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**QUANTIFYING LONG RUN AGRICULTURAL RISKS AND EVALUATING
FARMER RESPONSES TO RISK**

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BUSINESS RISK ECONOMIES OF SIZE:

EVIDENCE AND IMPLICATIONS

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The possibility that size and business risk might be related in production agriculture has received little attention in agricultural economics literature. Yet the possible implications of such a relationship are far reaching and intriguing. Such a relationship combined in a possibly complex fashion with financial risk and economies of size could have a profound influence on the structure of production agriculture, as well as very interesting research potential. This paper provides a framework for discussing the idea, reviews reports of research related to size and business risk, and discusses some of the implications of such a relationship.

Figure 1 provides a framework to discuss the interrelationship between size, diversification, risk, and economies of size. Diversification (moves to the right in figure 1) has generally been viewed as a method of reducing variability of income (Heady and Jensen). Pope and Prescott recognized this benefit, but also recognized that economies of size exist. They have suggested that there is a trade-off between the diversification benefits of reducing risk and the economies of size benefits from specialization. So if one moves to the right in figure 1, one might reduce business risk but also forego reduced costs due to economies of size in enterprises. If substantial economies of size exist in an enterprise, then one gives up a substantial expected return to reduce the variability of return by diversifying.

On the other hand, Robison and Barry indicated that specialization (moves to the left in figure 1), in some cases, may reduce variability of incomes. They argued that learning may occur or quality control may increase because of specialization. They suggested that this phenomenon be called increasing returns to scale in risk.

Vertical moves in figure 1 also need to be considered. An increase in size, while holding diversification constant, may yield the benefits of economies of size with each enterprise, but may also affect business risk of the operation. Variability of net income will obviously increase as size increases because of increased volume of business. However, the relative variability of net income, which could be measured as the coefficient of variation of net income, is of most interest. The possibility of

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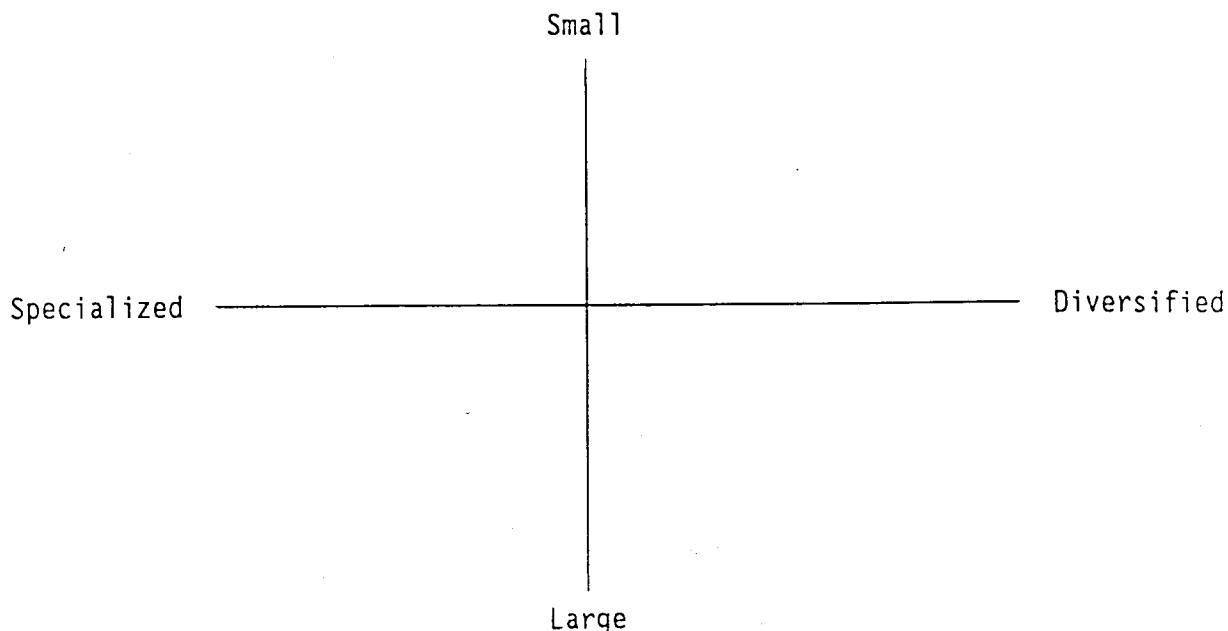


Figure 1. Framework to discuss interrelationships between size, diversification, risk, and economies of size.

relationships between size and the relative variability of net income has intriguing implications. It might be noted that farms have tended to become larger and more specialized over time. It is interesting to ask if changes in business risk have hampered, been neutral, or encouraged this shift in structure.

