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Saunders Hall 542, 2424 Maile Way,
Honolulu, HI 96822
Phone: (808) 956 -8496
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The Microeconomics of Agricultural Development: Risk, Institutions, and Agricultural Policy

By
James A. Roumasset

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James Roumasset[1]

Abstract

Assertions of pervasive inefficiency in the behavior and organization of developing agriculture are found to be based on unsound methodologies. Models apparently based on expected utility theory are theoretically flawed and use highly restrictive assumptions that make them largely irrelevant for explaining actual decisions. When a more appropriate model is applied to the case of the green revolution in the Philippines, the hypothesis that loss aversion impedes adoption of new technology is rejected.

Common assertions about the inefficiency of agricultural institutions are also found wanting. The risk-bearing theory of share-tenancy, which is thought to imply inefficiency, cannot explain observed tenant shares. Once the disadvantages of fixed-lease contracts are recognized, sharing is plausibly second-best efficient. The purported inefficiency implied by the inverse relationship between farm size and yield per hectare also dissipates once the endogeneity of farm size is accounted for.

Inasmuch as efficiency can explain the stylized facts of behavior and organization in developing agriculture, policy recommendations based on inappropriate theory and misplaced exogeneity should be viewed with skepticism.

Keywords: Loss-aversion, uncertainty, share tenancy, developing agriculture, nature of the firm, endogeneity

JEL codes: D01,G22,J43,O12,Q12,Q15

[1] Professor Emeritus, Economics Department, University of Hawaii at Manoa. jimr@hawaii.edu

1. Introduction

Many agricultural development policy recommendations are founded on unsound narratives. Others are grounded in misinterpreted empirical results, especially those with misplaced exogeneity. I review this claim in the context of farmer behavior under uncertainty and agricultural institutions. The errors reviewed can be avoided by basing economic policies on fundamental models of their consequences.

2. Risk

2.1 The RAUI hypothesis: risk aversion causes underinvestment

A common narrative in agricultural development circles is that, lacking well-developed markets for crop insurance, low-income and therefore loss-averse farmers will underinvest in modern, but more risky, farm practices. Instead of maximizing expected profits, which is thought to be socially efficient, they will stint on risk-increasing inputs such as fertilizer. Due to this apparent market-failure, governments should subsidize crop insurance (World Bank 2007).[2]

The popularity of the narrative is due in part to an apparent paradox. On the one hand, there had been a strong belief in the Schulzian (1960) proposition that farmers are rational. On the other hand, farmers in Asian countries were thought to reject the full package of techniques recommended in pursuit of the *green revolution*. The RAUI hypothesis resolved the paradox. If farmers were rational but risk averse, they would stint on modern inputs. (See Duflo 2006 for further discussion of the paradox).

In order to test the RAUI hypothesis, economists have naturally represented it with existing theory, requiring in turn some highly restrictive assumptions, including the following:

[2] The RAUI hypothesis was first articulated in by Mellor (1966) and Wharton (1969) and rigorously expressed by Dillon and Anderson (1971) and Binswanger (1980 and 1981). Others have purported to have found supporting evidence (e.g. Antle 2010, Rajsic et al. 2009, Khor 2018, Mukasa 2018, and the studies cited in Feder et al. 1986 and Roumasset et al. 1989). The hypothesis has now reached the status of conventional wisdom (e.g. Chetty and Looney 2006, World Bank 2007, and Karlan et al. 2014).

1. Expected utility theory appropriately represents loss aversion.
2. Fertilizer increases variance, which lowers expected utility.
3. Low-income farmers tend to be risk averse and will accordingly stint on fertilizer.
4. Crop insurance will ameliorate this “market failure,” and should therefore be subsidized.

Expected utility (EU) theory captures classical risk-aversion according to the concavity of the utility function (MIT 2015). Unfortunately, the theory does not support a complete and measurable definition of risk, only that “risk is what risk averters pay to avoid” and that a “mean-preserving spread” increases risk (Rothschild and Stiglitz). This is hardly sufficient to show that expected utility theory provides an adequate representation of loss aversion. A more direct representation employs a dictionary definition of risk, namely that risk is the chance of loss, a theme that we return to in the empirical section.

