# ECONOMIES OF SIZE, STRUCTURAL CHANGE, AND THE IMPACT OF A FAMILY FARM POLICY

By

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## ISSUES AND QUESTIONS

### Food Costs

Current interest in the structure of agriculture has raised two kinds of questions about economies of size. The first involves the efficiency of resource allocation in the farming economy. Inefficient resource allocation implies that total food production costs are higher than necessary. Society thus has a very definite interest in assuring that agriculture is efficiently organized so that production takes place on efficient farms that use all available economies of size.

A family farm policy that would limit or reduce farm size must be carefully considered in reference to its possible negative impact on the overall efficiency of food production.[1/] Alternatively, in the absence of size economies, there is no efficiency loss to society from creating smaller farms out of large farms if the average total cost for both sizes is the same. In such a "constant cost industry," several alternative farm size structures may be possible without

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1/ The terms "family farm policy" and "size limit policy" used in this paper refer in general to policies that would limit or reduce farm size, or slow the rate of farm consolidation (2, pp. 63-65). A USDA report provides background (3). The proposed "160 acre limitation" is a specific example (9, 12). Since per capita incomes, economic factors and resource availabilities change over time, any such policy would have to be dynamic or indexed to be appropriate over time.

affecting overall production efficiency. Then society could choose among these structures based on their direct merits without worry about increasing total food production costs.

Structural Change

A second economies of size question involves future trends in the size distribution of farms. The popular hypothesis here is that economies of size are a moving force behind structural change in agriculture (9, p. 925).[2/] The most efficient size of farm changes over time as the availability of new technology allows additional efficiencies in resource use. This shifting to the right of the long run average cost (LRAC) relationship forces farms to grow to remain efficient. This hypothesis implies that (a) economies of size in farming must be constantly monitored to anticipate future structural change and that (b) policies to change the size distribution of farms must focus on the technical factors responsible for increasing size.

Alternatively, this hypothesis may also be misleading. Inflation, tax laws, and a search for larger incomes may be the driving forces behind the growth in average farm size--economies of size may allow this growth to take place but not be the cause of it. In this case we should turn our attention toward these other economic factors in our attempts to understand and/or influence future structural change in farming.

Questions

When our work on economies of size began, I expected to clarify some of the relationships between economies of size, structural change, and the effects of policies to limit farm size. Now, a year later, little clarification has

2/ Structural change in agriculture encompasses a number of factors--the size distribution of farms, the pattern of land ownership, social characteristics of the farmers, specialization, and barriers to entry (15). This paper addresses only one of these factors, changes in the size distribution of farms.

been accomplished. Instead, I have encountered four separate but interrelated questions that continue to confuse me--even though many others appear to have discovered acceptable answers. Specifically I am confused about the following questions:

1) Does the labor efficiency of large machinery contribute to economies of size?
2) What land costs should be included in LRAC estimates?
3) Do economies of size cause farms to get larger or merely allow such growth?
4) Do policies encouraging a smaller, higher cost farm size really increase food prices?

In the remainder of the paper I would like to share with you my confusion on each of these four topics and suggest some directions for future economies of size research.

## LABOR EFFICIENCY AND ECONOMIES OF SIZE

### The Problem

There is no doubt that the labor efficiency of large machinery lowers the hours of labor per unit of output on large farms. My confusion concerns whether or not this labor efficiency represents economies of size. In a multi-product, multi-input firm, empirical economies of size estimates are generally represented by some cost/sales ratio by size of firm. To convert this physical labor efficiency into some economies of size concept, a reservation price, opportunity cost, or hired labor expense must be related to these physical labor requirements.

Looking at past economies of size studies, the general procedure has been to surmize that the cost per hour of this labor is the same on all farms, often the hired labor wage rate. The study by Hottel and Reinsel followed this

process (7). Most of the economies of size studies reviewed by Madden used similar assumptions (8).

