TRANSACTION COSTS AND

CONTRACT CHOICE*

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The relationships considered by contract theory tend to be simple ones. Some contracts indeed are simple. Real relationships, even when appearing to be simple, however, are in fact usually exceedingly complex. The reason is that most transactions have numerous unpriced margins. Simplification, although essential for theorizing, is not free, and existing models may miss significant aspects of contracting by oversimplification. Eschewing direct mathematical analysis, this paper explicitly, though informally, accounts for aspects of this complexity. Several of the propositions considered here are well recognized. One of the contributions of this paper is to analyze them within a unified framework. Some complexities, particularly those associated with contracts involving more
than two individuals will not be addressed. In terms of methodology, this paper focuses on measurement costs,\(^1\) and substantively, it focuses on the notion of the reciprocity of exchange.

In an exchange, each party usually provides the other with commodities and services. Commodities and services have many attributes that often vary in their levels, and the cost of measuring some of these is prohibitive. Such attributes are not charged for, and their use is expected to fail the marginal conditions for optimum. The approach here, then, is of double moral hazard. In what follows I assumed away risk-aversion. Rather moral hazard is generated by the costs of transacting.

Discrepancies between marginal values and marginal costs are a fundamental feature of taxation. Several of the main results of the optimal tax literature are relevant to the study here. I will exploit Harberger’s (1974) formulation of the welfare loss from taxes, as it is especially well suited for my purpose. The tax model, however, overlooks the reciprocal nature that the relationship may take as the principal-agent approach also tends to do.

Section I points to the sources of the difficulty in forming comprehensive contracts and to the resulting departures from the Pareto

\(^1\) The role of measurement cost was introduced in Barzel (1982). Allen and Lueck (1991,1992) provide strong empirical support to the measurement cost approach. See also Barzel (1997, Chapter 3) where I
conditions. Emphasized is the parties’ ability to exploit free attributes that are present in complex transactions. In Section II I consider three questions: 1. How will each of the contractors react to the specifications of a fixed-rent contract? 2. What will the levels of provision and use of the unpriced attributes be? 3. What will the outcome of the interaction be? Section III analyzes features that maximize the value of a fixed-rent contract and compares it to the share and fixed-wage contracts. In Section IV I discuss the share contract, as well as the common elements of, and the differences between exchange and taxation. The conclusions are presented in Section V.

I. Contracting in the Face of Heterogeneous, Multi-Attribute Inputs and Outputs

Cooperation among owners of productive factors requires agreement as to what each will cede and what each will receive. Numerous attributes are present in any transaction, and the levels of many of these are not fixed. To maximize the value of the relationship the transactors must economize

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Herbert Simon (1957) seems to have been the first to adopt such a view of contracts. He also analyzes the choice among contract forms.
on the policing and enforcement of contract stipulations. Questions arise then as to what will the parties choose to include in a contract, and what behavior is to be expected in a relationship if the contract spells out only part of it and all of it is costly to measure, to police, and to enforce. I explore here how the value of the contract between pairs of individual resource owners is maximized while the individuals are exploiting the stipulated and unstipulated attributes of their resources (such that the outcome is Nash equilibrium). Farms operated by single persons are used throughout to illustrate the problems encountered.

To proceed, I am making several strong assumptions. First, apart from the role of the state in enforcing contracts, the relationship between transactors is governed only by their contracts. By abstracting from factors such as brand name, reputation (but not contract-duration which is discussed below), and customs, the nature of contracts is brought into a sharper focus. Second, I assume risk neutrality and thus avoid the need to rely on unobserved tastes; a serious problem in the principal-agent literature. Finally, I assume that contractors' behavior and contract terms are constrained by competition from numerous similar resource owners.

Commodities are viewed here as collections of attributes, and the levels of some of these differ from one specimen to another. The attempt to
maximize gains from trade is subject to the cost of classifying non-uniform commodities and factors of production into more homogeneous classes. The cost of measurement required for perfect classification is prohibitive. Consequently, cooperating units of input such as labor and land, and of the outputs they produce are equally priced even though each encompasses a collection of a large number of attributes whose levels tend to vary from one specimen to another. Consider the following three examples. 1. Farm workers of a given grade are usually rewarded uniformly. Nevertheless, they invariably differ from each other in numerous personal characteristics. 2. Some parcels of land that differ in their improvements and the levels of groundwater and nutrients are still priced uniformly. 3. Output selling as the same commodity is often subject to random variations in attributes such as size, ripeness, bruises, and amounts of foreign matter.3

Contracts explicitly delineate some specific attributes of the transaction. They also implicitly delineate others that are governed by common law. However, they do not delineate attributes that though are part of the transaction are prohibitively costly to measure; the contracts are “incomplete.” Such attributes will nevertheless be exploited, which implies

3 The use of quality control in industry implies that even the repetitive process of the modern production-line generates heterogeneous specimens. The costliness of detecting even the apparently easy to measure attribute of
that the contracts between the owners of productive services do not award each his precise contribution. Among the unspecified attributes, some are subject to control by the buyer and some by the seller. By "control" I mean one's freedom to manipulate the particular unspecified attribute without making marginal payments to others.4

Contracting is viewed here as a strictly symmetric operation. Each of the contracting parties owns productive services that can contribute to the collaboration and whose total value stands to increase by the collaboration. In order to maximize their income, the parties attempt to design their contracts so as to minimize the associated inefficiencies. Both parties are partial residual claimants of the relationship.5 Competition, in the traditional sense, cannot eliminate the inefficiencies; competitive forces, however, force transactors to consistently choose the contracts that maximize the value of their transactions, subject to all the costs facing them.

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water content of stored wheat is described in WSJ, July 1, 1993.

4 What I call “control” is similar to, but differs in important details from what Grossman and Hart (1986) call “ownership.”

5 Holmstrom and Milgrom (1991) also study complex (multitask) relationships. Using the principal-agent model, they focus on the (risk-averse) agent performance of the interrelated tasks. However, they do not consider the potential for moral hazard by the “principal.”

