**Human capital and its effect on the farm business life cycle**

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**Abstract:**

Human capital has been identified as significant determinant of farm size growth. However, there are numerous measures for human capital. Traditional measures include age, experience, and education of the principal operator and a management measure. This study identifies three types of management capabilities: production, financial, and human resource, as human capital measures. Farm size growth is estimated over a 15 year time period, 1994-2009. Results indicate that age of principal operator, financial management, and human resource management are significant determinants of farm size growth.

## Introduction

Farm Business Life Cycle theory states that farms exhibit a life cycle that parallels the life cycle of the farmer-entrepreneur. Much of this research was completed from the 1970-1990s (Boehlje, 1973; Gale Jr., 1994) when the majority of farming operations were organized as sole proprietorships. However, farm structure has changed drastically in the past 25 years which has resulted in many farming operations using alternative organizational structures (ie. General partnerships, Limited Liability Companies, and Corporations). These changes inherently will affect the S-shaped growth curve of the farm business life cycle which assumes the farmer enters the agricultural industry once enough capital is generated through disposable income and borrowing opportunities and exits the industry when they near retirement. The growth stage of the farm business life cycle requires additional capital and labor requirements to expand the farm resource base.

With the continued structural changes in the agricultural sector, it may be argued that farms are no longer exiting the industry, but rather transferred to the next generation or merged with another existing farm. With new ownership structures the life of the farm can no longer be tied to the principal operator, but rather the farm entity. In earlier research, the growth stage of the farm business life cycle was considered a function of the age, education, and experience of the principal operator (Gale Jr., 1994). However, in the past two decades, more farm managers have been obtaining two or four year college degrees. Education and age has always played a role in farm size growth, but human capital has been shown to demonstrate a more significant effect on farm size levels (Sumner and Leiby, 1987). Goddard et al. (1993) found that the net effect of human capital on farm growth was unclear. Upton and Haworth (1987) analyzed a cross-sectional time series of 81 farms over 14 years and found that the farmer's managerial

ability, propensity to invest in the farm, and planned future expansion played a significant role in changes in farm growth across time. They also found that farm growth was positively correlated with family size and negatively correlated with off-farm income sources. Weiss (1999) argued that in addition to farm experience and characteristics, human capital and off-farm income (part-time farming) played a large role in farm growth. Weiss (1999) measured farm size using farm acres and number of livestock. Results indicated a negative relationship between growth and survival with part-time farms less likely to survive or grow.

The farm business life cycle is highly dependent on the farm production function. Human capital is an input in the farm production function which helps reduce the marginal factor cost. Increased human capital (defined as a function of age, experience, education, and management capabilities of the farm operators) has been shown to allow for more flexible responses on the part of the farm manager to changing prices and technology to result in larger farm sizes and faster growth (Sumner and Leiby, 1987). Sumner and Leiby (1987) also argued that younger farmers with education and an initial wealth level tend to adopt technology at a more progressive level than older farmers, which resulted in a higher payoff to younger farmers. The specific objectives of this analysis are (1) determine if additional management measures (ie. financial, human resource, production) define human capital and (2) provide a measure of the direct causation between size and growth within the farm business life cycle as a function of human capital.

**Human Capital and Farm Growth**

Agricultural producers maximize profit as a function of output prices, fixed inputs, human capital, and unobserved factors (Sumner and Leiby, 1987). Output prices and fixed inputs are directly observable inputs in a profit function. Human capital is not defined by one

specific variable, but rather is a combination of various factors, such as age, experience, and management capabilities of the principal operator. Human capital allows agricultural producers to adapt more quickly to result in increased farm growth. Goddard et al. (1993) argued that the net effect of human capital was uncertain, since with increased human capital, the opportunity for off-farm employment increased. Weiss (1999) supported Goddard et al.'s claim and demonstrated that human capital affects earning capacity, which reduced the probability of farm survival or farm growth. Weiss also found that education was not found to have a significant effect on farm growth while age and the number of family members had a positive effect on farm growth. Zepeda (1990) found that as human capital increased the farmer was more effective in allocating scarce resources which resulted in higher growth rates due to increased technology adoption.