Madden discusses the problem arising from the fact that operator labor is a residual claimant and that some opportunity cost or reservation price must be used (8, p. 18). He argues that the opportunity cost is likely to be relatively low for small farmers who lack the skills, education, and mobility to be attracted into off-farm employment. He notes that the reservation price on the management function will likewise increase on larger operations that require more supervision of hired men and coordination of a highly complex operation. Madden's proposal for viewing the farm as a goods and services firm implies that the cost of all available operator labor hours should not be charged against small farms. Excess labor as well as machinery capacity is often sold to another firm, particularly in the form of a part-time off-farm job.

Holland questions studies such as the one by Hall and LaVeen (which charges a fee of $20,000 per year for unpaid family labor) and asks whether it is reasonable to attach such a high labor opportunity cost to small farms (6, 4). Miller and Skold (11) and Pasour (13)have also discussed the arbitrary processes involved in imputing residual returns to operator labor. None of these studies leave me with a clear guide of how to include labor costs in empirical economies of size estimates.

Some Observations and Suggestions

Clearly an individual farmer with a constant and substantial opportunity cost for his labor can lower per unit labor costs by the use of large machinery. From a firm planning perspective, the opportunity cost and quantity of operator labor are known, or expectations are used, and the firm LRAC covers all labor.

The situation is much different as we attempt to estimate economies of size in the aggregate to answer the policy questions addressed in this paper. As we look at this type of LRAC relation, many different classes of farmers are represented along the curve. Likewise many different opportunity costs are represented.

Arguments that these opportunity costs vary by size of farm include:

1) There are an increasing number of small hobby farms. Because such farms are essentially leisure time activities, the reservation price on such labor is likely very low, or even negative when the hobby farmer derives psychic utility from this work.
2) Large capacity, complex machinery requires highly skilled operators, compared to the smaller, older and less complex machinery found on smaller farms. This fact suggests that both the quality and cost of labor on larger farms is higher.
3) USDA estimates that 60 percent of the income of farm families comes from off-farm sources and this figure is much higher on small farms. This substantial off-farm income offsets most of the family living expenses on such farms--support for Madden's goods and services concept.
4) The viability and efficiency of a home garden, with its attending low opportunity cost on labor, is an extreme but illustrative example. Such endeavors may be economically efficient even though they are not labor efficient.

Summarizing, the opportunity cost or reservation price on operator labor likely varies by size of farm. But since it is a subjective concept for each individual farmer and is not observable by the independent analyst (13),

we are without empirical measurement of this relationship. My confusion is therefore whether (a) the physical labor efficiency on large farms contributes to economies of size or (b) this efficiency is balanced or offset by increasing labor costs. For much of our research, (b) is the appropriate null hypothesis. Unless this hypothesis can be soundly rejected, it is probably better to omit operator labor "costs" from aggregate empirical estimates of economies of size used in policymaking. To do otherwise arbitrarily predetermines results and obscures otherwise defensible cost economies. 3/

## LAND COSTS AND LRAC RELATIONSHIPS

### Perfect Competition

The second confusing question I have been unable to answer is what land costs to include in empirical estimates of LRAC relationships. My dilemma here can be best described by comparing two theoretical models. In model A, every firm is in a perfectly competitive industry and there are no externalities either in production or consumption. Freedom of entry and resource mobility assure that the industry supply functions for all resources are perfectly elastic. Market prices correctly reflect resource values and scarcities. The LRAC includes a normal profit and return to all resources necessary to retain them in production. This situation is shown in Figure 1. In equilibrium the price of the industry product, $P_1$, equals the LRAC and each firm is at a size corresponding to a low point on the LRAC curve, $q_1$.

Increases in the demand for the industry output in the short run increase the price and cause excess profits. New firms enter the industry and production increases in the long run, until such excess profits disappear. The opposite

3/ This does not suggest that the opportunity cost concept be abandoned, particularly in firm planning. My intent is only to expose the actual empirical content of our aggregate economies of size estimates.

