Revealing an Equitable Income Allocation among Dairy Farm Partnerships

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In family farm succession planning there are two major decisions facing the family. The first is what family members should succeed in the management and ownership of the business. The second major decision is how to allocate the business income when these family members provide unequal amounts of equity, labor, and management to the business. And unequal amounts of contributions is the norm in agriculture as parents begin to provide less labor and management but still have a significant ownership of the business while they transfer the business to the next generation. This study addresses the dilemma of income allocation by estimating the earned returns to unpaid factors of production using a panel of dairy farms with various amounts of income, and unpaid factors of equity, labor, and management. Results suggest guide lines in separating farm income for the family farm business.

Although several forms of succession plans are possible, many farm families have their business structured as general or limited partnerships during the succession process, with the general partnership being the most common (Kay, Edwards, and Duffy 2004).[1] This is especially true in dairy farming. According to the 2007 U.S. Agricultural Census approximately 14.7% of businesses labeled with a NAICS classification code indicating dairy cattle and milk production had partnership listed as their legal form of organization (USDA 2009).[2]

Others have discussed the process of allocating farm partnership income to the unpaid factors of production. In one study linear regression models were estimated to determine a systematic division of dairy income among the three unpaid factors of production: operators' labor, capital, and management (Tauer 1997). The results suggest income should be allocated to management after equity and unpaid labor have been reimbursed at their opportunity costs. Similarly, other studies suggest reimbursing one or more of the unpaid factors of production by the associated opportunity cost, then allocating the residual to the remaining unpaid factors

(Hepp and Kelsey 1988; Thomas, Kunkel, and Dahl 1981). However, the residual unpaid factors of production may be subject to excess gains or losses should income be high or low. In addition, how management should be reimbursed when considering unpaid labor and capital poses a challenge.

The objective of this paper is to formulate a method to determine an equitable division of dairy farm partnership income when partners provide unequal amounts of capital, labor, and management and empirically estimate this relationship. New York dairy farm financial data are used within fixed effects panel regression and random coefficient models to reveal a systematic division of dairy farm partnership income among operators' labor, capital, and management while controlling for heterogeneity arising from differing herd size.

Dividing Dairy Farm Partnership Income to Labor, Capital, and Management

The U.S. Internal Revenue Service (IRS) defines a partnership as "the relationship existing between two or more persons who join to carry on a trade or business. Each person contributes money, property, labor or skill, and expects to share in the profits and losses of the business" (U.S. Dept. Treasury 2010b). A partnership, defined within a partnership agreement, does not pay income tax but must file an annual information return to report the income, deductions, gains, losses, etc., from its operations. In addition, a partnership may be liable for employment taxes and/or excise taxes (U.S. Dept. Treasury 2010a). Instead of the partnership paying income taxes, the profits or losses are "passed through" to the partners who file individual tax returns that may include income taxes, self-employment taxes, and estimated taxes (U.S. Dept. Treasury 2010b).

Family members can be partners within a farm partnership provided the following requirement is met: "If capital is a material income-producing factor, they acquired their capital interest in a bona fide transaction (even if by gift or purchase from another family member), actually own the partnership interest, and actually control the interest." (U.S. Dept. Treasury 2008).[3] Clearly, capital is material in farm partnerships. Federal and state income tax laws allow for the disproportionate allocation of partnership income and expenses across the partners. Payments to a partner for services, use of property, or use of capital may be deductible by the partnership or treated as a method of income allocation, and land into one of three categories. If the partnership has a partner acting in a nonpartner capacity then treatment of the payment to the partner are governed by Code Sec. 707(a) that appear as a partnership deduction reflecting fair market value compensation. If the partnership has a partner acting as a partner, but without regard to partnership profits, then treatment of the payments are considered guaranteed payments governed by Code 707(c) that appear as a partnership deduction reflecting fair market value compensation. If the partnership has a partner acting as a partner and payments are dependent on the level of partnership profits, the payments are first treated as a special allocation of income to the partner governed under Code Sec. 704 and then as a distribution of income governed under Code Sec. 731 that appear as a reduction in other partners' income simultaneous with payee's partner's income, but may not necessarily reflect fair market value compensation (Ricketts and Tunnell 2006).