I assert symmetry in the relationship, which implies that each contributes to the collaboration and each can be “exploited” by the other. Treating the two symmetrically also eschews the notion that one party is a “principal” and one is an “agent.”
Thus, in spite of the marginal inequalities—i.e., the violation of the Pareto conditions—no true inefficiencies can be present.

Suppose that one individual rents a factor of production from another. The renter (lessee) will tend to receive the mutually desired amounts only of those attributes specifically stipulated in the contract, although the transactors will manipulate these amounts too. Measurement errors in these attributes and the costs of policing them are discussed below. Consider valued attributes supplied by the provider (lessor) but placed under the renter’s control. The renter will exploit these attributes to the point where their net marginal products are reduced to zero, which is obviously below their marginal costs to the lessor. The lessor will provide low levels of the unspecified attributes he controls such that their marginal costs are zero; the marginal products of these attributes will exceed their marginal costs. It is as if the attributes the provider lets the renter control are subsidized by the provider at a rate of one hundred percent, and as if the renter taxes the attributes supplied by and left under the provider's control at a rate of one hundred percent. These violations of marginal equalities reduce the value of the transaction. Equilibrium in the market is attained by stipulating the terms of transactions as wholes, and by adjusting the transacted quantities.
Before analyzing the individuals' behavior and the nature of equilibrium, I will elaborate on the forces that generate the marginal inequalities.
The variability in the level of the attributes among specimens of a commodity and the costliness of measuring these attributes is at the heart of allowing some of them to be used non-optimally.\(^6\) Were the specimens of each commodity strictly uniform, full information would be obtained by counting the number of specimens and measuring just one. To illustrate, consider nutrients that crops extract from the soil. Suppose that over a substantial land area, the initial levels of these nutrients and the rate of their extraction to be strictly uniform. For such a uniform area and given the uniform rate of nutrient extraction by crops, one single accurate measurement at the beginning of the relevant period and one at its end would reveal the exact total amount of nutrients lost. Lacking such uniformity, comprehensive accurate measurement is needed to reveal the exact amount of nutrients taken from the soil, and such measurement is prohibitively costly. When, instead, the amount of nutrients actually extracted is estimated, errors, which can be substantial, are inevitable. Random sampling would produce unbiased and perhaps low cost estimates, but it is exceedingly difficult to implement in a non-cooperative relationship.

Landowners are sometimes more familiar with the land than tenants are, and may be able to cheaply measure the use of nutrients. However, they

\(^6\) Some prefer the term “inefficiently” over “non-optimally.”
may also be in a position to manipulate their data. The tenants, then, will fear that the landlord’s compensation will be based on an exaggerated amount of the nutrients they expect will be extracted. Resolving the conflict may be expensive, and it may be more profitable for the landlord to forgo explicitly pricing the attribute. The tenant then is implicitly granted control over the soil nutrients and may extract whatever amount he wishes without paying a marginal charge.

II. Contractors Reaction to Contract Specification

Suppose a tenant rents a plot of land on a fixed-rent basis. I assume that soil nutrients are placed under the tenant’s control, and are not priced on the margin. I also assume that the maintenance of land improvements is left under the landowner’s control and are not priced on the margin. The three panels of Figure 1, portraying different aspects of the land rental, are used to analyze the nature of the equilibrium and the forces that lead to it; Panels A and B for behavior within the transaction, and Panel C for market behavior.

Under the assumption that the tenant will cultivate the land the way he sees fit, the horizontal axis in Panel A is the per-acre amount of nutrients
extracted from the soil. The vertical axis is dollars per nutrient, and $L_N$ is the marginal fall in land value due to the depletion of the nutrients. Although to the tenant the nutrient is free, its use is constrained by the cost of extraction. $C_N$ is the cost of extracting the nutrients, arising, for instance, from the use of water that plants require in order to transform the nutrient into a form they can use. $C_N + L_N$ is the sum of the two costs. $D_N$ is the demand for the nutrients reflecting the (marginal) increase in the value of output as the amount of nutrients being extracted increases. A self-employed landowner will extract $N_0$, the quantity at which $D_N$ and $C_N + L_N$ intersect. Since there is no charge for nutrient use in the land rent contract, the tenant does not pay, on the margin, for the depletion of the nutrient. He will extract $N_R$, the quantity where $D_N$ intersects $C_N$; $C_N$ being the cost borne by the tenant.\footnote{Given measurement costs, the tenant will use such nutrients to the point where the estimated rather than actual net gain from an extra unit is zero. For simplicity of exposition, such inaccuracies are ignored whenever the consequences are not germane to the argument.} It is as if he receives an implicit per-acre subsidy at the rate of $u_0$ equal to the height of $L_N$, the marginal fall in land value at $N_R$. The tenant will deplete the nutrient at the rate of $N_R$. On the other hand, the self-employed worker will deplete the nutrient at the rate of $N_0$, the optimal rate. The per-acre loss
due to the excessive use of the nutrient by a renter is the shaded area $U$ (Allen and Lueck, 1992).

Although the tenant controls the use of the nutrient and is able to extract an “excessive” amount, such as $N_R$ per acre, ultimately, the gain of that control is, in part, at his own expense. A tenant who could somehow commit to use only $N_0$ units of the soil nutrients per acre would produce a lower output. However, the reduction in the fixed-rent he would have to pay would be still larger than the income loss due to the smaller output; his net income could increase by up to the area $U$. This, of course, is a general phenomenon. On average, those able to shirk, or to cheat, or to enjoy “free” perks must, under competition, pay for the privilege an amount that exceeds, in expected terms, the value of the privilege. The right is granted only because it is too costly to eliminate.