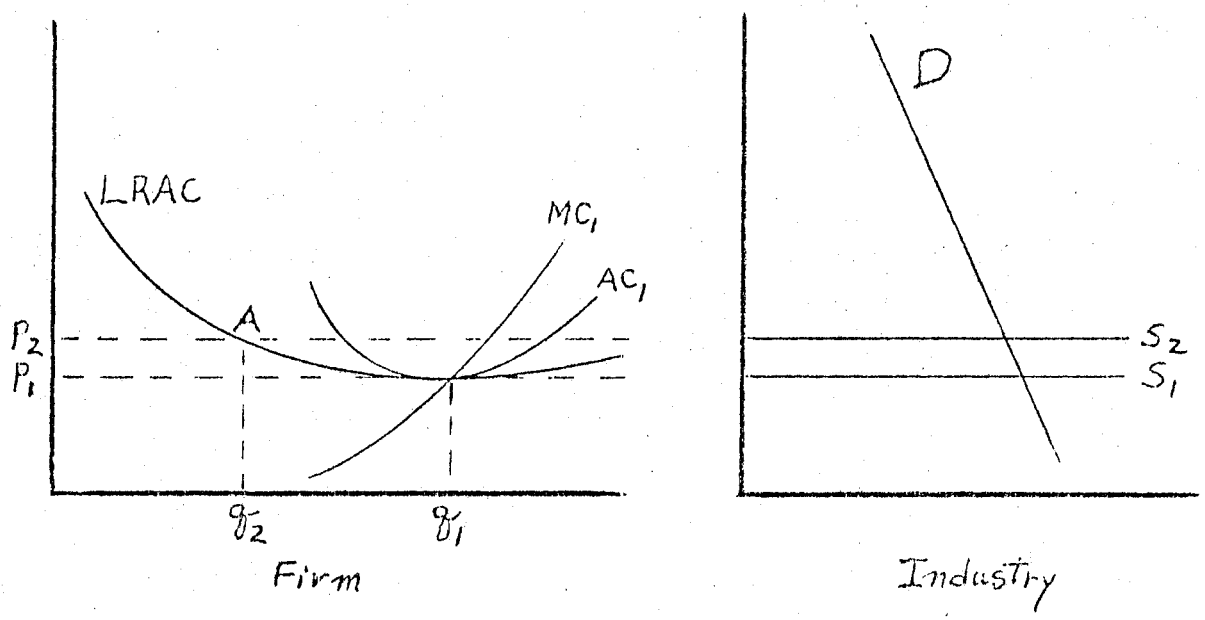


Figure 1. Model A: perfectly competitive industry

adjustments occur under a decrease in demand. Price remains unchanged in the long run and $S_1$ represents the long-run industry supply (5, p. 96).

Land Rent

Contrast this case with theoretical model B, which is identical to model A except for the assumption that the supply of the land resource to the industry is perfectly inelastic. Now the LRAC may be drawn to cover all resources except land, as in Figure 2. At equilibrium, firms still operate at a size designated by the low point on the LRAC, or $q_1$. For a given level of demand, the price exceeds the LRAC of variable resources and the excess profit is defined as land rent--it becomes capitalized into land values and becomes one determinant of the price of land.

An increase in demand to $D_2$ in the short run causes firms to expand production to $q_2$, equating the marginal cost with the higher price and with land fixed. This represents the intensive margin. In the long run, the increased rents earned by land are capitalized into land values. Firm size (measured in acres of land) and numbers change little since the minimum point on all LRAC relations occurs at the same output but more inputs are applied to each acre.[4/]

Downward adjustments are similar as long as the equilibrium price exceeds the minimum LRAC covering variable resources. At P = min LRAC, land earns no economic rent but all other costs plus a normal profit are covered. Further declines in prices cause production to be unprofitable, firms leave the sector, and the industry supply function shifts left to a point where P = min LRAC for the remaining firms. This adjustment is along the extensive margin for land--land is in surplus--and the model A argument applies.

Now considering U.S. production agriculture, what can be said about the appropriate land cost to include in empirical economies of size estimates?

4/ I suspect that long-run adjustments on the intensive margin could involve some changes in land per farm, depending on the long run elasticity of substitution between land and other inputs.