Does a variance-increasing input such as fertilizer lower expected utility such that the model predicts stinting its use? By expressing expected utility, based on a uniformly-concave utility function, as a Taylor series approximation, it can be shown that increasing variance tends to lower EU but that this tendency may be overcome if a variance-increasing input, such as fertilizer, also increases negative skewness (Antle 1983, 2010). In the case of convex as well as convex segments of the utility function, increased variance can increase or decrease expected utility.

There is no compelling reason that low-income farmers are risk-averse in the sense of strictly-concave utility functions. Even within the expected utility paradigm, if the farm family has a target income, utility may fall steeply before flattening out well below target as well as above the target. By providing a higher probability of meeting the target, variance-increasing production techniques may be preferred. This is Banerjee’s (2000) case of *desperation*, previously analyzed by Kunreuther and Wright (1974) and Roumasset (1973 and 1976). Prospect theory (Kahneman and Tversky 1979) can be considered a special case of the argument, where the target is zero income (no losses), utility is convex for losses and concave for gains, and utility is steeper for losses than gains in the neighborhood of zero income.[3]

If farmers were fully rational, their decisions would be based on the lifetime utility of a vector of annual consumptions (e.g. as in Chetty and Looney 2006). Yet applications regarding farmer decisions typically assume a utility function in current-period income. As shown by Spence and Zeckhauser 1972), however, such a function does not generally exist in the sense that it can be derived from the utility of lifetime consumption. While it is possible to derive a one-period function under the assumption that lifetime utility is additively separable over time, such a function would typically have convex as well as concave segments due to transaction costs that make buying prices higher than net selling prices and borrowing rates higher than lending rates (Roumasset 1979a). Simply assuming that utility of current income exists and that it is uniformly concave is unwarranted.

The most telling critique of expected utility theory is that it is not procedurally rational. As Day (1971) put it: "Rational men do not behave according to models that smart men can't solve." Fully rational evaluation of expected utility in the face of imperfect information about alternative states of the world would require knowing whether the benefits of obtaining more information about expected utility warrant the costs of obtaining that information. But as Winter (1971) has shown, this process involves an infinite regress. Once the infinite regress is stopped by an arbitrary rule of thumb, one is no longer in the world of fully rational behavior.[4]

2.1 Lexicographic safety first: a Philippine illustration[5]

Given the highly restrictive and unwarranted assumptions needed to verify the RAUI

[3] Kahneman and Tversky emphasize that said utility in income describes experimental behavior better than the more rational case of expected utility based on wealth.
[4] Kramer (1967) and Gans (1996) have formalized Winter's argument about the impossibility of rational choice under incomplete information.
[5] This section draws on Roumasset (2024), which provides additional details.

hypothesis using expected utility theory, we reformulate the hypothesis with a procedurally rational decisions model. Our approach is to require a plausible decision process corresponding to the decision model itself. We assume that the farmer is able to assess the risk of falling below a critical income threshold and act accordingly. Instead of assuming that farmers minimize risk, we assume that they can distinguish farm practices that are safe enough according to their own standards. If more than one farm practice is safe enough, the one with the highest expected value is preferred.

It remains only to adapt Encarnacion's (1965) lexicographic satisficing to the problem of choosing production techniques under uncertainty. Formally, *Lexicographic Safety First* (LSF) can be specified as follows. The decision maker's preference ordering corresponds to a lexicographic ordering of the vector,

$W_i = (V_i , E_i)$,

where

$V_i = 1 - Max[\alpha, F_i(d)]$ is the *satisficed* safety of the ith technique,

d = threshold income level below which the consequences of loss are especially severe,

α = acceptable risk (as in hypothesis testing, e.g. 5%, set according to the ability to tolerate loss), $F_i(X)$ = the cumulative distribution of profits for the ith technique (where X is a vector of inputs), and E_i = expected profit of the ith technique.

$F_i(d)$ is the probability that profits of the ith technique fall below the "disaster" level of income d and is a measure of risk. For techniques with risk less than α, *satisficed risk* (the safe-enough level) is just α. If more than one technique is safe enough, these techniques tie according to V, and the tie is resolved by the second criterion, expected profit E. When all techniques are more risky than α, the technique with the lowest risk, F_i (i.e. the highest V_i), is chosen.