Panel 1B depicts the per-acre level of maintenance and improvements under the landowner’s control. The horizontal axis is (an index of) the per-acre level of maintenance. $C_M$ is that part of the cost of the landowner's maintenance activity that affects the contract-period crop, and $D_M$ is the

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8 It was assumed above that contracts are enforced by the state, and implicitly that the enforcement is complete and costless. Since under the Coase Theorem resource allocation must be efficient, the result in the text may appear to refute the theorem. What the theorem requires, however, is
demand for maintenance within the contract period. A self-employed landowner will operate at the intersection of $D_M$ and $C_M$, providing maintenance at a rate of $M_0$. When the land is rented out and maintenance is not stipulated in the contract, (and assuming that there are no cross effects between maintenance and nutrients) the landlord, who does not gain from the contribution of maintenance to current output, will supply the amount $M_R$.\textsuperscript{9} It is as if the landlord pays a 100 percent tax on the improvement's contribution, which amounts here to $t_0$ per acre. The per-acre loss from maintenance at level $M_R$ rather than $M_0$ is the shaded area $T$.

Panel 1C portrays the market for land under fixed-rent contracts. Were marginal discrepancies absent, $D$ and $S$ would be the relevant demand and supply curves, and $Q_0$ the equilibrium quantity. As contracts for rented land fail to price some attributes, account must be taken of the resulting discrepancies, which are part of the costs of transacting. In order to simplify the exposition, I assume that the discrepancies occur only in nutrients and maintenance. The quantity $U + T$ is the combined per-acre loss to renters and landlords; it arises from their failure to stipulate and police the use of that economic rights are well delineated, which is not so in the case discussed in the text.

\textsuperscript{9} $M_R$ can be positive because current maintenance, which enhances the post-contract value of improvements, may also benefit current production. A landlord will lubricate his water pump during the current period even if that
nutrients and the level of maintenance. Assuming that the average and the marginal losses due to the discrepancies are equal, \( QR \), the quantity for which the height of the demand curve exceeds that of the supply curve by \( U + T \), is the amount of land that landlords will rent to tenants. \( U + T \) is the loss on the marginal acre. The total loss on the land being rented is \( (U+T)Q_R \). In addition, there is a loss due to too little land rental, shown as the shaded triangular area \( W \) in panel 1C.\(^{10}\)

Although Panel 1C incorporates only two unspecified attributes, one controlled by the tenant and one by the landlord, generalizing to any number of independent attributes is straightforward.\(^{11}\) In the discussion of panel 1C it is implicitly assumed that the unit of the transaction—an acre here—is measured without error, and that the parties’ contract policing and enforcement costs are zero. Whereas "errors of measurement" and "policing and enforcement costs" are not usually considered attributes, the analysis of attributes applies to them too, and they can easily be incorporated into the model. To the extent that error in measuring acres can be influenced by one enhances his income in future periods only.

\(^{10}\) The quantity \( W + (U+T)Q_R \) is what, in this case, is the cost of transaction as I define it in Barzel (1985). This definition of the cost of transacting is identical to what Jensen and Meckling (1976) call "agency cost." See also Allen (1991).

\(^{11}\) In the next section I discuss the use of attributes that are substitutes or complements to each other.
of the transactors, say the seller, it can simply be added to the rest of the attributes he controls.

Regarding contract performance, to the extent that contracts are not self-enforcing, various forms of supervision, inspection and certification have to be employed.\(^\text{12}\) A contract that grants one of the parties the right, say, to supervise, grants that party control over a particular subset of attributes supplied by the other party. Granting the right to supervise implies that some attributes become free to the supervisor. Subject to his own cost, the supervisor will exploit such attributes, as he would all other attributes he controls, to the point at which, to him, their net marginal value is zero. This condition may apply, for instance, to the monitoring of the other’s level of effort or it may apply to the care in the performance of a particular task.

### III. Constraining Factors That Affect the Inefficiency Level

In this section I explore avenues available to the parties to form a contract that will constrain the cost incurred from treating certain valued attributes as if they were free. Given the framework in which each of the parties obtains control of a subset of the attributes of a transaction, the

\(^{12}\) Barzel and Suen (1992) model monitoring costs.
maximization of the value of the transaction implies the constrained minimization of the deadweight losses that arise because attributes are free. Attributes are not priced because the cost of explicitly contracting for them exceeds the gain. The use of attributes too costly to price or to directly constrain may nevertheless be controlled indirectly, as the parties may be able to cheaply manipulate a whole array of related factors.

In the analysis that follows I exploit the analogy between tax distortion and the marginal discrepancies that arise because of transaction costs. The optimal tax literature started with the fundamental contribution by Ramsey (1927). Many elaborations have been made since. Harberger’s (1974) is most useful here because his formulation is directed to empirical application. He shows (p.73) that, linearized, the deadweight (or distortion) cost of a set of excise taxes, $\Delta W$, in an otherwise first best economy is

$$\Delta W = \frac{1}{2} \sum_i \sum_j R_{ij} T_i T_j.$$ 

$T_i$ and $T_j$, respectively, are the excise taxes on commodities $X_i$ and $X_j$ and $R_{ij} = \frac{\partial X_j}{\partial T_i}$. This relationship can be manipulated to obtain

$$\Delta W = \frac{1}{2} \sum_i \sum_j C_{ij} (-\eta_{ij} + \varepsilon_{ij}) t_i.$$ 

The $C_{ij}$'s are constants, the $\eta_{ij}$ and $\varepsilon_{ij}$ are, respectively, the own demand and supply elasticities for $i = j$, and the cross elasticities for $i \neq j$ and $t_i$ and $t_j$ the
excise taxes in percentage terms.\textsuperscript{13} The distortion, then, increases linearly with the own supply and (the absolute value of) the demand elasticities and with the cross elasticities, and quadratically with the tax rates. In the analogy, the domain of the contract is taken as the economy, and the attributes are taken as the commodities. In the remainder of this section I consider the part of the taxation proposition concerned with elasticities. In the next section I will consider ways of manipulating the own tax rates.