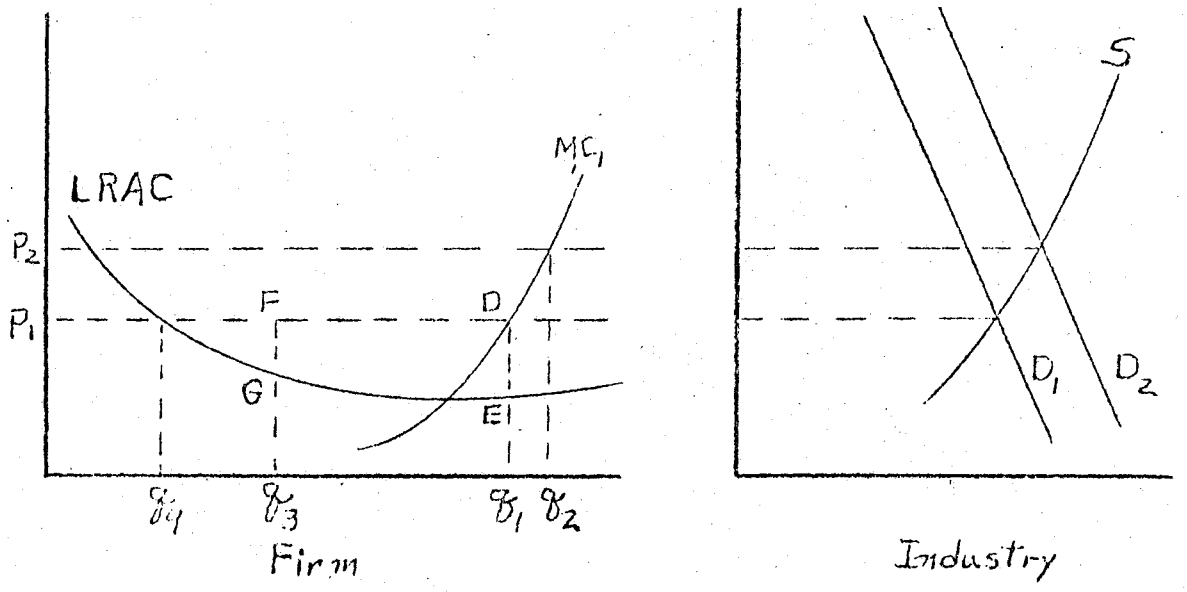


Figure 2. Model B: Total land fixed

Clearly model B is more appropriate for agriculture in general.[5/] In fact in the special case of the 160 acre limitation, model B would appear to be perfect. The boundaries of an irrigation district are well defined, both by physical factors and by the quantity of water available. The supply function of irrigated land to such an industry approaches perfect inelasticity. When such an industry is in equilibrium, all land earns a normal rent and (a) either the LRAC for variable resources plus the economic (land) rent equals the price or (b) using the convention of some economics textbooks, the "normal" economic rent for land is included in the LRAC definition and it equals the price directly.

If model B applies, empirical estimates of land costs to include in LRAC estimates must be carefully handled. Five options that have occurred to me are: (a) leave it out, (b) estimate land costs as the opportunity cost in some lower use such as livestock grazing, (c) include aggregate cash rents actually paid by farmers, (d) compute the return to land for the most efficient sized firm and charge this as a cost of land to all other firms, or (e) use the Federal Land Bank interest rate as the land cost, as is the current practice of USDA production cost estimates.

As with labor, an argument can be made for varying the land charge by size of farm. Raup has argued that large farm businesses (corporate or noncorporate) must include the full opportunity cost of land capital in their profit calculations, but that family-type farms carry this capital at lower rates because of intangible returns from farming (14, p. 306).

5/ Obviously this is an oversimplification. Any aggregate of farms is likely to include subregions that represent combinations of the model A and model B cases, although the weights may differ greatly. I will consider this complexity in the last section of this paper. For now it is sufficient to say that giving model B a weight of 1 and model A a weight of 0 is likely more appropriate for agriculture than the practice of giving model A a weight of 1 and ignoring model B.