Usually, when unequal contributions are made, an allocation of returns is determined and made to either labor or capital which is subtracted from net income leaving the remaining residual income to be allocated to remaining unpaid factors of production such as management. For an example, we refer to the following IRS example: "A father sold 50% of his business to his son. The resulting partnership had a profit of $60,000. Capital is a material income-producing factor. The father performed services worth $24,000, which is reasonable compensation, and the son performed no services. The $24,000 must be allocated to the father as compensation. Of the remaining $36,000 of profit due to capital, at least 50%, or $18,000, must be allocated to the father since he owns a 50% capital interest. The son's share of partnership profit cannot be more than $18,000." (U.S. Dept. Treasury 2008).

One problem with the income allocation scheme described above is that the residual factor of production may receive a windfall gain or loss quite different from its implied opportunity cost or contribution to the business. In addition, a decision must be made whether to recognize and reimburse management. It is clear that there exists a relationship between farm financial performance and managerial ability (Gloy *et. al.* 2002; Fox *et. al.* 1993). This management may be separable or linked with labor and/or capital. Any procedures outlined to remedy the income allocation problem will require an estimate of the opportunity costs or contribution of one or more of the unpaid factors of production.

Methods to Determine an Equitable Division of Partnership Income to Factors of Production

Gross farm income from the sale of output is allocated to the factors of production. Profits differ from farm to farm due to several reasons including initial resource endowments, output prices, factor prices, farm efficiency, management, expectations, and risk preferences. Ignoring expectations and risk preferences, profit-maximizing farms in the long run attempt to maximize the following objective function:

$$\pi(\mathbf{p},\mathbf{w}) = \text{Max}_{\mathbf{x}\in\mathbb{R}^L}\ \mathbf{p}\bullet\mathbf{q}(\mathbf{x}) - \mathbf{c}(\mathbf{w},\mathbf{q}(\mathbf{x})) \tag{1}$$

where $\mathbf{p} \in \mathbb{R}^M$ is a strictly positive vector of output prices; $\mathbf{q}(\mathbf{x})$ represents output and is a vector valued function that includes a set of production functions dependent on the input vector $\mathbf{x} \in \mathbf{X} \subset \mathbb{R}^L$; $\mathbf{c}(\mathbf{w}, \mathbf{q}(\mathbf{x}))$ is a vector valued cost function that is dependent on input prices $\mathbf{w} \in \mathbb{R}^L$ and output $\mathbf{q}(\mathbf{x})$ representing total input costs.[4] Equation (1) can be satisfied if the first and second order conditions of profit maximization are met.[5] If there exists free industry entry and exit, then profits will be driven to zero through the process of farm managers equating the value of marginal product of each output to the associated marginal cost, fully exhausting gross farm income. The residual portion of income left from subtracting the total input costs $\mathbf{c}(\mathbf{w}, \mathbf{q}(\mathbf{x}))$ from gross income as expenses consists of net income and unpaid factors of production that have not been reimbursed. Thus, a measure of the total costs of the unpaid factors of production represented by $\mathbf{r} \bullet \mathbf{y}$ may be used to reveal the returns or opportunity costs that the unpaid factors of production should receive to fully exhaust net farm income, where $\mathbf{r}$ represents a vector of prices or returns associated with the unpaid factors, and $\mathbf{y}$ represents a vector of quantities of the unpaid factors. The unpaid factors of production for a farm partnership are operators' labor, management, and capital in the farm business. Each of these three unpaid factors of production receives a share of net farm income according to the following identity:

$$(2) \quad \begin{aligned} Net\ Farm\ Income \ = \ & Management\ Return * Quantity\ Management + wage * Quantity\ Labor \\ & + Rate\ of\ \ Return * Quantity\ Equtiy \end{aligned}$$

To implement equation (2), panel regression methods can be used to empirically estimate reimbursement rates for each of the three unpaid factors of production. Specifically, the estimated coefficients on the quantities of management, labor, and equity would be the rates of return that each unpaid factor contributed to net farm income.