IIIa \textit{Affecting Elasticities and Levels of Demand And of Supply of Free Attributes}

In the conventional land-rent model it is implicitly assumed that land is unchangeable; whatever attributes it has, their quantities are fixed. In other words, the supply elasticities of all its unspecified attributes are zero. Under these conditions (given risk-neutrality, which I assume) the fixed rent contract is efficient.\textsuperscript{14}

Land users, however, can alter the land they cultivate. The question whether land use will be efficient arises then. Cheung (1969) points out that

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\begin{itemize}
  \item\textsuperscript{13} Harberger (pp. 35-37) himself manipulates his basic expression. He does it, however, only for the simpler case of a single tax and a perfectly elastic supply.
  \item\textsuperscript{14} Had land been truly unchangeable (and abstracting from risk-aversion), Henry George’s single tax would have been non-distorting. It is
\end{itemize}

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when the cost of transacting is zero, efficiency will always be attained because the transactors can then costlessly fix the level of any factor they supply. By fixing all attributes at the desired levels, the over- or under-utilization of any attribute will be avoided. I now elaborate on the theme of operating on the levels of land attributes, but drop Cheung’s costless transacting assumption.

The transactors can gain by constraining their actions such that they reduce utilization where it would have been excessive, and increase provision where it would have been inadequate. I concentrate on reducing the use of soil nutrients, which tends to be overused, being a free attribute to the tenant. Consider an attribute that is complementary with the soil nutrient but was not initially made part of the exchange contract. Suppose that a self-employed individual would have used the complementary attribute at a per-acre rate of $W_0$ and that the landowner can, at a low cost, fix the level of the complementary attribute. Fixing the level of the complementary attribute at $W_0$ will increase the cost of using the free attribute around the equilibrium point, making it less elastic, thereby lowering the associated distortion.
For example, suppose that water-use is the attribute complementary to the extraction of a soil nutrient. The landlord can reduce the tenant's cost elasticity for the extraction of the soil nutrient and the associated distortion by installing a pipe with capacity $W_0$ per acre.\footnote{See Barzel 1981. Guesnerie and Roberts (1984) discuss the problem in the context of optimal taxation.}

The effect of fixing the amount of water at $W_0$ is shown in Figure 2, which elaborates on Figure 1A. The points on $C_N$ are obtained by optimizing the level of inputs. Each of the points uses the input combination that minimizes the cost of extracting the corresponding amount of the nutrient. The amount of water used in the process of cost minimization of extracting the amount $N_0$ of nutrients is $W_0$. When $W$ is constrained to an amount no greater than $W_0$, the cost of extracting the nutrient shifts from $C_N$, which is derived under the assumption that the tenant can adjust the amount of water purchased, to $C_N|W_0$ where $W$ is fixed at or below $W_0$. The latter is less elastic to the right of $N_0$. To the left of $N_0$, $C_N|W_0$ coincides with $C_N$, but this is of no consequence to the desire to restrict nutrient use to no more than $N_0$. When $W$ is fixed at up to $W_0$, then, the use of nutrients falls from $N_R$ to $N_1$. $C_N|W_0 + L_N$ is the new total cost curve.
The total loss is reduced from $U$ (Figure 1A) to $U|W_0 + C|W_0$ the sum of the two shaded triangles in Figure 2. The triangle $U|W_0$ is the loss from still overexploiting the nutrients. The triangle $C|W_0$ reflects the resource cost associated with of the inefficiency of operating along $C_N|W_0$ rather than along $C_N$. The sum of the two triangles $U|W_0$ and $C|W_0$ is necessarily smaller than $U$ because the excess use of nutrients is smaller, and the marginal loss at $N_1$ is less than at $N_R$.\(^{18}\)

Although $W_0$ is the amount of water used by a self-employed individual, constraining $W$ to $W_0$ does not quite minimize the distortion. It will be minimized when the amount of water is restricted to an amount (somewhat) less than $W_0$. As the amount of water used falls below $W_0$, a new distortion is introduced in that water use becomes "too small." But as the quantity of soil nutrient extracted falls with the reduction in the amount of water, the associated loss also falls, and initially at a rate faster than the increase in the new one induced by the insufficient use of water (the “envelope” theorem). Some value of $W$—$W_1$, such that $W_1 < W_0$—is the optimizing level of water to use. Nevertheless, water is likely to be

\(^{18}\) As drawn, the slope of $L_N$ is positive, so that the rate at which land value falls rises as the extraction of the nutrient rises. In that case, the sum shaded triangles $U|W_0 + C|W_0$ in Fig 2 must be smaller than that of $U$ in Fig. 1a. This relationship need not hold if the slope of $L_N$ is negative.
restricted at $W_0$ because that value may be observed--this is the actual amount used by self-employed owners--whereas there is no direct method of estimating $W_1$.\(^1\)

The landlord may operate on additional inputs. He may impose alternative or additional restrictions to reduce the use of subsidized attributes and increase the supply of taxed ones. One is stipulating that the tenant must supply minimal amounts of factors that are substitutes to the (free) nutrient, thereby lowering further the demand elasticity (and the demand) for the nutrient. A parallel argument applies to attributes controlled by the landlord. Consider a factor complementary to maintenance. If the tenant agrees to supply an amount of that complementary factor equal to (or, preferably, somewhat greater than) the amount a self-employed tenant would have provided, the landlord’s supply of maintenance will increase toward its optimal amount, thus reducing the loss associated with that factor. For example, the landlord will provide more pumping equipment if the tenant agrees to lubricate it.

When it is desirable to fix the level of an attribute, who should be assigned the fixing task? To the extent that the cost of that action is the

\(^{19}\) The solution to the problem of deciding on the water level is akin to the choice between Slutzky’s and Hicks' compensation of the cost of living
same to the two parties, it should be carried out by whoever stands to gain most from it, since it becomes more fully self-policing then. In the case of the soil nutrient, the landlord will gain more from reducing its exploitation, so he is the one more likely to take charge of restricting water use. The costs of such actions, however, are unlikely to be the same to the two parties. It may be preferred, on balance, to have the lower cost party supply the attribute and supervise the other if necessary.

Free attribute losses can be also reduced by manipulating the prices of commodities related to the free attributes (Braverman and Stiglitz (1982)). For instance, if the price of a commodity that is a substitute to a free attribute is reduced, the demand for the free attribute will decline, and thus the associated loss will also decline. A landlord who wishes to reduce the tenant's use of an unpriced soil nutrient and who finds it too costly to police the use of a complementary fertilizer may instead subsidize the tenant's purchase of the fertilizer. In order to further reduce transaction costs, the landlord may supply at no marginal charge some commodities that are substitutes to unpriced attributes in order to reduce the use of these attributes.20 (Barzel, 1997, Ch. 3 and Holmstrom and Milgrom, 1991).