The problem is that I don't believe any of these options are defensible. The last four options increasingly obscure cost and return conditions in the industry and may suggest inappropriate conclusions about firm survivability. Any legitimate conclusions that can be drawn from economies of size estimates can probably be drawn from estimated LRAC relationships that don't include land costs. As economists, there may be less danger of misleading ourselves if arbitrary land cost assumptions are not included.

Digression--What Difference Do Land and Labor Make?

At this point it is interesting to look at our preliminary estimates of LRAC relationships for the Palouse wheat area of Washington.[6/] Figure 3 shows three LRAC estimates. The bottom curve covers all variable resources except operator labor and management and land. The difference between this curve and $1.00 represents a return to land, labor, and management--analagous to the net farm income concept used by USDA. The second LRAC includes an imputed charge for operator labor at the hired wage rate of $4.50 per hour. The highest LRAC relation includes the imputed return to operator labor plus a charge for land defined under option (d), such that it touches the $1.00-line at the low point on the LRAC function. The prices and costs used in these curves represent 1980 dollars.

The LRAC relationship covering all costs except land and operator labor and management is relatively flat over the range of $14,000 gross sales to $150,000 gross sales--it ranges from $0.54 to $0.38 cost per dollar sales. The second LRAC relation, including the subjective $4.50 per hour charge for operator labor, is from $0.08 to $0.02 higher than the first curve for farms smaller than about $75,000 sales. If small farms actually have such a labor

6/ Currently the National Economics Division, ESCS, USDA, is studying economies of size in eight U.S. farming regions. The author, along with Gordon Rodewald, Bob McElroy, and David Fawcett are working on this project.