LSF provides a complete ranking of alternative production techniques, unlike *chance constrained programming* (Charnes and Cooper 1959), which does not rank techniques that fail to satisfy the chance constraint. It also formalizes "loss aversion" (Kahneman and Tversky (1979) without the contrivance of a real-valued utility function in one-period money. LSF is a full optimality model in the sense that it leads to a complete and consistent preordering of the *i*'s. It is also a behavioral model in that it corresponds closely to a plausible decision process: Decision makers first screen out techniques that are not viable in the sense of satisfying the risk constraint. They then use the criterion of expected profits to choose the best of the viable acts. When none of the feasible techniques is safe enough, the decision maker picks the risk-minimizing technique.[6]

2.2 Testing LSF: fertilizer adoption during the green revolution

Very early in the *green-revolution* process of HYV diffusion, several luminaries suggested that the RAUI hypothesis explained the slow adoption of new technology (e.g. Wharton 1969, Dillon and Anderson 1971, and Binswanger 1980 and 1981). However, adoption of the varieties themselves is not a suitable focus of the hypothesis. Adoption of new varieties was extremely rapid and limited primarily by the availability of seeds (Ruttan 1977). Moreover, the new technology was characterized as a package of inputs especially fertilizer, inasmuch as the high yielding varieties were developed largely to be more responsive to nitrogenous fertilizer and to accommodate larger amounts per hectare before they tipped over of their own weight. Accordingly, the RAUI hypothesis is applied to nitrogenous fertilization in the Philippines during the early days of the green revolution.

In the standard approach with uniformly concave utility functions, the positive effect of fertilizer on the variance of profits reduces the utility-maximizing fertilizer level below the expected profit maximizing level (e.g. Roumasset et al. 1989). When risk is defined as the chance of falling below the critical level, skewness may play a more important role. As shown by Day (1965) for corn yields in the U.S., and verified for the case of rice yields in the Philippines (Rosegrant and Roumasset 1985; Roumasset et al. 1989), nitrogenous fertilizer increases negative skewness as well as variance. The same holds for the distribution of profits.

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[6] Since E is a continuous variable, we assume there are no ties among the viable techniques. If there were, complete ordering would require the specification of a third variable in the vector-valued function.

We now have cases in which loss aversion does not inhibit fertilization. If multiple techniques are safe enough, the decision is made according to the second criterion of the lexicographic ordering, expected profits. For this case, the optimal fertilizer quantity is the same as given by the risk-neutral model. If no technique is safe enough, the predicted quantity is that which minimizes risk. But that may well involve a quantity even greater than the risk neutral amount. Fertilizer increases expenses, expected profits, and negative skewness. This means that the probability density function of the expected-profit-maximizing technique is initially higher than that of an arbitrarily low-fertilizer technique, then lower for a wide swath of profits, and higher again at high profit levels. But loss aversion in our LSF model (for the same confidence level) is measured by the threshold below which the consequences of loss are especially severe—the higher the threshold, the more loss averse. This means that for very low threshold values, i.e. for farmers who are very mildly loss averse, the chance of loss is greater for higher values of fertilizer. But as farmers become more loss averse, greater amounts of fertilizer actually decrease the chance of loss. In other words, with very parsimonious assumptions—that fertilizer increases both the variance and negative skewness of profits—we see that the logic behind the RAUI hypothesis does not hold up

The RAUI hypothesis has also been empirically rejected for a sample of Philippine farmers observed during the early 1970s. By specifying the agro-climatic conditions and relevant prices for each farmer, it is possible to calculate the optimal fertilizer quantity for LSF and risk neutrality for each farmer. The actual fertilizer used can then be regressed on the prediction for the LSF hypothesis and the alternative hypothesis of risk neutrality. The result is that risk neutrality, along with a constant for learning lags, predicts actual fertilizer use quite well. The fit for the LSF model is inferior, albeit close to the risk-neutral model. The closeness of fit between the two models results from the fact that for most farmers, the LSF prediction is the same or quite close to the risk neutral model (Roumasset 2024).

In summary, most attempts to verify the RAUI hypothesis are fraught with highly restrictive and unwarranted assumptions. But even when the hypothesis is represented by a procedurally rational model of loss aversion, it fails to predict better, let alone significantly better, than a hypothesis of risk neutrality.

2.3 Implications for crop insurance

In the absence of compelling evidence that risk aversion inhibits adoption of expected-profit increasing techniques, the case for government subsidies of crop insurance collapses. The overall welfare loss from such subsidies has almost never been calculated,[7] but the following considerations suggest that it is substantial.