The approach implemented within this paper to determine an equitable division of partnership income to the unpaid factors of production is through fixed effects and random coefficient panel regression models. Fixed effects panel regression models are useful when determining an equitable division of partnership income to the unpaid factors of production as they are an effective tool at evaluating dynamic relationships between variables, and allow for the incorporation of relevant dependent and independent variables which may be of various forms.[6] The general form of the panel regression model is described as

(3) $$y_{it} = (\mu) + \mathbf{x}'_{it}\boldsymbol{\beta} + u_{it}, \; i=1,\ldots,N, \; t=1,\ldots,T,$$

where y_{it} represents the firm i, year t dependent variable, μ represents an intercept term, $\mathbf{x}'_{it}$ represents a row vector of independent variables for firm i, year t, $\boldsymbol{\beta}$ represents a column vector of coefficients, and

$$u_{it} = \begin{cases} \gamma_i + \varepsilon_{it} & \text{if fixed cross-section effects} \\ \delta_t + \varepsilon_{it} & \text{if fixed time effects} \\ \gamma_i + \delta_t + \varepsilon_{it} & \text{if both} \end{cases}$$

where ε_{it} represents an error term for firm i, year t which is desired to be distributed $N(0, \sigma_{\varepsilon}^2)$.[7] The other desired features of the panel regression model include (strict) exogeneity, non-autocorrelation, and achieving the full rank condition (Wooldridge 2002). In addition, either balanced or unbalanced panels may be used for estimation purposes as unbalanced panels pose no estimation difficulties (Wooldridge 2002),

Random coefficient models (RCM) are more general than fixed effects models in that they allow for parameter heterogeneity that can be modeled as stochastic variation across subjects or firms (Greene 2003; Swamy 1970). Random coefficient models have been extended to accommodate panel data and can be described as

(4) $$y_{it} = (\mu + \gamma_t) + \mathbf{x}'_{it}\boldsymbol{\beta}_i + (\mu_i + \varepsilon_{it}),\ i=1,\ldots,N,\ t=1,\ldots,T,$$

where y_{it} represents the firm *i*, year *t* dependent variable, μ represents an intercept term, γ_t represents a time fixed effect, μ_i represents a random intercept term for firm *i*, $\mathbf{x}'_{it}$ represents a row vector of independent variables for firm *i*, year *t* , $\boldsymbol{\beta}_i = \boldsymbol{\beta} + \mathbf{v}_i$ represents a column vector of unit coefficients, and ε_{it} represents an error term for firm *i*, year *t* which is desired to be distributed $N(0, \sigma_\varepsilon^2)$. RCM adjoins to equation (4) the assumption that the $\boldsymbol{\beta}_i$ are all related and typically has $\boldsymbol{\beta}_i \sim N(\boldsymbol{\beta}, \boldsymbol{\Gamma})$ where $\boldsymbol{\Gamma}$ is a matrix of variance and covariance terms to be estimated representing the degree of heterogeneity of the unit coefficients implying $\mathbf{v} \sim N(\mathbf{0}, \boldsymbol{\Gamma})$. Thus, equation (4) can be rewritten as

(5) $$y_{it} = (\mu + \gamma_t) + \mathbf{x}'_{it}\boldsymbol{\beta} + [\mu_i + \mathbf{x}'_{it}\mathbf{v}_i + \varepsilon_{it}],\ i=1,\ldots,N,\ t=1,\ldots,T,$$

where the term in brackets represents a complicated error term. An important restrictive assumption of the RCM is that the stochastic process which generates $\boldsymbol{\beta}_i$ is independent of the error process and is also uncorrelated with the vector of independent variables $\mathbf{x}'_{it}$ ensuring the $\mathbf{x}'_{it}$ are uncorrelated with the complicated error term. The complication of the error term causes the conditions of the Gauss-Markov theorem to not hold, and therefore methods of Maximum Likelihood or other iterative methods must be used to obtain coefficient estimates. The other desired features of the model in equation (5) are the same as those for the panel model presented in equation (3) (Beck and Katz 2007).