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20 The success of a price subsidy depends on the presence of a particular

adjustment. The former is chosen in practice because it employs observable magnitudes whereas the latter does not.
IIIb Why Ownership by a Cultivator is not Necessarily Efficient

As just argued, under the fixed rent contract each of the parties controls attributes owned by the other and reaps the reward from using them at no charge. A similar statement applies to the wage contract; there too the owners of certain attributes are distinct from their users, leading to under-provision of some attributes and overutilization of others. Were the owners of the particular attributes to coincide with those who gain from their use, the discrepancies associated with these attributes would disappear. Such a pattern of ownership would eliminate the tax or subsidy, i.e., reduce its rate to zero. The beneficiary from use and the cost-bearer would be one, and incentives would be perfectly aligned.

It may seem that turning the fixed-rent or the fixed-wage contract to one of self-employment, thereby unifying the ownership of the whole set of factors required for production is a low-cost method that avoids the incentive misalignment. In both, the tenants in the tenancy case and the wage workers in the wage case could become owners of the land they cultivate. However, for at least three reasons cultivators are not necessarily the most efficient owners of the land they use. First, some cultivators are too transaction cost--that of reselling the subsidized commodity. That cost must be high enough so that the gain from reselling the commodity is smaller
poor to own the land without borrowing. Were they to borrow and use the land as collateral, problems with the overuse of soil nutrients would likely have re-emerged. Second, ownership is often patterned so as to avoid externality problems such as those associated with pest control or underground water pools which individual ownership may upset. Third, and least recognized but seemingly most fundamental, is that profitable ownership is not, in general, passive. The management of resources takes skills, and specializing in it can yield important benefits. Landowners, for instance, have to acquire skills in, among others, how to protect the land from erosion, how to best rotate crops, and how to preserve moisture in the soil. Such skills are useful for landlords who cultivate their own land. Separating the ownership of land from that of labor-services permits each owner to specialize in a subset of skills; the tenant in improving his labor services and the landlord in the skills required for the maintenance of the land. However, they have to also develop skills that help them protect the value of the assets when worked by others, which reduces the direct gains from specializing.

In any case, “land” and “labor” are not the only factors used in production; production requires the collaboration of numerous and diverse inputs. Even when the cultivator owns the land, some costs of collaboration
remain. To entirely avoid any costly exchange, the farmer must become fully autarchic, which requires, among other things, self-reliance in farm machinery and in plant research. The loss from non-specializing is evident. The parties however, can gain from aligning their incentives, which, to a degree they may be able to short of one of them becoming the owner of more, if not all the relevant attributes.

IIIc Affecting the Tax Rate by Reversing Attribute Ownership

The physical entities described as "commodities" or "assets" usually constitute the units of transacting. As is emphasized throughout this paper, these, as a rule, are collections of attributes. Owners, however, do not have to transact whole assets; they may sell or rent just a subset of the attributes of their assets. They are likely to do so as the gains from dealing with individual attributes increase, due, say, to a rise in the market value of attributes. Dealing separately with individual attributes of physical entities incurs its own costs; one of these is that the explicit pricing of an attribute may be too expensive. The parties, however, can still increase the value of their transaction by reassigning ownership to subsets of attributes of whole

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21 Eswaran and Kotwal (1985) emphasize the loss from such reductions in specializing.
commodities. These notions obviously apply to a complex asset such as a whole farm, or to the set of attributes constituting a tenant’s services.

Pumping equipment, work animals and tractors are some of the factors needed to produce crops. Who should provide such items and who should maintain them is a matter of choice. The landlord, who is usually the capitalist in the partnership, may seem to be the natural candidate for providing the capital goods, while it may seem that the tenant, who is usually the supplier of labor services, should be in charge of maintenance. The classification of factors into capital, land, and labor, however, is not useful here. Having the landlord supply the capital goods implies taxing him for providing these goods, since he is not fully rewarded for the increase in output generated by the more intensive use of capital. The tenant's maintenance effort will also be taxed, since he is not fully rewarded for capturing its full value. It is advantageous to assign the supply of pieces of capital and their maintenance to the party for whom the difference between the gains and the costs from these operations is the largest.

One factor that affects the decision is durability of the equipment and the ease of “exploiting” it. The less durable a piece of equipment is relative to the duration of tenancy and the easier it is to exploit it beyond its “normal” use, the greater is the advantage of the tenant supplying it.
Consider a tenancy contract of a one-year duration. Work animals or tractors supplied by the landlord are most likely to be severely depreciated by year-end if the tenant is in charge of their upkeep. The tenants’ demand elasticity for the services that result in wear and tear is high, and the associated loss is large. If, however, the tenant has to supply such items, no shirking in maintenance is expected. More generally, the tenant here gains from affecting the value of the capital much more than the landlord does. By making him owner of this input, he, rather than the landowner, bears the bulk of the reduction in value his use induces. He will then use this capital carefully, which is likely to more than compensate for the greater difficulty he may have in raising capital.

A similar argument applies to land improvements. These may seem to be an integral part of the land and thus a “responsibility” of the landlord. The less long lasting their effects will be, however, the less inclined is the landlord to perform these functions while the contract is in force. The problem becomes less acute if shorter-term improvements such as fertilizing and weed control are assigned to or simply assumed by the tenant. It is expected, then, that the contract will assign to the tenant the shorter-term

22 Recall the assumption that the relationship between tenant and landlord is governed only by the contract; the expectations of renewal are abstracted from.
improvements and to the landlord the longer-term ones; the longer the
duration of the contract, the farther the division line is expected to move
toward the longer term improvements.23 Still, since the effects of the
improvements are seldom confined to a particular period, where policing
costs are low enough, each may be required to provide no less than some
prespecified amount.