Figure 2 provides a hypothesized relationship between business risk and size. Relative variability of income, which could be measured by the coefficient of variation, decreases as size increases up to A. This could be called business risk economies of size. This concept is slightly different from that of Robison and Barry. They argued that quality control reduces variability of income when individuals specialize. This concept argues that increased size causes reduced relative variability, while specialization remains the same. Beyond A, relative variability increases as size increases. This could be called business risk diseconomies of size and would be caused by management breakdown, which also typically is hypothesized to cause diseconomies of size.

Review of Literature

A number of factors could affect net income variability as size of operation increases. These include change in production variability, differing marketing strategies, and variability of costs. However, there appears to be little indication in the literature that either marketing or cost control have been suspected of affecting relationships between business risk and size. However, changes in production variability as size increases have been explored previously as having an impact on business risk.

Relative
Variability
of Net
Income

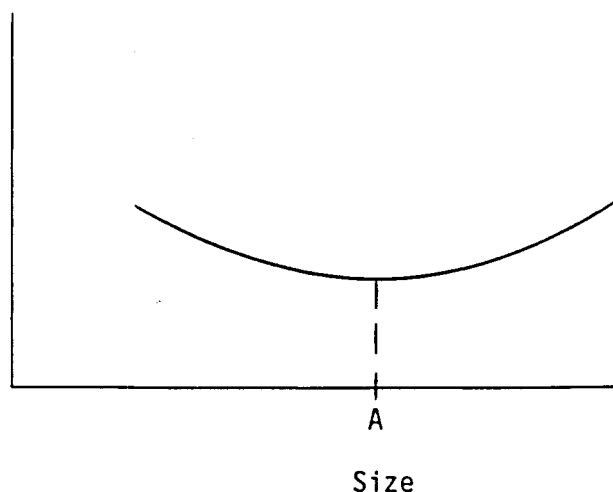


Figure 2. Hypothesized relationship between relative business risk and size.

A substantial research effort into risk in Great Plains agriculture began in the 40's, following the dust bowl days. Some effort was directed to exploring relationships between size and risk, mostly resulting in comparisons of the worst incomes for small and large farms. Schickele showed that the frequency of falling below an income that provided some standard of living was less for large farms than for small farms. Two key assumptions in the budgets used for comparison were that economies of size reduced average costs and that yield variability per acre was constant for all farm sizes.

Subsequent work in the 60's by Bostwick is even more relevant to the possibility of relationships between size and business risk. He studied relationships between yield variability and size on Montana wheat farms. He found that relative variability of wheat yield per acre (coefficient of variation) was reduced by 50% as wheat acreage increased from 100 to 900 acres. He suggested that increasing size of operation is a strategy to reduce business risk.

A related study by Jensen and Nash investigated spatial diversification of Montana wheat farms. They tested the hypothesis that total production varied less from year to year on geographically dispersed farms than on those that are not dispersed. They found that variances of yield were reduced by 1/3, 1/4, 2/3, and unaffected for four different spatial diversification scenarios. In a similar vein, Johnson suggested that one should consider the changing spatial distribution of farming units as they increase in size and also examine the influence that typical spatial dispersions might have in analysis of increasing farm sizes. Changes in variance of yield per acre as farms increase in size was another issue raised in that paper.

Reduced yield variability as size increases has been identified previously as an issue of aggregation (Eisgruber and Schuman). A study by Pachta and Schurle found that yield variability decreases as size of aggregated area increases. They found that the average standard deviation of wheat yield was 9.5 bushels/acre on 29 farms, each having 16 years of data, whereas the average standard deviation for the 10 counties in which they were

located was 7.2 bushels per acre. In an additional study, they found that the average standard deviation of wheat yields from experiment station plots was 12.7 bu/acre.