Data

The data used for the analysis are taken from the New York Dairy Farm Business Summary (DFBS) (Knoblauch *et. al.* 2009) which is collected by Cornell University. An unbalanced panel of 230 multiple operator farms over the ten year period 1999-2008 was used for a total of 1,165 observations. An unbalanced panel was chosen in order to maintain the most representative sample as possible. The 230 farms included within the analysis are full-time operations that primarily produce milk.

The four variables within the regression analysis include measures of income, equity, labor, and farm size. Income and equity are presented in real terms by adjusting to base year 2008 dollars using the Consumer Price Index (CPI) (U.S. Dept. of Labor 2010).[8] In addition, the real measures of income, equity, and the measure of labor are divided by the yearly average number of cows to permit farm comparison on a per cow basis. Summary statistics for the pooled ten year data of the four variables can be found in table 1.

The dependent variable for income is labeled $nfipcow_{it}$ representing real net farm income per cow for firm *i*, year *t*. Net farm income is defined as accrual net farm income without appreciation and unpaid family labor removed (not owners). Over the ten year period 1999-2008 net farm income per cow averaged $564 per cow in real terms of base year 2008 dollars. Net farm income per cow was notoriously variable across each of the ten years, ranging from $179 per a cow in 2006 to $1,188 per cow in 2007. In addition, net farm income per cow varied greatly across farms within each year, as four out of ten of the years the standard deviation in income was greater than the mean income.

Three independent variables are included within the regression analysis. The independent variable for equity is labeled $equitypcow_{it}$ representing real equity per cow for firm *i*, year *t*. Equity is based on the average total farm assets market value and the average total farm liabilities book value.[9] Average equity per cow only slightly differed year to year and averaged $6,038 per cow over the ten year period, but did differ substantially between farms within each year. The independent variable for labor is labeled $oplaborpcow_{it}$ representing operators' labor months per cow for firm *i*, year *t*. Operators' labor months is defined as the summation of the full time months worked by each operator, including up to six operators. On average, the farms within this analysis had 30 full time months between 2.4 operators. Operator labor months consistently dropped each year over the ten year period as farms acquired technology to replace labor. The independent variable for farm size is labeled $logcow_{it}$ representing the logarithm of the average herd size for firm *i*, year *t*.[10] The logarithm of the average herd size was included to account for the unobserved heterogeneity between farms. Arguably, larger farms may require greater amounts of management ability and effort. The average herd size per farm over the ten year period was 413 cows, and consistently increased each year from 295 cows per farm in 1999 to 542 cows per farm in 2008. Histograms of the pooled data for net farm income per cow, equity per cow, operators' labor per cow, and the logarithm of average herd size can be found in figures 1 through 4 in the appendix I

Empirical Results

Two fixed effects panel regression models and two random coefficient panel regression models were formulated to determine estimates for an equitable division of dairy farm partnership income when partners provide unequal amounts of capital, labor, and management. Panel regression models are useful when assessing the income allocation problem since annual variation in income implies the requirement for a dynamic decision process, which panel models are useful for considering sufficient longitudinal data are obtainable. The choice of two fixed effects panel models, one including both fixed time and firm effects and the other including only fixed firm effects, were chosen for comparison purposes to emphasize the importance of time effects. Two random coefficient panel models were chosen to emphasize the stochastic nature of the returns to management across farms over the ten year period. Further discussion of each model estimated follows.