We begin with the reasons that crop insurance is not provided by the private market. The first is *moral hazard*. Crop insurance cuts off the tail of the profit distribution inducing positive as well as negative negligence. As Quiggin (1982) explains, *negative negligence* regards the failure to take risk-reducing actions, such as pest control and cleaning the irrigation system. *Positive negligence* regards risk-increasing actions such as using more fertilizer than the expected profit-maximizing amount. Both of these mean that the benefits of crop insurance can easily be negative, even before accounting for costs. The second reason is *adverse selection*, the tendency of crop insurance to be chosen only by those facing the largest risks. This raises the necessary insurance premiums, worsening the risk levels of those choosing to buy insurance and increasing premiums further (Akerloff 1970). In order to reduce adverse selection, governments tend to increase subsidies further, but this increases moral hazard and the size of negative benefits (Roumasset 1978).

As a result of the above and administrative costs, the *loss ratio* of all-risk crop insurance tends to be very large. Even in the U.S., with much larger farm sizes and correspondingly lower administrative costs, the loss ratio is 2.5 or higher (Wright and Hewlitt, 1994 and Wright 2014).

[7] See Yu (2017) for an exception, including the finding of negative welfare effects for the U.S. program.

A further reason for the negative benefits of subsidized crop insurance regards the nature of risk aversion towards current period income. As discussed above, such an indirect utility function, if it even exists, is based on idiosyncratic parameters, especially transaction costs. This type of risk aversion is not sharable in the Arrow (1969) sense. Rather it is socially efficient for farmers to face their own transaction costs, e.g. that cause buying prices to be higher than selling prices for the farm household.

In summary, subsidized crop insurance is likely to have high costs and negative benefits. With such an overwhelming case against it, why do subsidized crop insurance programs still exist? The first reason regards political economy. As Balisacan (1984 and with Roumasset 1987) explains, once per capita incomes are high enough, coalition forces supporting agricultural protection outweigh those against it. But since direct protection through import tariffs or export subsidies may violate world trade agreements, crop insurance may be viewed as the next best alternative means of protection. Given political support for crop insurance subsidies, there is money to be made, and agricultural economists are incentivized to rationalize those subsidies (Wright 2014). Economists are also misled by the false narrative of Pigouvian interventionism—that the "failure" of markets to be perfect implies the need for government intervention.

3. Institutions

The *new institutional economics* (NIE; Williamson 1975) has been thoroughly adapted to understanding the causes of agricultural institutions (e.g. Roumasset 1978, Ruttan and Hayami 1984). Unlike the Williamson version, the Philippine version distinguishes between levels of analysis. The first-best level is used to understand the terms of agricultural contracts. The second-best level (with transaction costs) is used to understand their forms.[8]

3.1 The terms of agricultural contracts

[8] See Dixit (1994) for a lucid explanation of the first, second, and third-best levels of abstraction.

The first-best theory of agricultural contracts (without transaction costs) was pioneered by Cheung (1969). In what amounts to a *Cheung-Coase proposition*, Cheung suggested that without transaction costs, share tenancy, rent, and wage contracts are all efficient and perfect substitutes. The proposition can be proved by invoking the Debreu-Scarf theorem such that the core of a share tenancy economy shrinks to the competitive equilibrium with rent or wage contracts (Roumasset 1979 and Johannsen and Roumasset 2002).[9]

The first-best theory is useful for explaining the terms of agricultural contracts. For example, high quality land has been shown to be organized into smaller family farms with higher landlord shares than lesser quality land. It also explains why more capital-intensive crops such as coconut have higher landlord shares than labor-intensive crops such as abaca (with rice and corn being in between). Both results require additional *restrictive assumptions*. The first result requires the assumption of Ricardian land quality.[10] The second result requires the elasticity of substitution between land and labor to be less than one (Roumasset and James 1979). These results share a family resemblance with the Alchian-Allen shipping-good-apples-out theorem. Efficiency alone is not enough to derive the result that apples shipped out, instead of consumed locally, are of higher average quality the further they are shipped. Rather an additional restrictive assumption is required, namely that the elasticity of substitution between good and lesser quality apples is greater than one (Borcherding and Silverberg 1978). Unlike Friedman's (1953) *abstracting assumptions* that are meant to be false, albeit in a useful way, restrictive assumptions are meant to be true, otherwise the resulting theory does not apply to the case in question.[11]

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[9] Allen and Lueck claim that Cheung (1969) proved the Coase theorem, but the alleged proof is actually just an application of the first fundamental theorem of welfare economics. To wit, if share tenancy lies on the efficient wage-rent frontier, and wages are fixed at their competitive equilibrium level, then the rent (and the implicit share) must be the competitive equilibrium one (Reid 1976, 1979).