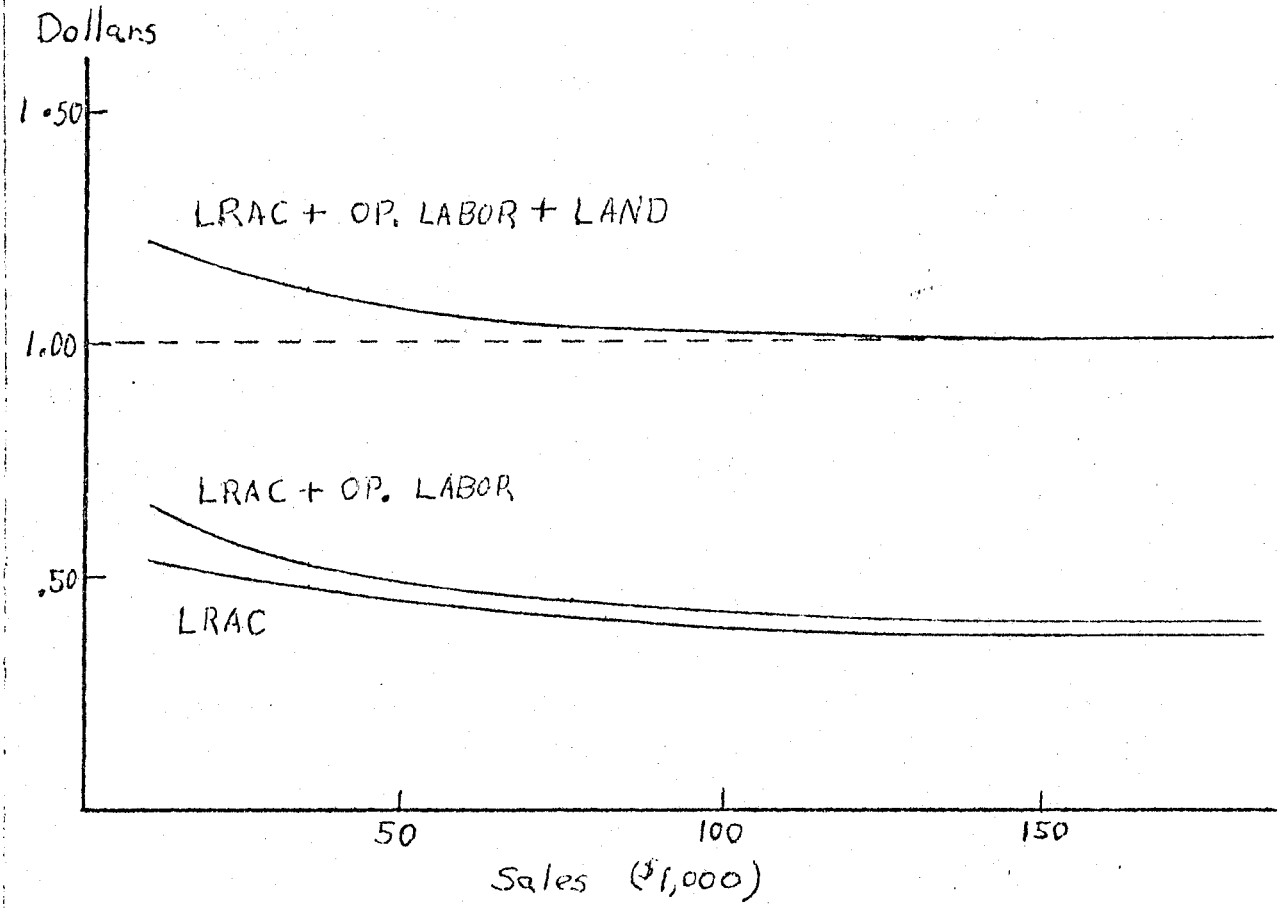


Figure 3. Economies of size on wheat farms, Palouse area of Washington

(opportunity or reservation) cost, residual returns to equity (land) would be relatively low, compared to the most efficient farm size. This procedure and result are comparable with Hottel and Reinsel (7). The third LRAC relation--including both operator labor costs and land returns--suggests that farms up to about $50,000 sales are quite inefficient and that the most efficient farm size is in the $100,000 to $180,000 sales range.

The questions I have raised in these first two sections suggest that the higher two curves are subjective and arbitrary and based on indefensible assumptions about the real world that are not likely to exist. More will be said about limitations of this subjectivity and the interpretations and conclusions that can be drawn from such relationships in the following sections.

## ECONOMIES OF SIZE AND STRUCTURAL CHANGE

### What Causes Structural Change?

My third area of confusion concerns the relationship (if any) between economies of size and structural change in agriculture. Farms continue to get larger in most regions of the U.S. Nevertheless, I can find little hard evidence on whether (a) economies of size provide a major incentive for farms to grow or (b) the lack of diseconomies merely allows farms to grow, with the pressure for growth deriving from other sources. My initial article on the subject also raised this question (10).

Other researchers have also considered this question. Seckler and Young observe that increasing average farm sizes do not necessarily imply the presence of economies of size--they only imply the absence of significant diseconomies of size (16). They conclude that generalizations which attribute increasing farm size to economies of size or decreasing LRAC will not stand up, and that more empirical studies of intertemporal changes are needed to understand the factors behind the changing farm sizes.

Madden appears to lend support for this viewpoint. He observes only that most farm enlargement occurs in areas and types of farming with minimal management diseconomies (8, p. 12). He also describes the weaknesses of the "survivorship technique" and questions inferences that small farms are disappearing because they are inefficient (8, pp. 24-26).

Boussard argues convincingly that there is an absence of economies of size in agriculture, based on such evidence as a heterogeneous farm size structure (1). He observes that any time scale economies exist in a certain enterprise, that enterprise breaks away from agriculture and becomes a separate industry, such as the textile industry. He suggests that continued increases in the average size of farm are due to the growth in national per capita income and the farm size needed to obtain adequate incomes.

The role of income goals in farm growth has received attention by several others. A Congressional Budget Office report observes that "farmers have a strong incentive to expand the size of their farms in order to increase total profits (2, p. 31). Sparling (18) and Seckler (17) have also argued that family farms expand to keep up with the Joneses who live in the city--an adaptation of Veblen's "pecuniary emulation" concept.

A Suggestion

These admittedly few studies suggest that we should not quickly conclude that (a) small farms do not support families adequately because they are inefficient and (b) that farms grow to become efficient. An alternative explanation is that (a) small farms generate low incomes and (b) these low incomes cause such farms to exit, become part-time units, or expand to increase income, whether or not economies of size exist.