Fixed Effects Models

The two-way fixed effects panel regression equation estimated is defined as

$$(6) \quad nfipcow_{it} = \left(\beta_0 + \delta_i + \gamma_t + \beta_3 logcow_{it}\right) + \beta_1 equitypcow_{it} + \beta_2 oplaborpcow_{it} + \varepsilon_{it}$$

where ε_{it} represents an error term for firm *i* in year *t* which is distributed $N\left(0, \sigma_\varepsilon^2\right)$. Within equation (6) β_1 represents the implied rate of return earned by equity per cow, and β_2 represents the implied return per month of operators' labor per cow. The parameters within the parenthesis represent the returns to management. The intercept term β_0 can be considered a portion of the residual return to management. The fixed firm effects δ_i represent returns to management related to differences between individual farms. The fixed time effects γ_t are considered to be exogenous bonuses to management in a given year.[11] The coefficient on the variable $logcow_{it}$, β_3, represents the return to management associated with herd size. Herd size is included to reduce heterogeneity across farms and is considered an important determinant when considering financial returns (Gloy *et. al.* 2002).

The one-way fixed effects panel regression equation estimated is the same as equation (6) excluding the fixed time effects γ_t. Note that β_0, δ_i, or γ_t may be positive or negative depending on the farm, year, and whether fixed time effects are included. Therefore, the returns to management within the two-way fixed effects model in equation (6) would be the sum of three parameters plus the coefficient on $logcow_{it}$ multiplied by the logarithm of average herd size: i.e. $\beta_0 + \delta_i + \gamma_t + \beta_3 logcow_{it}$. The returns to management within the one-way fixed effects model would be the sum of two parameters plus the coefficient on $logcow_{it}$ multiplied by the logarithm of average herd size: i.e. $\beta_0 + \delta_i + \beta_3 logcow_{it}$. Also note that for a given farm, or for a given farm within a given year, returns to management may be negative indicating a shortfall. Results for the one- and two-way fixed effects panel regressions can be found in table 2. The two-way fixed effects panel regression results within table 2 indicate that in the long run equity earns approximately 6 percent per year per cow, operator labor earns \$259 per a given number of labor months per cow, and management earns the sum of $-\$2,685 + \delta_i + \gamma_t + 346 * logcow_{it}$ for a given firm in a given year, with all estimated t-ratios including the intercept but excluding operators labor being highly statistically significant. A 6 percent return to equity may seem low; however, equity owners accrue any capital appreciation, which over the ten year period 1999-2008 averaged approximately 10 percent per year in real terms for the 230 multiple owner farms within this study. Given the two-way fixed effects regression results, on an average 413-cow farm over the ten years 1999-2008, the 12 month salary return would be \$42,787.[12] The average management return of a 413-cow farm would be \$330 per year.[13] The average number of operators per farm is 2.4, indicating a residual operator return of \$138 per operator per year, or \$42,925 per operator per year if the 12 month salary is included, and assuming management and operator are conducted by the same individual. Therefore, on average the model indicates that the individuals conducting farm management will receive a low return; however when coupled with the returns to the operator the results are not unreasonable. On most dairy farms it is very likely that the management and operator roles are coupled together. In addition, the results indicate that heterogeneity across farms due to herd size is an important factor when dividing net farm income among unpaid factors of production.

The F-statistic for no fixed effects based on 238 numerator, and 922 denominator degrees of freedom has a critical value of 8.18 indicating that together firm and year fixed effects are significant within the model. Eight of the nine year fixed effects have large t-ratios indicating that income varies annually. This is not unexpected as net farm income within the dairy industry is highly variable year to year. The year fixed effects can be interpreted as bonuses to management. Management differs across farms, as some managers are better than others financially and/or achieve higher efficiency. In return for this management differential across farms, firm fixed effects represent an awarded premium or deducted penalty for differences in management across farms. The firm fixed effects estimates range from -417 to 1,771 with 134 significant. The fixed effects estimates distribution for the two-way fixed effects model can be found in appendix II, figure 1. Overall, the two-way fixed effects model does a modest job by explaining 62 percent of the variation in net farm income per cow after adjusting for the number of coefficients estimated. Also, inspection of the model residuals indicates that the desired properties associated with equation (6) described previously are satisfied.