[10] Ricardian land quality requires that the marginal product of labor on marginal quality (*extensive*) land be constant at labor intensities less than the equilibrium one. For higher quality land, the marginal product of labor is constant at low labor intensities, but begins to fall at labor intensities less than that of extensive land (Roumasset and James 1979).

[11] Non-categorical theories have only abstracting assumptions. Categorical theories are created by adding restrictive assumptions (Roumasset 2014).

3.2 The form of agricultural contracts

The second-best theory of contracts is useful for explaining the form of agricultural contracts. The second-best proposition states that since different contractual forms are equivalent in a first-best world, their efficiency is best evaluated with a *comparative institutions* approach (Coase 1937, 1960, 1988; Demsetz 1967, 1969, 1973, 1988), specifically that the chosen institutional form is that which minimizes transaction costs. The proposition was first formalized by Jensen and Meckling (1976) who portrayed the optimal set of firm contracts as the one that minimizes agency costs, or more generally that the firm maximizes profits net of agency costs (Roumasset 1995).

Second-best theory has been used to explain, for example, why piece rate contracts are preferred to wage contracts when the output of the piece contract, say for transplanted sugar cane, are readily observable (Roumasset and Uy 1980). It can also usefully explain the nature of the agricultural firm (Roumasset 1995; Allen and Lueck 2003), including, the choice of contract between the landowner and the farm operator.

3.3 The alleged inefficiency of share tenancy

In a mostly comprehensive review of share-tenancy theories, Hayami and Otsuka (1993) find the canonical Stiglitz (1974) theory of share tenancy to be the most acceptable. Stiglitz proposes a second-best theory wherein share tenancy and rent and wage contracts are alternative labor contracts. Wage contracts and rent contracts have high agency costs relative to share contracts because of labor shirking and inefficient risk-bearing respectively. Stiglitz (1994) concludes that share tenancy is “pairwise efficient” but that efficiency could be improved by mandating land-to-the-tiller reform. Once the former tenants became owners, he reasons, the labor-shirking problem disappears and there is no need to hire workers via any contract at all.

While the Hayami-camp authors agree with Stiglitz, that an omnipotent government could implement efficiency-improving land reform, they detail its impracticality without replacing the ruling elite as in the case of the successful reforms in Japan and Taiwan. With the existing elites in place, actual land reform attempts have a wide range of unintended consequences, including tenant eviction, crop switching, allowing the land to lie fallow, and switching to permanent workers (Hayami et al. 1990, Hayami and Otsuka 1992).

A stronger case against converting share tenants to owner operators can be made by showing that the Stiglitz theory is incomplete and that share tenancy incentivizes good management and contractual resilience. Fitting the Stiglitz (1974) model to the Philippine case leads to its rejection. First, the optimal tenant share is found not to be uniformly declining but U-shaped with respect to tenant risk aversion. Second, the trough of the U is at 80% making it impossible for the theory to explain actual tenant shares, which are clustered around one half and two thirds. Moreover, no other quantification, say in other countries, has been found capable of explaining actual tenant shares. The alleged risk-bearing disadvantage of rent contracts is at most a minor drawback (Deweaver and Roumasset 2002).

Given the minor role of risk aversion in tenure choice, there must be an additional disadvantage of rent contracts to explain the historical prevalence of share tenancy. As shown both theoretically and empirically in the *nature of the farm* literature (Allen and Lueck 2002, Roumasset 1995), that disadvantage is land shirking.[12] Farm operators can stint on pest control (including weeds), irrigation-canal maintenance, and make cropping choices that deplete soil nutrients. This is especially tempting for contracts of short duration. This means that share tenancy may have efficiency advantages over rent as well as wage contracts and that making it illegal may result in productivity losses.

The other problem with the Stiglitz view is the assumption that share tenancy is a labor contract. This is a *restrictive* assumption such that the theory does not apply where the tenant

[12] The idea of stinting land improvements dates back to Adam Smith, as cited by Reid 1975.

performs other important functions. And it is well established that the tenant's primary function is often management, in particular decisions regarding when to plant, what inputs to apply, when to apply them, and diagnosing and treating pest problems (Roumasset 1995; Allen and Lueck 2003).