The duration of the contract, obviously endogenously determined,
often plays a major part in better aligning the parties’ incentives. The
duration of the contract is the length of the period in which the parties cede
control of some attributes to each other. Changes in the duration of the
contract affect the parties’ incentives to exploit free attributes. This can be
easily seen by comparing a tenancy contract that covers the planting season,
but not the harvesting season to one that covers both seasons. Under the
shorter duration contract, the tenant is not expected to do any planting,
which is a "land improvement," since the landlord will receive the entire
output and the tenant will pay a one hundred percent tax. The tenant's
incentive for planting is restored by extending the contract period to cover

23 A landlord may undertake an improvement before signing the
contract even if it is optimally taken in the middle of the contract period.
The reason is that, so long as it is not stipulated in the contract, he is not
expected to undertake it during the contract period, and the rent he can
charge depends, in part, on the improvements he provides.
the harvest season too. The longer the time span between planting and harvesting, the longer we expect the duration of tenure to be.\textsuperscript{24}

Changing responsibilities can take another, radically different, form: altering the unit by which the transaction is conducted. Such a change in units alters the whole structure of attribute ownership, or responsibility, and the associated incentive system. The contract between the owner of land and the owner of labor can use acres as the basic transaction unit—the rental contract—or it can use man-hours as the basic unit—the employment contract. Shifting from one contract to the other constitutes a global change in the tax-subsidy structure; it completely alters the demand and supply of the various unpriced attributes. For instance, since the pay of an employed worker is not, on the margin, a function of output value, he does not gain from exploiting the soil nutrients. The basic character of the problem, however, remains unchanged. Each party will over-use those attributes that are both controlled by him and are subsidized by the other, and each will reduce the supply of those attributes that he subsidizes. The wage contract,

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\textsuperscript{24} The incentive to exploit free attributes intensifies towards the end of the contract period. The more acute this problem is, the more likely it is that the parties will sign a new contract before the expiration of the older one. In professional sports, such phasing-in of contracts is quite common for athletes and for coaches presumably to prevent under performance by the athletes toward the expiration of their own contracts and to reduce the overuse of athletes by coaches whose contracts are about to expire.
for instance, seldom stipulates all work-place amenities, and the employer is expected to shirk in providing them.\footnote{The use of the “principal-agent” terminology tends to obscure the symmetry of the relation and of the advantage of shifting responsibilities as conditions change.}

The symmetry between the two contract forms also applies to supervision. Although I largely abstract from supervision, its general relevance is worth noting. It is obvious that workers rewarded by a fixed wage must be supervised; otherwise they would tend to do nothing. The employer, however, must also be supervised in providing the amenities he contractually agreed to. In the fixed rent contract, the landlord must be supervised if, for instance, he agrees to maintain the irrigation system, and the tenant may have to be supervised to not induce too much erosion. The need for supervision is general, but its desired intensity varies, and thus its application will not be uniform.

The decision of whether to adopt land rent or a wage contract depends on which of the two results in a smaller total loss from the marginal discrepancies and thus maximizes the net gain of the cooperation. Abstracting momentarily from sharing, the two contracts obviously cannot be compared marginally. We expect that the one that will maximize the net value of the resources will be adopted. Although we cannot tell which of the
two forms yields a higher net gain, we can specify conditions under which a shift from one contract form to the other is expected to occur. For example, as land attributes become more difficult to measure or to police, the wage contract is more likely to be adopted. A switch from one contract form to another may even change the desired characteristics of exchange partners, and thus may change their identity.

IV. Affecting the Tax Rate by Share Contract

The sharing arrangement is attractive because it reduces the need to measure and separate the parties’ efforts and it correspondingly lowers the deadweight losses. In the absence of constraint, the losses associated with the fixed wage contract are certain to be large, and those associated with the fixed rent contracts may be large. If constraining the parties’ behavior is difficult, the share contract may be used because, as Eswaran and Kotwal (1985) note, it is, in part, self-policing. The two parties may gain from cooperating even when unilaterally deciding on their levels of effort. Each party is induced to perform because they share whatever output there is, and, therefore, each will be remunerated only if the other is remunerated.
too. Consequently, as with the optimal tax-rates, as one’s share of the income increases, the deadweight loss associated with taxed attributes is lowered at a faster rate. This lowering of the deadweight losses, however, applies only to the attributes each contributes and controls but not to those each places in the other’s control. The next few paragraphs exploit, but also point to a caveat with the analogy between deadweight losses from sharing and those from taxation.

The conventional analysis of the agricultural share contract characterizes the tenant as one who gets to use land in exchange for a share of the output. It concludes that since the tenant’s marginal contribution is taxed, he will apply less of his labor and other inputs than the joint maximizing levels. Cheung (1969) pointed out the relevance of the Coase Theorem to this issue and challenged the notion that the share contract is necessarily wasteful. He demonstrated how dissipation can be lowered (and also indicated a role for risk-aversion). However, he, as well as those he criticized and those who followed him overlooked the reciprocal nature of the relationship. The landowner is not necessarily a passive party, and may

26 Two issues not considered in the main text are monitoring and the sharing of inputs. Barzel and Suen (1992), construct a simpler model than the one used here, and derive conditions under which monitoring will be used. Allen and Lueck (1993) emphasize the effect of the cost of measurement on share-contract provisions, including the sharing of input
unilaterally improve the land as long as the increase in his share of the output exceeds the improvement cost. More generally, the two are collaborating in producing the output, each applying some inputs and each placing some attributes under the other’s control. Given sharing, each will provide some of the former, even if too little. Independent of the sharing formula, however, each will use the latter to the point where their marginal values are zero.