The one-way fixed effects panel regression results within table 2 suggests that in the long run equity earns approximately 8 percent per year per cow, operator labor earns $13 per a given number of labor months per cow, and management earns the sum of $\$-2,079+\delta_i+182*logcow$ for a given firm in any year. The 8 percent return on equity differs from the 6 percent return estimated within the two-way fixed effects model as the year “bonuses” are all accrued to equity. On an average 413-cow farm of this data set over the ten years 1999-2008, the 12 month salary return would be $2,148. The average management return for a 413-cow farm would be $191 per year. With an average of 2.4 operators per farm, indicating a management return of $80 per operator per year, or $2,228 per operator per year if the 12 month salary is included, and assuming management and operator are conducted by the same individual.

The F-statistic for no fixed effects based on 229 numerator, and 932 denominator degrees of freedom has a critical value of 2.55 indicating that firm fixed effects are significant within the model. The firm fixed effects range from -299 to 2,144 with 172 significant estimates. The fixed effects estimates distribution for the one-way fixed effects model can be found in appendix II, figure 2. Compared to the two-way fixed effects model, the one-way fixed effects model is not as robust as only 28 percent of the variation in net farm income is explained after adjusting for the number of coefficients estimated. Inspection of the model residuals indicates that the desired properties of equation (6) described previously are satisfied.

Overall, the results from the two-way and the one-way fixed effects models are qualitatively similar. The returns to the unpaid factors of production depend on whether yearly "bonuses" are accrued to management or equity. In addition, it is important to take into account heterogeneity across farms in a given year by controlling for herd size differences.

Random Coefficient Models

Two random coefficient panel models were estimated to allow for stochastic variation across firms which are modeled through parameter heterogeneity. Specifically, in addition to the estimation of coefficients on fixed effects unique random coefficients are estimated for each firm for the variables which are considered to include a random component across firms. For the income allocation problem within this paper the following random coefficients model with random firm and herd size components is defined as

$$nfipcow_{it} = (\mu + \gamma_t + \beta_3 logcow_{it}) + \beta_1 equitypcow_{it} + \beta_2 oplaborpcow_{it} + [\mu_i + v_3 logcow_{it} + \varepsilon_{it}] \quad (7)$$

where μ represents an intercept term and can be considered a portion of the residual return to management, γ_t represents the fixed time effects which act as bonuses, β_1 represents the implied rate of return earned by equity per cow, β_2 represents the implied return per month of operators' labor per cow, β_3 represents the return to management associated with herd size, and $[\mu_i + v_3 logcow_{it} + \varepsilon_{it}]$ represents a complicated error term in which the firm effects and herd size variable have associated random components. The difference between the random coefficients model and the fixed effects model described previously in equation (6) is that now management returns would be considered stochastic across farms and would be represented by $(\mu + \mu_i) + \gamma_t + (\beta_3 + v_3) logcow_{it}$. Arguably management returns would include stochastic components due to the heterogeneity across farms management abilities as some farms have better managers due to experience, education, efficiency attainment, etc. Herd size may also randomly affect management as some managers are better at managing relatively small herds rather than large herds when considering the average size farm. The random coefficients model with only stochastic firm effects differs in that the returns to management would only include $(\mu + \mu_i) + \gamma_t + \beta_3 logcow_{it}$.[14]

Results for the two random coefficient panel regression models can be found in table 3. The random coefficient model including random intercept and herd size components indicates that in the long run equity earns approximately 5 percent per year per cow, operator labor earns \$323 per a given number of labor months per cow, and management earns the sum of $-\$778 + \mu_i + \gamma_t + (\$167 + v_i) * logcow_{it}$ for a given firm in a given year. The distribution of the estimates for the random firm effects and the random herd size effects can be found in appendix II, figure 4, and figure 5. The firm random effects range from -3,143 to 1,700 with 124 significant at the $\alpha = 0.05$ level. The herd size random effects range from -307 to 475 with 77 significant at the $\alpha = 0.05$ level.