Some studies attempt to judge the relative efficiency of share tenancy vs. owner operator and/or fixed-lease contracts. Bell (1977) and especially Shaban (1987) have often been cited for suggesting that share tenancy is inefficient. In a sample of farm households that both own and lease land (mostly via share tenancy), Shaban (1987) finds that output on owned land is 32.6% higher than under share tenancy. Since this is partly due to land quality (Roumasset 1976), he attempts to control for land quality by including dummy variables for irrigation status, soil quality, and a subjective estimate of plot value. These reduce the yield differential to 16.3%. Of course, the proxies for land quality are highly imperfect. They don't measure the quality of irrigation and other locational variables; soil quality is notoriously hard to measure (which is why it turns out to be insignificant); and plot value is subjective, possibly including speculative value. We simply don't know, how much of the 16.3% would be explained by a better measure of land quality (e.g. potential profits).[13]

The problem of incomplete control variables is potentially eliminated by directly confronting the endogeneity of contract choice with instrumental variables. As far as I know, the only study to do this is the one by Jacoby and Mansur (2008), who estimate that the productivity gains from *costlessly* converting share contracts into owner operation to be only 4%. Of course, such conversion may have high costs, whether by progressive land taxation or by land reform. These include administrative costs, tenant eviction, land-fallowing, poor matching of land and farmer characteristics, and both over and under-compensation of landlords (Hayami et al.,1990, Fabella, 2014, and Jandoc and Roumasset 2020).

[13] Shaban conjectures that rent-contracts are likely to be more efficient than share contracts since output on fixed-rent contracts is not significantly lower than that on owner-operated plots But as Hayami and Otsuka (1993) point out, this is a statistical artifact of the rarity of fixed-lease contracts in the sample.

The small productivity advantage of owner operation, relative to share tenancy, helps to resolve an apparent paradox between the Stiglitz theory and the Hayami-Otsuka position. Stiglitz (e.g. 1994) concludes that 50% sharing has the same disincentive effect as a 50% income tax, i.e. is highly inefficient. In contrast, Hayami and Otsuka (1993), while opining that the Stiglitz theory is the most compelling of existing theories, conclude that share tenancy is nonetheless efficient. The resolution of the paradox is that share tenancy indeed carries some Marshallian disincentive, but it may be *second-best efficient* in the sense that wage and rent contracts have even greater disadvantages. Moreover, the labor-shirking disadvantage of share tenancy may be quite small due to labor supervision (Otsuka 2007), the ability to terminate contracts of tenants performing worse than neighboring tenants (Cheung 1969), and interlinked transactions, especially the provision of credit by landlords (Roumasset 1976).

Another advantage of share tenancy is its resilience. If a bad crop year occurs soon after entering into a tenancy contract, a fixed-lease tenant is more likely to conclude that the rent is too high, not renew the contract, and engage in asset abuse. Since landlords share in bad times, tenants are more likely to renew their contracts (and not engage in land abuse) despite disappointing harvests (Deweaver and Roumasset 2024).

Looking across empirical studies, there is no consistent pattern indicating that one contractual form is more efficient than others (Singh 2000, Otsuka 2007). My own view is that trying to determine the relative efficiency of share tenancy relative to fixed-rent and owner operation is analogous to a search for the Heffalump, that mythical creature in Winnie-the-Pooh stories. The three-way classification misrepresents the nature of the agricultural firm. There are very different types of the three arrangements, in particular regarding the degree of specialization. Owner farming ranges from completely specialized, with 100% hired labor, including management, to completely unspecialized with no hired labor. The scope of specialization of fixed-lease systems is slightly less. At the unspecialized end of the spectrum, we have the lessee furnishing all the labor. On the other end, the lessee provides management and performs a few of the hard-to-monitor tasks, with the rest being performed by hired labor.

Share tenancy occupies the middle of the specialization spectrum, but still accommodates substantial variation—from sharecropping where the tenant provides all of the labor and there is limited scope for management—to *pure share tenancy*, with tenant management and substantial hired labor—to an intermediate form with a higher tenant share, less hired labor, and less scope for management (Roumasset 1995).

The distinction between sharecropping and share tenancy[14] helps to resolve another paradox in the literature. Day (1965) explains the "demise of the sharecropper" in eight Mississippi Delta counties, due to the labor-saving effects of mechanization. Yet share tenancy persisted, especially in the American Midwest, where it was found to be compatible with innovation and mechanization (Allen and Lueck 2003). The virtual elimination of sharecropping did not extend to share tenancy.