The analogy between a share and an (ad valorem) tax is instructive, then, but by no means complete. First, unlike the tax relationship, a share contract is a partnership. Subject to the costs of transacting, the parties are expected to maximize the net value of the transaction. They will make contract stipulations to bring the inputs close to their jointly maximizing levels. Thus, in a share contract the parties will, for instance, assign tasks to each so as to reduce the divergence between effort and reward. No such adjustments are considered in the tax analysis. A second point not

\[ \text{\textsuperscript{27} In tax analysis commodities are treated as one-dimensional and the government unilaterally makes all the tax stipulations. If commodities are indeed complex and free attributes unavoidable, then the government and the taxpayers can emulate the partnership relationship pointed to here thereby increasing real income. It is reasonable to hypothesize, then, that such arrangements are actually implemented, subject, however, to government inflexibility, presumably due to its high cost of adjusting contracts.} \]
recognized by the literature is that the share contract is two-sided. Each of the two sharing individuals retains control of some of the attributes of the factors he provides, and each is given control of some of the attributes of the factors the other provides. Each receives only a portion of his contribution, but at the same time each also receives a portion of the other’s contribution. Correspondingly, the contribution of some of the inputs of each is taxed. Each is also able to take advantage of the inputs supplied free by the other; each, then, is also subsidized in the use of some of the other's inputs. I will now show why the analogy from the taxation model applies to the taxed, but not to the subsidized attributes.

I begin the discussion of the behavior of the two parties with regard to the taxed attributes. The taxed attributes are those each party supplies and retains control of. In the fixed-rent contract, the tenant who supplies effort receives, on the margin, one hundred percent of the output, so his effort is optimal. In the share contract, as the conventional model shows, the tenant’s effort is taxed and, if he is unconstrained, the effort he will provide is below its optimal level. In the fixed-rent contract the landlord's share is zero, and he will provide maintenance to the point where the value of its marginal

28 Allen and Lueck (1993) also assume that the relationship is one-sided. They concentrate empirically on contracts in which one party is seemingly more active than the other.
contribution is also zero, as shown above in conjunction with Panel B of Figure 1. Under the share contract, his tax is lower and his contribution will be larger. As the landlord's share approaches one hundred percent, his contribution will approach its optimal level.

Momentarily confining the discussion to the above two inputs, under the fixed-rent contract one of the inputs—the tenant’s effort—is provided at the optimal level, while the other one—the landlord’s maintenance—is distorted. Both are distorted under the share contract; the tenant’s effort newly so, compared with the fixed-rent contract, and the landlord’s maintenance is still too low, but not to the extent under the fixed-rent contract. The two changes may appear to more or less cancel each other out. However, since the deadweight loss from the distortion is a quadratic function of the tax rate, the initial move from fixed-rent to the appropriate share in the share contract necessarily lowers the overall deadweight loss. The nature of the process is revealed by noting that due to the quadratic relationship, lowering the landlord’s tax from one hundred to ninety nine percent reduces the deadweight loss by a finite amount—a first-order gain, whereas increasing the tax on the tenant from zero to one percent generates almost no deadweight—a second-order loss.29

29 This is an application of the envelope theorem.
Under the share contract, since output is shared, rather than being either at zero or one hundred percent, as is the case under both the wage and the fixed-rent contract, the “tax” rates lie somewhere between the two extremes in the share contract, and thus are more uniform. To see how the deadweight loss changes with the share, suppose the landlord’s share is two-thirds. Under the fixed-rent contract, the landlord’s share is zero, he supplies $M_R$ maintenance, and the deadweight loss is area $T$, the triangle below $D_M$ and above $C_M$ to the right of $M_R$. This is shown in Figure 3, which reproduces Panel B of Figure 1. $D_L$ (the solid line below $D_M$) in Figure 3 is the landlord’s demand under the share contract. It is equal to two thirds of $D_M$, as the landlord receives 67 cents of each dollar of revenue. He pays a "tax" of 33 percent of the contribution of his input. $D_L$ intersects $C_M$ at a quantity $M_{SH}$, which lies to the right of $M_R$, and part of the way towards the optimal level $M_O$. The proposition that the distortion changes quadratically with the tax is derived for the unit tax, and not to the ad valorem tax, however. Were the tax fixed on a per-unit basis at two-thirds of $t_0$, as is $D_L'$ (the dashed line) rather than at a fixed percentage, the intersection with $C_M$ would be at quantity $M_V$, which lies at two-thirds of the distance between $M_R$ and $M_O$. The deadweight loss would then be one-
ninth (one-third squared) of T. The lower deadweight loss from the share contract is the result of the more uniform tax rates—in the example, 33 percent on the landlord’s maintenance and 67 percent on the tenant’s effort. On this score alone, the two parties will choose the share that minimizes the total deadweight loss (while making a fixed payment to one or the other to bring the remuneration of the factors to their competitive levels). This sharing formula corresponds to the optimal tax structure derived in the tax literature.

The party that supplies each of the two attributes considered in the last paragraph is the party that controls it. The parties supplying some of the attributes in the sharing relationship, however, do not control them. Soil nutrients are one such attribute; they are supplied by the landlord but controlled by the tenant. The tenancy literature and, indeed, much of the

30 The landlord’s share implied by the fixed tax $D_L$ to the right of $M_R$ is less than 67 percent. Thus $M_{SH}$ is to the right of $M_V$. Therefore, the welfare triangle corresponding to $M_{SH}$ is smaller than that corresponding to $M_V$.

31 The taxation proposition is that for a given tax revenue, taxing two commodities at rates that equalize the marginal distortions will result in a smaller deadweight loss than when only one of the commodities is taxed.

32 Sharing, of course, may be superimposed on a fixed-rent or fixed wage contract. Allen and Lueck (1993) observe some sharing superimposed on fixed-rent contracts.
optimal tax literature, provide no analogy for this relationship.\textsuperscript{33} Consider Figure 4, which reproduces Panel A of Figure 1 and adds the line $D_T$ to it. $D_T$ is the tenant’s share of $D_N$, i.e., his demand for the nutrient given his share of the output. The value of the marginal product of the nutrients falls to zero at $N_K$ both under $D_N$ and under $D_T$. Consider momentarily the case where $C_N$, the cost of extracting the nutrient, is zero. On the margin the tenant does not pay for the nutrients whether he receives the entire output (operating on $D_N$), or a share of it (operating on $D_T$). The amount of nutrients he will extract, then, is $N_K$.\textsuperscript{34} In this case, then, imposing a tax on tenant’s output has no effect on his behavior.

