effectively sets rental payments after the value of a lease is known, rather than before. The charge rises with appreciation and declines with depreciation. In this the AVC resembles a general property tax, with improvements exempted. The AVC also resembles a profit (or income) share--but not the individual's lessee's profit, but profit imputed to the lease at some given discount rate. Thus if the assessed value of the lease is V , the assessed value charge at rate k is kV . This is the same as a profit share at rate k/r on profit imputed to the lease at rate r - Vr .

Because it varies with the value of the lease, the AVC does share risk with government. But unlike other forms of risk sharing, the AVC does not cause a "moral hazard" problem--encouraging excessive risk-taking. For the AVC shares only risk arising from factors beyond the lessee's control, such as the quality of oil deposits or the market price of oil--factors which will show up in the assessed value of reserves.

The AVC appears to eliminate the obvious problems of pre-set rentals: it collects more rent by rising with appreciation; and by declining with depreciation, it avoids encouraging looting and underimprovement.

As between large and small firms: a rental approach, whether preset or AVC, clearly favors small firms more than the other approaches. For a rental narrows the gap between revenues and costs. It may even make the sum of costs and rent exceed revenue for large firms. In effect, a rental at a high rate makes all resources marginal from the perspective of the lessee--small firms specialize in marginal resources.

Another way to see the impact of the AVC in particular is to remember that it is a charge on the profit (income) imputed to the lease at some uniform discount rate. Since a large firm will earn a lower profit/income on the same asset than will a small firm, the same dollar charge amounts to a higher percentage of the large firm's profit than of the small firm's profit. It may in fact amount to over 100 percent of a large firm's profit, rendering the lease worthless to it.

As between pre-set rentals and AVC, AVC is probably a little less favorable to small firms than pre-set rentals, because of the risk sharing feature. But

that isn't necessarily a disadvantage. There is no need to favor small firms at all costs, for they are just as inefficient in their own way as large firms.

In conclusion, the AVC approach seems best to meet the criteria of leasing policy listed earlier, which is why Gaffney makes it his first choice. AVC is also an approach that favors smaller firms. It accords with our suspicions about the impartial majesty of the law, however, that public policy makers neglect AVC or other rental approaches for approaches that clearly favor large firms.

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