What is endogenously chosen is the form of the agricultural firm and its degree of specialization. A primary determinant of the choice of firm and its degree of specialization is land quality as potential locational profitability. Locational profitability goes well beyond soil quality, including agro-climatic parameters, irrigation and other capital investments, and shadow prices. The better the land quality, the more specialized the firm.[15] This means, for example, that owner farming can produce both the highest and lowest yields per hectare. Which it is depends on the particular sample, and imperfect measures of land quality only serve to dampen the relationship not eliminate it.[16] No wonder the empirical studies are inconclusive!

Judging the relative efficiency of different organizational forms commits the most fundamental fallacy in economics – judging performance without understanding the nature and

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[14] I am indebted to the late Wally Falcon for making me aware of this distinction in the 1970s when he ran the Food Research Institute at Stanford.

[15] For a full elucidation of this view, see Roumasset and Uy (1987) and Roumasset (1995).

[16] As noted by Singh 2000), "sometimes sharecropping is more productive than other forms of tenancy or self-cultivation, sometimes it is not." That is different samples produced different comparative results regarding the relative productivity of contractual forms.

causes of the phenomenon of interest. Inasmuch as the firm is a *nexus of contracts* (Jensen and Meckling 1976) between ownership, control, production decisions, credit, and labor, the nature of the firm will be determined by idiosyncratic conditions involving land characteristics, abilities, and shadow prices. While this perspective is congruent with the Chicago-UCLA tradition (Coase 1937 and 1988, Alchian and Demsetz 1972, and Demsetz 1988)—so influential in law and economics, industrial organization, and the practice of anti-trust law—it is rare in development economics.

3.4 Is small really beautiful?

A similar fallacy characterizes the inference of land-to-the-tiller reform based on mere correlation. There is a fairly large literature documenting the inverse relationship between farm size and yield per hectare, beginning e.g. with Sen (1962 and 1966), Mazumdar (1965), and Berry and Cline (1979). A later literature found that, even controlling for land quality, a significant inverse correlation persisted (e.g. Burgess 2001, Barrett et al. 2010, Lipton 2009, World Bank 2009, Deininger 2003, and Ali and Deininger 2014). Lipton's (2009) conclusion that the inverse relationship is not an artifact of missing variables is typical but incorrect. As argued above, land quality includes several locational variables, some of which are statistically unavailable, and simply including a few proxy variables does not remove the statistical bias associated with the error term being causally related to the dependent variable.

Recognizing the endogeneity problem, Benjamin (1995) uses an instrumental variable for farm size (based on population density) and finds no significant inverse relationship. Since farm size depends on land quality as well as population density (Roumasset and James 1979), a more complete empirical analysis would estimate the parameters of said relationship. That is, the appropriate role of empirical analysis regarding farm size is to explain it, not prematurely assess its efficiency.

Another purported reason that the inverse relationship indicates large-farm inefficiency lies in their alleged transaction cost disadvantage. Large farms require more labor, meaning a greater dependency on hired labor and its attendant agency costs due to shirking and monitoring costs (Otsuka 2007 and World Bank 2007, 2009).[17] The conclusion of inefficiency requires the restrictive assumption that all labor is perfectly substitutable. Of course, this is not true. A major reason for hired labor is often the skill acquired from training and practice, for example, by the teams of men that did straight-row rice transplanting in Laguna, Philippines (Roumasset and Smith 1981, Roumasset 1995).

Both the alleged inefficiency of share tenancy and the inefficiency of large farms are used as justifications for land reform. As we have just seen, both explanations fail. The Marshallian inefficiency theory does not explain anything, even the existence of share tenancy. The Stiglitz explanation explains the existence of share tenancy but is incomplete; it does not explain the other stylized facts, in particular the distribution of landlord shares. The econometric demonstration of inefficiency commits the error of misplaced exogeneity. But more fundamentally, econometrically testing for inefficiency is scientifically unsound in the absence of documentation and explanation of the nature of agricultural firms.

The failure of the large-is-inefficient thesis is remarkably similar. It rests on an ad hoc explanation of the inverse correlation between yield per hectare and farm size. The explanation is incomplete without explaining other aspects of the agricultural firm that are codetermined. The empirics is poorly specified by failing to account for endogeneity and the causes of the firm. Testing for inefficiency while regarding farm size as exogenous is invalid.