Human capital affects farm growth in several ways, as was represented by previous studies. Sumner and Leiby summarized the effects human capital may have on farm growth assuming agricultural producers are profit maximizers: (1) Human capital is a production function input, (2) Human capital makes farmers more flexible in their responses to price and technology shifts, (3) Human capital as defined as age and experience results in lower interest rates, (4) Life-cycle patterns are connected with human capital levels, (5) pay-off to human capital outside of farming affects human capital relationship with farm growth.

Management capability allows for a more efficient use of human capital by agricultural producers. The majority of earlier studies captured human capital through age, experience, and education levels. Sumner and Leiby (1987) included a management component which was defined by the number of production technologies adopted by dairy producers. These technologies included such items as herd performance testing, artificial insemination, feed

testing, and milk production grouping. This management measure only captures production management techniques. In the past twenty years, financial and human resource management have become just as important pertaining to a farms ability to grow in size. Weiss (1999) mentioned that including financial measures of performance or management would add to the discussion of the relationship between human capital and farm growth. Gloy et al. (2001) analyzed long-term farm performance rather than growth, but his emphasis on three potential management categories (financial, production, and human resource management) coincide with farm growth as well.

This working paper further extends the research done by Sumner and Leiby (1987), Goddard et al. (1993), and Weiss (1999) to include financial, production and human resource management measures of human capital in addition to the traditional measures of age, education, and experience. Including these additional management variables provides an opportunity to further analyze the effect of human capital on farm growth putting emphasis on management capabilities, which are not always directly observable.

**Data**

Annual farm data was collected for up to 15 consecutive years (1994-2009) through the North Dakota Farm and Ranch Business Analysis (NDFRBA) summaries for approximately 500 North Dakota farms. This data provides information on farm financial statements, marketing strategies, management techniques, and farm producer characteristics. This data set is unique in the sense that information is collected regarding the age of the farm operators when they started farming as well as experience. Experience is defined as "time working on a farm," therefore we have two distinct measures of traditional human capital in addition to management. Few datasets make this distinction, which further strengthens the human capital measure.

Early studies used up to three different years of census data to determine the entry-exit and growth of a farm. This study used a balanced panel of four years of data (1994, 1999, 2004, 2009) to determine farm growth over a 15 year time frame which resulted in a total of 93 farms. Allowing for this large time frame provides an opportunity to follow the farm through gained experience and management components as well as the opportunity to add additional principal operators providing increased human capital.

**Econometric Model**

A fixed effects model was used to estimate farm growth as a function of human capital. Fixed effects models are widely used with panel data sets that have unobserved effects. In this research, the fixed effect model is appropriate since factors outside of human capital may affect farm growth. The items are captured in the unobserved effect, which are removed from the analysis with the fixed effects transformation. Farm growth can be represented as:

(1) $Growth_{it} = \beta_1 X_{it} + a_i + u_{it}, \quad t = 1, 2, \ldots T,$

where $Growth_{it}$ is defined as the growth measure for farm size (ie. acres), $X_{it}$ are individual human capital characteristics, $a_i$ is the unobserved effect, and $u_{it}$ error term. Using the fixed effects transformation, the unobserved effect is removed. Expanding equation (1) to this research, we get the following:

(2) $Growth_{it} = \beta_1 AGE_{it} + \beta_2 Exp_{it} + \beta_3 Exp_{it}^2 + \beta_4 Exp*AGE_{it} + \beta_5 Operators_{it} + \beta_6 Rev/Labor_{it} + \beta_7 WC/GS_{it} + \beta_8 Interest_{it} + \beta_9 ProdMGMT_{it} + u_{it},, t = 1994, 1999, 2004, 2009$

where *Growth* is total acres or value of farm production, *AGE* is the age of the principal operator in years, *Exp* is the years of experience as reported in the NDFRBA for the principal operator, *Operators* is the number of operators on the farm, *Rev/Labor* is the labor efficiency measure,

*WC/GS* represents working capital as a percentage of gross sales, *Interest* is the interest expense ratio, and *ProdMGMT* is the production management variable. Further explanation of the variables follows below.

This analysis looks at two measures of farm growth. Past literature has indicated that farm growth can be measured as a physical unit, farm acres, or a financial unit, gross sales or value of farm production (VFP). The physical measure, *Acres*, included owned, rented, and pastures acres used on the farm. *VFP* was used as the financial growth measure, and was collected from the NDFRBA income statement and represented gross sales less purchased feed and livestock at its market value. Deducting purchased feed and livestock allowed for a more accurate depiction of the farm's inventory levels based on their production, rather than purchases throughout the year.