An expanded study of farm level data also supports this contention. Data from 617 Kansas farms that raised wheat for 10 years from 1974-1983 were used to estimate the relationship between standard deviation of wheat yield and number of acres of wheat. The estimated equation was:

$$\text{Standard deviation} = 9.65 - .0012 \times \text{number of wheat acres.}$$

The coefficients were significant at the 5% level, and the R^2 was .027. This suggests that variance of wheat yield decreases as farm size increases.

Program provisions of the Federal Crop Insurance Corporation give additional support for the contention that variance of yield decreases for larger size units. FCIC currently charges a higher premium for farmers who divide their farms into units. The reasoning behind this is that variance of smaller units is higher, thus, indemnities are higher, so farmer's premiums should be higher when they split their farms into units.

Research also suggests that relative business risk is smaller for larger farms. Zenger and Schurle investigated net income variability for a sample of 128 farms in north-central Kansas from 1973-1979. The GNP deflator was used to adjust data for inflation, then the standard deviation of net income and the average net income were calculated for each farm. They then estimated the equation:

$$\text{STD of NET} = 15,568 + .35 \text{ AVNET} + .0000035 \text{ AV NET}^2$$

(6.55) (2.15) (1.72)

The R^2 was .41, and the coefficients were significant at the 10% level. Taking this equation as given, it can be shown that the coefficient of variation of net income decreases up to an average net income of \$66,693 then increases for average net incomes above that level. The large majority of farms in the sample had average net incomes below \$66,693. More importantly, this work appears to be the first that explores the relationships between business risk and size.

Subsequent work by Schurle and Williams using stochastic dominance to identify preferred farm organizations suggested that large farms usually generate net income distributions that are preferred by risk-averse individuals. The income distributions from larger farms tend to have higher average incomes and higher variances, but the variances do not increase enough for larger farms to make the distributions unattractive to risk-averse individuals. This is another indication that business risk does not increase fast enough with farm growth to discourage growth in size.

More recently, Schurle and Tholstrup investigated net income variability of 686 farms each having 13 years of data. They found that relative variability of net income was smaller for larger farms. They also found indications that farmers with higher returns had higher variability of net income. This confirms the usually assumed trade-off between return and risk. In addition, to complicate matters, they found some indication that as

financial obligation increases (measured as interest payments as a proportion of gross income), relative variability of net farm income increases. This suggests the possibility of a relationship between financial risk and business risk.

Potential Implications

The combination of business risk economies of size, economies of size, and financial risk has complex implications for farm structure. Additional research into the implications of combinations of these concepts is desperately needed. Economies of size and business risk economies of size both tend to encourage growth of farms. Increases in financial risk tend to limit the growth in farm size. In addition, if relative business risk increases as financial obligation increases, then a change in business risk can be viewed as an initial incentive to grow that may eventually turn into a retardant to growth in farm size. Furthermore, recognition of the tradeoff between higher returns, which enable growth, and greater business risk, which impedes growth further, complicates the dynamic forces affecting farm structure. Much additional theoretical work needs to be done to provide a framework for analyzing these complex relationships.

Additional research needs to be devoted to determining the causes of and magnitude of business risk economies in agriculture. This paper provided some support to the idea that reduction in production variability as size increases could play a role in reducing relative business risk. There may be other causes for this phenomenon as well.

Recognition of decreasing production variability as size increases should also be tested across broader geographic regions than the Great Plains. Livestock production variability and the impacts of marketing also need to be investigated.

This phenomenon of decreasing variability with increased size also should be recognized for its impact on risk models in agricultural economics. One reason this occurs in agriculture but does not occur in finance is that additional units of productive resources in agriculture are similar, but they cannot be identical. Thus, localized natural phenomena cannot affect each unit in an identical fashion. Therefore, "natural diversification" results from the numerous small differences between one unit of an enterprise and the next unit. In contrast, each additional unit of a stock purchased behaves exactly the same as every previously owned unit of that stock.

Portfolio models, in particular, contain the implicit assumption that variance of income per unit is constant as more units are used in an enterprise. Although this relationship does hold in finance, it does not hold in agriculture. This suggests that our risk model results have been biased implicitly toward diversification among enterprises. Specialization in one enterprise carries along its own "natural diversification", which has not been recognized in our risk models to date.

Theoretical models of yield and income variability need to be developed so that further testing of these relationships can be done. These and possibly many other questions need to be addressed in order to ascertain the full importance of business risk economies of size.

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