While there are few rigorous economic analyses to support either hypothesis, it may be a better research strategy to adopt the second case as the null hypothesis--attribute the growth in size of farm to factors other than economies of size and then search for hard evidence that the existence of significant size economies warrants rejection of this hypothesis. This hypothesis may also have advantages in developing a family farm policy. If the villain in the concentration of farm size is actually farmers' search for larger incomes, spurred by inflation, general economic growth, and tax incentives, it may be advantageous to pursue this villain directly, without first trying to identify economies of size. Focusing the initial pursuit on hypothesized economies of size may divert attention from the real villain until it is too late to do anything about structural change.

## FARM SIZE LIMITS AND FOOD PRICES

### The Limiting Possibilities

The fourth question confusing me is whether farm size limits will increase food prices, even in the presence of economies of size. There is little agreement on this point. Writing about the 160 acre limit, Hall and LeVeen conclude that "the major impact of enforcing the acreage and residency provisions of the Reclamation Act will, therefore, be to reduce the wealth of the current land owner--" (4). They argue that "... food prices will not increase; rather, land values in reclamation projects may decline, causing substantial wealth losses to the current land owners." Suggesting the opposite conclusion, Martin argues that if these restrictions are effective, "given that there are economies of size, the marginal cost curves for the average farm, excluding the cost of land, will shift to the left. Thus assuming a constant total demand for food and fiber, total output of food

and fiber will decline and prices will rise" (9). Assuming that the economies of size are present, these researchers appear to disagree over whether farm size limits would primarily affect food prices or land values.

It is useful to return to the two earlier figures at this point. Under perfect competition in Figure 1, consider a farm size policy limiting all farms to $q_2$. New firms would enter the industry until a new equilibrium is reached with all firms having short-run average cost curves tangent to the LRAC at this output, point A. However, since the minimum cost of these firms is greater than the original average cost, $P_2$ is greater than $P_1$ and the new supply function becomes $S_2$. Total production costs are increased and efficiency is decreased by a farm size limit policy under the perfect competition assumed in Model A.[7/]

Alternatively consider a farm size limit policy under the assumed inelastic land supply of Model B, Figure 2. Here the size limit policy limits farms to $q_3$. New farms enter the sector until a new equilibrium is reached with all farms at size $q_3$. Land rents adjust downward from DE to FG at this point, and the equilibrium price is unchanged. Total food production costs are not affected by the farm size policy even though each farm is operating at a less efficient point on the LRAC curve. The inefficiency is translated into reduced land rents and values, and borne by land owners.

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7/ This example corresponds to a policy placing a limit on the output (or gross sales) of individual farms. Farms with a size such that their AC is tangent to the LRAC at point A would be the most efficient allowed under this policy--both MC and AC "become infinite" at point A and MC=AC=LRAC=price. A policy limiting one input (like land) on each farm would cause a slightly different long-run equilibrium. Slightly less land would be used to produce $q_2$ output, MC would exceed AC on these farms, and the resulting product price for output $q_2$ would be slightly higher. These differences are minor and may be ignored for purposes of my argument.

Food prices will not increase under Model B until the size limit is less than $q_4$, again the extensive margin. Limiting farm size to less than $q_4$ would cause the equilibrium food price to increase.

Interestingly, economies of size and the slope of LRAC for firms larger than $q_4$ is irrelevant to society's concern with the price of food. Under demand $D_1$, economies of size beyond $q_4$ only affect the relative land value adjustment required to reach a new equilibrium. If economic rents to land are high before the size limit, significant downsizing can occur before food costs are affected. This is apparently the situation that Hall and LaVeen are referring to when they conclude food prices would not be affected (4).[8/]

Generalizations for U.S. Agriculture

Of course these two models are gross simplifications of extreme cases. Henderson and Quant describe a situation in agriculture where one category of firms operates on a fixed amount of fertile land and the remaining firms operate under perfect competition (5, p. 99). In this case, a size limit policy confined to the firms on the fertile land would not affect the equilibrium price until their costs exceed the product price with zero rent. A size limit policy for the remaining firms operating at the extensive margin would increase food prices, except that this increase would be partially offset by the farms on fertile land expanding production along their intensive margin. A similar situation could arise from geographic location and transport costs, even if land qualities were similar (5, p. 102). Here a size limit policy in the most distant