Given the results of the random coefficient estimates, on an average 413-cow farm over the ten years 1999-2008, the 12 month salary return would be \$53,360. The average management return of a 413-cow farm would be \$214 per year. The average number of operators per farm is 2.4, indicating a residual operator return of \$89 per operator per year, or \$53,449 per operator per year if the 12 month salary is included, and assuming management and operator are conducted by the same individual. Model fit statistics for a model including a random coefficient for herd size indicate a -2 residual/restricted log likelihood of -17101.5 which is a significant improvement at the $\alpha = 0.01$ level over the null model, and a model which only includes a random intercept term as indicated by likelihood ratio tests.[15]

The random coefficient model including only random intercept components indicates that in the long run equity earns approximately 5 percent per year per cow, operator labor earns \$231 per a given number of labor months per cow, and management earns the sum of $-\$690 + \mu_i + \gamma_t + \$153 * logcow_{it}$ for a given firm in a given year. The distribution of the estimates for the random firm effects can be found in appendix II, figure 3. The firm random effects range from -1,044 to 615 with 55 significant at the $\alpha = 0.05$ level.

Given the results of the random coefficient estimates, on an average 413-cow farm over the ten years 1999-2008, the 12 month salary return would be \$38,161. The average management return of a 413-cow farm would be \$311 per year. The average number of operators per farm is 2.4, indicating a residual operator return of \$130 per operator per year, or

$38,291 per operator per year if the 12 month salary is included, and assuming management and operator are conducted by the same individual. Model fit statistics indicate a -2 residual/restricted log likelihood of -17,121.2 which is a significant improvement at the $\alpha = 0.01$ level over the null model.

Both the fixed effects and random coefficients panel regression models were quantitatively and qualitatively similar and support the results found in Tauer 1997. Also, according to the Bureau of Labor Statistics Occupational Employment Statistics, New York farmers, ranchers, and other agricultural managers' earnings averaged $66,876 per year over the 1999-2008 periods (Bureau of Labor Statistics 2010). The results from the two-way fixed effects and both random coefficient panel models are quantitatively similar to the actual averages over the ten year period reinforcing the robustness of these models as tools to correctly specificity a division of income.

The question then becomes which model should be used to assess an equitable division of partnership income for a given farm, and how the income should be allocated among management, labor, and capital. Arguably both types of models could be used, with the exception of the one-way fixed effects panel model, to assess the income allocation problem; however, someone using these models to reveal their implied opportunity cost should take into account their individual situation by deciding whether stochastic returns to management is an appropriate feature. Likely, conclusions based on either type of model indicate that labor and equity should receive the majority of returns, with the residual being allocated to management. Since for most farms the operator and management roles are usually conducted by the same individual it is reasonable to allocate the residual after operators and equity is paid to management. A reasonable approach supported by the empirical results is to assign a justifiable opportunity rate and wage to both equity and labor and given the quantities of equity and labor determine the share of each to total opportunity cost. Those share percentages which sum to one can be used to allocate annual net income. This assumes that management is provided by both equity and labor holders. But deviations from this suggestion can also be justified based upon the empirical results.

Summary and Conclusions

Fixed effects and random coefficients panel regression models based on 230 New York dairies from 1999-2008 were estimated to determine an equitable division of dairy farm partnership income when partners provide unequal amounts of capital, labor, and management. Both fixed effects and random coefficient models indicate the importance of the dynamic structure of the income allocation decision. Fixed time effects in both types of models can be considered "bonuses", and were highly significant in all models which included time effects. Both types of models indicate that equity should receive an implied return of approximately 5 to 8 percent without accounting for capital appreciation. The implied returns to labor ranged from $14 per cow to $323 per cow depending on the type of panel model specified. The implied returns to management varied from $191 to $330 per year indicating, and are likely low considering that most farms have the operator and management roles conducted by the same individual. Any shortfalls would be distributed across partners according to their ownership shares. In addition, it is important to account for heterogeneity across farms by controlling for herd size differences.