The effect on farm growth of the principal operator's age, *AGE*, is uncertain, but typically results in a negative effect since age is tied to the farm business life cycle. For example, as farmers near retirement, traditionally farm size decreases or remains stable. Farm experience, *Exp*, is the number of years the principal operator has worked on a farm. This is not limited to their current operation, but rather includes experiences gained on other potential farming operations if they were not a principal operator at the beginning of their farming career. Interactions were included between *AGE* and *Exp*. It is hypothesized that as the principal operator increases in age, the number of operators, *Operators*, on the farm will increase due to potential farm transitions. It is hypothesized *Operators* will have a positive effect on farm growth.

As stated earlier, management can be divided between three areas: financial, production, and human resource. Financial management in this model is captured with two measures. First,

the working capital to gross sales ratio is used, *WC/GS*, to capture the short term liquidity of a farming operation as a function of gross sales. It is anticipated that WC/GS will have a positive effect on farm growth, since increased liquidity indicates appropriate management of current assets and liabilities. Second, the ability to obtain credit and pay back loans indicates a farmer's financial management capability. The interest expense ratio, *Interest*, is included in the analysis as a proxy for the farm's ability to pay back loans. For example, a high interest expense ratio indicates a producer's inability to obtain low-interest rates on loans. Financial institutions typically reward "good" patrons with lower interest rates on long-term loans. It is hypothesized that *Interest* will have a negative effect on farm growth.

Labor efficiency is an important management concept that may have a direct effect on farm growth, but there is little consistency regarding an accurate measure for labor efficiency. Labor expense indicates the quantity and quality of labor used across farms and has been the most common proxy for labor efficiency (Kaufman and Tauer, 1986). El-Ostat and Johnson (1998) expanded Kaufman and Tauer (1986) to include a labor cost per unit of input to estimate labor efficiency for livestock operations. Using the framework from Kaufman and Tauer (1986) and El-Ostat and Johnson (1998) a labor efficiency indicator variable was calculated as the ratio of gross sales to labor hours (*Rev/Labor).* This indicator variable provides the level of revenue generated per labor hour incurred, which are standard measure across all farms. Labor hours included unpaid operator (management) labor and hired labor as reported on an hourly basis in NDFRBA. If unpaid operator labor was not reported, a base estimate was used as a function of commodities grown and farm location. For example, unpaid operator labor for crop operators is reported as 2,000 hours whereas livestock operations are 3,000 hours.

Production management is important to have a successful operation. Many times producers focus more on production management components rather than financial or human resources. The NDFRBA collects information of production practices employed by farms. These practices include tillage method, chemical use, insecticide use, and manure management. It is assumed that as the number of production practices adopted increases, the farmer has demonstrated increased management potential. *ProdMGMT* is the number of production practices adopted by the individual farms.

**Results**

As stated previously, there is debate regarding the appropriate measure for farm size. Therefore, in this analysis identical regressions were run for two farm size measures: *VFP* and *Acres*, results are presented in Table 1 and 2, respectively.

*Farm Size Growth: VFP*

*AGE* of the principal operator was found to have a positive and significant effect on farm growth as measured by *VFP*. This is not surprising since the farm life cycle follows closely with the age of the producer. As the producer increases in age we would expect revenue sources, in this case *VFP*, to increase over time. There is an assumption that this will level out and contract, provided no additional operators are brought onto the farming operation.

As the number of operators, *OPERATORS*, on the farm increased, the VFP increased approximately $190,000. As the number of operators on the farm increases, we would expect that revenue must increase to support the additional operators.

One of the two financial management measures, *WC/GS*, was found to have a positive and significant effect on farm growth. This demonstrates that current asset and liability management plays a significant role in farm growth. This emphasizes the importance of

"balance sheet" management which was not included in previous studies regarding the effect of human capital on farm size growth.

Labor efficiency (human resource management), measured as *Rev/Labor*, was also found to have a positive and significant effect on farm growth as defined by *VFP*. Labor efficiency presents a measure to capture the trade-off between labor and adopting labor-reducing technologies. From 1994 to 2009, many labor-reducing technologies have been adopted at the farm level in North Dakota. Most notably, these technologies include no-till practices, air seeders, and improved harvesting methods.