8/ Two reviewers have noted the multi-product nature of most farms and questioned whether the results would be the same when aggregate measures of production, supply and demand are used. Since small farms likely produce a different product mix (due to differing technical economies for different products), many separate price quantity adjustments would be imbedded in the final supply and demand shifts. It is beyond the scope of this paper to show whether or not this complexity leads to a different result in the multi-product case.

areas would affect equilibrium prices, but size limits in areas closer to the market would affect only land values.

The real world is still more complex. It may be useful for us to view U.S. agriculture as the total of: (a) many subsectors where land is perfectly inelastic and (b) a few subsectors, which operate at the extensive margin, and where the land supply function has a positive slope. In these marginal areas, downward pressure on product prices or higher production costs reduce the marginal value product of land and cause less land to be used at lower prices. Alternatively, increasing product prices or production efficiency increases the marginal value product of land and causes both an increase in land prices and the quantity used by agriculture.

Based on my earlier arguments, size limit policies would have no effect on product (food) prices in the numerous subsectors where land has an inelastic supply, unless sizes are reduced until the LRAC with zero land rent is forced above the price. In the marginal areas, a size limit policy affects the product price in a much more complex manner. Here the limit forces farms to operate at a higher point on the LRAC curve. The reduced returns to existing farms also cause a decrease in the marginal value product of land, decrease land prices, and result in movement back along the land supply curve (land abandonment). These adjustments tend to shift the industry product supply function to the left. In the aggregate, due to the buffering impact of production increases in the more fertile areas, the product price increase would be much less than in an industry composed solely of such marginal farms.

In this more general model, the amount of the food price increase depends upon (a) the size limit on the marginal farms, (b) economies of size on these farms, (c) the slope of the land supply function in the marginal areas, and (d) the relative importance of the marginal areas compared to the more fertile

areas. If the number of farms operating on the margin is small in reference to the number of total farms in industry--as is the case with a large, fertile flat valley surrounded by steep mountainsides--the pressure for increasing food prices would be small even though economies of size were great on the marginal farms.

Summarizing, farm size limit policies may have different effects on different subsectors of agriculture. In some cases they may increase the price of the product, that is, increase food prices. In other cases, such policies would likely decrease economic rents, depress land prices, and decrease the wealth of the land owners--but not affect food prices. The 160 acre limit may have this effect. In other cases a combination of food price increases and decreased economic rents for land would result, with the product price increase accompanied by land abandonment in marginal areas.

I am tempted to argue that even if significant economies of size are present, it is extremely unlikely that reasonable farm size limits in a fully developed agriculture would be translated fully into food price increases; land values would absorb most of the required adjustment.

## SUMMARY AND CONCLUSIONS

After nearly a year's study on economies of size, I have the uneasy feeling that my knowledge about the topic is less than when I started. It is difficult to discover the validity of many of the accepted linkages and conclusions relating economies of size, structural change, and policy impacts.

Generally one has to agree with Seckler and Young that (a) generalizations based on traditional economies of size assumptions will not hold up, (b) that the source of understanding structural change is in the dynamics of inter-temporal change, and (c) that economies of size do not explain the impact of

a size limit in agriculture (15, p. 585). The seeds of structural change are more likely to be found in the dynamics of intertemporal adjustments. Understanding this process is necessary to predict future changes, to define policies that may change current trends, and to estimate the effect of such policies.

The four areas of confusion I have discussed in this paper suggest four specific questions for further research:

1. To what extent do large farms achieve greater technical efficiency than small farms?
2. What is the relationship between farm size and the factor supply conditions for land and labor?
3. What is the motivation for structural adjustment in farming?
4. How are adjustments to farm size limits spread between product and factor markets?

Traditional economies of size studies may not provide us with much help in answering the last three questions. Knowing whether or not technical size economies exist in U.S. agriculture may be of very little help in developing a set of structures policies to preserve the family farm.

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