The share tenant will alter the amount of nutrients he extracts if he incurs a cost of extracting it such as when $C_N$ is positive. In that case he will operate at the intersection of $C_N$ with $D_T$, and, given the share represented by $D_T$, the amount he will extract is $N_{SH}$. The deadweight loss, however, does not bear a simple relation to the share. The amount of nutrients

\textsuperscript{33} In Barzel (1976), I point out, however, that the tax authority does not tax all the attributes of taxed commodities. Taxpayers’ ability to alter the level of such attributes is equivalent to their control of attributes “supplied” by the state.

\textsuperscript{34} Allen and Lueck (1993) incorrectly conclude that the value of the marginal product of nutrients to the farmer at equilibrium is positive (presumably, farmers do in fact incur extraction costs, which may explain Allen and Lueck empirical finding).
extracted increases as the share increases. Depending on the share, that amount can be either less or more than \(N_0\), the optimal amount.\(^{35}\)

The traditional share tenancy analysis implicitly assumes that output is measured and policed costlessly, which is not the case in reality. A necessary condition for sharing is that the output is easily identifiable and divisible because the sharing of the gains is what renders the collaboration self-policing, to some degree. Land used to grow wheat is seemingly suitable for a share contract, but land used to grow highly diversified crops is not as suitable for that contract because each component of output must be measured separately and may also be easier to conceal and to steal (Hart 1988). Obviously, where the prevention of output theft by cultivators is prohibitively costly, neither a wage contract nor a share contract will do. Instead, the landlord may cultivate his own land or secure a fixed-rent tenant to cultivate it.

Sharing may be used for at least three reasons in addition to those already stated: 1. To reduce theft by individuals who otherwise would have been “outsiders.” 2. To guarantee the parties’ remuneration. 3. To lower policing costs. Regarding theft, when, because of random factors, one

\[^{35}\] The tenant will extract the optimal amount of nutrients (i.e., \(N_0\)) when his share in output is equal to his share in the total cost of the nutrient, which is \(C_N/(C_N+L_N)\). Thanks to Wing Suen for this point.
person’s effort yields rich fruit while his neighbor’s effort yields no fruit, the latter’s cost of stealing is low, and most likely, its value high. By becoming partners ahead of time and sharing the product, they lower the incentive for theft. Johnsen (1986) offers this motive as the explanation for the custom of “potlatch” (gift giving) by Northwest Indians, where salmon catch varies widely from year to year and from stream to stream.

The problem of guaranteeing remuneration arises with contract forms other than sharing but is absent with sharing. In fixed rent contract, if the rent is to be paid in advance, financing it may be a problem. If it is to be paid when it ends, in a bad year the tenant may be short of funds with which to pay. In the share contract, however, transactors simply divide the output when it becomes available, and they divide whatever output there is.36

Consider, finally, parties who share an interest in the output of their collaboration. The self-policing of the share contract is then enhanced. Suppose, for instance, that two neighbors join efforts in experimenting with a new fruit tree (or two tennis players share the ownership and the exclusive use of a court). Their individual interests in caring for their asset are nearly

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36 The analysis in the text abstracts from means of payment problems, thus implicitly assuming a zero transaction cost for the means of payment. The share contract may be preferred to the fixed rent contract if the means of payment is also costly to transact, though the latter may stipulate pay in output units rather than in cash. This form of payment had been common
identical with their joint interest; the various aspects of caring that each
deems desirable are also desirable to the other. The same reasoning applies
to such diverse cases as the corporate shareholder since the per-share gains
are (approximately) of equal value to all, and to the two operators who share
a taxicab. In most other cases, however, commonality of interests conflicts
with specializing.37

The share contract, then, like the fixed-wage and fixed-rent ones may
appear simple, but it is very versatile. It is capable of solving a range of
problems, and here too the solutions are second best.

V. Conclusions

The specimens of productive factors and of the output they generate
tend to vary. When different individuals own the productive factors,
cooperation between them requires the delineation of the factors and of the
output. Variability makes the cost of full delineation of what each will cede
and what each will receive prohibitive. I have presented an analysis of the

37 Marriage seems to be the most important instance of sharing. Here,

too, the two parties collaborate in producing output that they share (see
precise meaning of operating under contracts that do not fully spell out all the dimensions of transactions and the expected behavior of the parties in the face of incomplete specification. I have shown that some of the attributes in two-party transactions are essentially left in the public domain and how resources are expended to reclaim such attributes.

I have also considered how the value of the transaction is maximized given that public domain problems are expected to occur. Whereas contractors will not stipulate on all attributes of transactions, they possess means to constrain the potential deadweight losses. Essentially, contracts are designed such that each of the transactors is induced to bear a larger share of the effect of his actions. Contracts tend to assign control to each party over those attributes they can most easily affect. For example, tenants will tend to furnish capital equipment that is prone to damage and landlords will furnish durable improvements that are not very sensitive to tenants' actions. It has been further argued that when such assignments are impractical, quantity or price restrictions will be imposed to better align the individuals' behavior with the jointly maximizing one. Responsibilities can also be reassigned by changing the unit governing the exchange. In particular, by switching from a wage to a fixed rent contract, each of the parties becomes a residual claimant to a very different set of attributes.

Allen, (1991)).
Finally I have explored the analogy between the approach here and that of the optimal tax literature. First, I have emphasized the reciprocal nature of the share (and other) contracts. Second, I have demonstrated that although share contracts "tax" more activities than are taxed by the wage or fixed rent contracts, since the rates of these taxes are more even, the arrangement can result in higher net value transactions. Lastly, I have shown why the tax analogy does not apply to the attributes that the parties to a share contract provide each other free of charge.
REFERENCES


A: Per Acre Cost of and Demand for (Valuation of) Nutrient

B: Per Acre Cost of and Demand for (Valuation of) Maintenance

C: Market for Land Under Fixed Rent Contracts

FIGURE 1
$ / N$

$D_N$

$L_H$

$C_N + L_H$

$D_T = 1/3 \, D_N$

$U$

$N_{SH} \quad N_0 \quad N_\beta \quad N_K$

$N_i$, per acre amount of nutrients

FIGURE 4