Surprisingly, the experience of the principal operator (*Exp*) and production management (*ProdMGMT*) were not found to be significant in this analysis. This may be due to the fact that *AGE* and *Exp* are closely related in this specific data set. *ProdMGMT* is significant at 20% level, which is not ideal. However, it may be the fact that some of the production practices captured within this variable are identified within the labor efficiency measure. These items must be explored further to determine how these effects are changing over time.

*Farm Size Growth: Acres*

The impact of farm growth as measured by acres is reported in Table 2. As was the case for the analysis with *VFP, AGE* had a positive and significant effect on farm growth measured in *Acres*. Again, *AGE* follows the farm life cycle, and we would expect that older producers would have a large land base than those producers just starting farming.

Labor efficiency, *Rev/Labor,* was found to have a positive and significant effect. This is not surprising since it is anticipated that as the amount of physical units (ie. acres) increases on a farm, you would need to more use labor more efficiently.

The financial management measure, *WC/GS*, was found to be negative and significant effect on farm growth. It was hypothesized that the sign on this would be positive. One potential explanation is the fact that producers with a large land base may own a majority of theirland. Owning land requires farm mortgages. Land will be reported in the long-term assets section of a balance sheet, but the principal payments on the land mortgage are reported in the current liabilities section of the balance sheet. This may be outweighing the effect, and will need to be investigated further.

**Conclusions**

The preliminary findings of this working paper suggest that age of the principal operator, financial management, and labor efficiency (human resource management) are significant determinants of farm size growth regardless of the size measure, *VFP* and *Acres*. This captures the financial and human resource management components of human capital, which was missing in previous work. This further emphasizes that while production management was an important indicator of farm growth in the late 1980s and early 1990s, financial and human resource management play a more significant role today. This is not surprising due to the increased specialization of larger farms in the U.S. which require additional attention on financial management and the increased need for labor efficiency (ie. human resource management).

Additionally, Weiss (1999) emphasized the importance of the trade-off between the opportunity costs of human capital in the form of off-farm income possibilities. This was not included in the preliminary analysis, but will be added in the future since it is hypothesized that it will have a significant effect on farm growth. It is apparent that human capital plays a role in farm size growth and must continue to be further developed in order to appropriately capture its effects on the agricultural sector.

**Table 1.** Impact of Human Capital on Farm Growth, Value of Farm Production (VFP)

| Explanatory Variable | Coefficient | Std. Error | P-Value | |
|---|---|---|---|---|
| *AGE* | 31,806.6 | 11,755.4 | 0.007 | *** |
| *Exp* | -54,531.8 | 90,973.7 | 0.549 | |
| $Exp^2$ | 1,274.5 | 1,869.7 | 0.496 | |
| *ExpAge* | -725.8 | 515.7 | 0.160 | |
| *Operators* | 119,442.2 | 74,642.0 | 0.101 | * |
| *Rev/Labor* | 1,635.3 | 171.0 | 0.000 | *** |
| *WC/GS* | 484.5 | 290.4 | 0.096 | * |
| *Interest* | -3,116.6 | 3,654.8 | 0.395 | |
| *ProdMGMT* | -27,640.2 | 21,377.5 | 0.197 | |

$R^2$ within = 0.6384, between = 0.3098, overall = 0.4572

*** 1% significance level, **5% significance level, *10% significance level

**Table 2.** Impact of Human Capital on Farm Growth, Acres

| Explanatory Variable | Coefficient | Std. Error | P-Value | |
|---|---|---|---|---|
| *AGE* | 109.8 | 48.2 | 0.023 | ** |
| *Exp* | -103.3 | 373.0 | 0.782 | |
| *Exp*$^2$ | 3.2 | 7.7 | 0.673 | |
| *ExpAge* | -2.9 | 2.1 | 0.167 | |
| *Operators* | 327.2 | 306.0 | 0.286 | |
| *Rev/Labor* | 2.5 | 0.7 | 0.000 | *** |
| *WC/GS* | -2.2 | 1.2 | 0.063 | ** |
| *Interest* | 2.3 | 15.0 | 0.879 | |
| *ProdMGMT* | -71.5 | 87.7 | 0.415 | |

$R^2$ within = 0.2517, between = 0.0046, overall = 0.0388

*** 1% significance level, **5% significance level, *10% significance level

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