4. Fundamental explanations as the basis for policy prescriptions

As reviewed above, the agricultural development literature is replete with false narratives that lead to misleading policy recommendations. The key to avoiding these fallacies lies in the use of *fundamental explanations*. A fundamental explanation specifies only behavioral postulates of the smallest units in the theory and characteristics of the solution. It

[17] More recently, Otsuka (2024) argues that farm size is too small in the Philippines because land reform has prevented size adjustments needed to capture the economies of scale associated with mechanization.

does not introduce *ad hoc* assumptions about the behavior or nature of higher-level units. The most famous fundamental explanation is the *invisible hand* model, whereby conclusions about the whole economy are drawn from behavioral postulates of consumers and producers (Nozick 1975).

The Ranis-Fei (1961) model of an inefficient economy due to sectoral dualism provides a good example of a non-fundamental explanation (of structural transformation). Dualism is assumed not derived. The theory requires the assumption of an exogenous institutional wage in the industrial sector and surplus labor in the agricultural sector. By assumption, moving labor to the industrial sector increases the total value of output. In contrast, Jorgenson (1961) provides a fundamental explanation of structural transformation based on maximizing behavior, without assuming any disparity between the marginal product of labor in the two sectors.

The central paradigm of economics, pioneered by Adam Smith, is captured in the title of his famous work, *The Nature and Causes of the Wealth of Nations*. As seen in the above examples, the full nature of the agricultural firm goes well beyond the tenancy contract and farm size. Without a complete characterization of the agricultural firm, one is unlikely to diagnose the right causes. And without the correct diagnosis, one can hardly expect to prescribe a welfare-enhancing cure.

The econometric problems with failing to properly account for endogeneity of farm size and contract choice tend to obscure a more basic issue. Efficiency cannot be determined by regressing a performance characteristic on a set of available variables and using an arbitrary functional form. Only by first providing a theory of the behavior or institution of interest can a useful explanation be made.

Nor can one add restrictive assumptions that do not fit the question at hand as in the case of uniformly-concave utility functions of one-period income. The resulting theory simply does not apply to the relevant case.

The fundamental-explanation methodology also involves recognizing the appropriate level of analysis. As discussed above, the first-best level is appropriate for explaining the terms of economic institutions; the second-best level (with transaction costs) is appropriate for explaining their form.[18] The third-best level, explaining the role of interest groups in policy formulation, is useful for explaining why governments choose the policies they do (Dixit 1996; Balisacan and Roumasset 1987).

Before proceeding from explanation to prescription, another analytical model is typically required—that of assessing the consequences of alternative policies. For matters of direct market interference, such as taxes, subsidies, price ceilings and floors, tariffs and quotas, the first-best level of analysis is often suitable. For understanding the macro consequences of policy reforms, general equilibrium analysis may be used (e.g. Clarete and Roumasset 1984). But in many cases, e.g. showing the welfare losses from stabilization policies, partial equilibrium analysis is sufficient.

For assessing the consequences of institutional policies such as land reform, descriptions of actual consequences are helpful (e.g. as in Hayami et al. 1990, Hayami and Otsuka 1993, and Fabella 2014). Establishing rigorous foundations for comparative institutional analysis largely awaits further research. This may be why policy prescriptions are so often based on the failure of markets to achieve a first-best result (e.g. as in World Bank 2007). Coase and Demsetz have taught us to recognize such fallacies, but convincing policy makers would be greatly enhanced if the losses from proposed institutional reforms could be quantified. In particular, quantifying agency costs would allow researchers to emulate the behavioral test of lexicographic ordering described in section 2. In that way, the nature of the value-maximizing organizational form

[18] Transaction costs can be modelled as exogenous (Roumasset 1979, de Janvry et al. 1991) or endogenous (Jensen and Meckling 1976, Roumasset 1995).

could be determined for each farm household. Only then could one ask whether any other theory explains firm choice better than the efficiency theory.[19]

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[19] Armen Alchian once enigmatically remarked that efficiency is really the only thing economists have to explain behavior, organization, and policy; it just depends on what kind of efficiency. I interpret this to mean first, second, and third-best efficiency. Third-best efficiency needs further development to flesh out Alchian’s insight, but see Wittman (1989) and Acemoglu and Robinson (2001).

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