Revealing implied opportunity costs through the use of fixed effects and random coefficients panel regression techniques proved useful when determining an equitable division of income among dairy farm partners. The results of this analysis could be used to help guide dairy farm partners when facing the decision of how to allocate income when each partner makes unequal contributions. The implied opportunity costs of the unpaid factors of production are guidelines to determining an income distribution plan among the partners within a partnership. Arguably labor and equity should receive the majority of returns, with the residual being allocated to management since most farms have the operator and management roles conducted by the same individual. However, adjustments to returns should be made if the operator and the manager roles are conducted by different individuals.

The results of this analysis are based on a sample of New York dairy farms. The same analysis performed on different data may yield different results, but the generality of the methods is applicable to all dairies. The results of this analysis may be used as a guideline to determining an equitable division of farm income. Any income distribution plan between partners should be further investigated and agreed upon by each partner within the partnership agreement.

Footnotes.

[1] Our analysis focuses only on the general partnership as limited partners retain no managerial responsibilities.
[2] The NAICS code for the category "dairy cattle and milk production" is 11212.
[3] Capital is material is defined as: "Capital is a material income-producing factor if a substantial part of the gross income of the business comes from the use of capital. Capital is ordinarily an income-producing factor if the operation of the business requires substantial inventories or investments in plants, machinery, or equipment." (IRS 2008).
[4] A constraint may be included within the profit maximization problem defined in equation (1) indicating that input demand can not exceed the initial input endowment: $\mathbf{g}(\mathbf{x}) \leq \mathbf{X}$.
[5] Assuming continuity of $\pi(\mathbf{p},\mathbf{w})$, the FOC's having $\mathbf{p}\bullet\mathbf{q}_{\mathbf{x}}(\mathbf{x}^*) = \mathbf{w}$, and the Hessian, $\mathbf{H}_{\mathbf{x}}(\mathbf{x}^*)$ is negative definite.
[6] Various forms refers to any differencing, lagging, squaring , interactions, etc. of a variable.
[7] Note equation (3) includes an intercept in parenthesis to indicate that the model may or may not include an estimate for the intercept.
[8] $real\ price_t = current\ price_t \left(\frac{Base\ CPI}{Current\ CPI} \right)$
[9] Averages are taken between beginning year and end year values.
[10] The log of average herd size was chosen because dairy farms traditionally incur larger profits with larger herds, but displays diminishing marginal returns with regard to herd size.
[11] Any bonuses associated with a given year are allocated to management as it is unknown if equity or labor should receive a portion of these bonuses. Bonuses could be attributed to good or bad weather years or other unobservable factors.
[12] $259*413 cows = $106,967/2.5 years = $42,787. The 2.5 years is the average operator labor months per farm which is 30 months.
[13] (-$2,685+$782+$149) + $346*ln(413 cows) = $330. The $782 and $149 are the average yearly firm and time fixed effects values.
[14] A random coefficients model that only includes a random component related to the constant term is also considered a random effects model. See Greene 2003.
[15] The likelihood ratio test when compared to the null model is evaluated as a chi-squared test with 3 degrees, and 2 degrees of freedom for the random intercept model.

Tables

Table 1. Pooled Variable Summary Statistics and Definitions New York Dairies 1999-2008 (Farms = 230, N = 1,165)

Variable	Mean	Std. Dev.	Definition
nfipcow	$564	$549	Net farm income per cow in 2008 dollars.
equitypcow	$6,038	$3,016	Equity per cow in 2008 dollars.
oplaborcow	0.159	0.138	Operator labor in months per cow.
logcow	5.582	0.971	Natural logarithm of average yearly total cows.

Table 2. Parameter Estimates for Two-way and Cross Section Fixed Effects (FE) Panel Models of 230 New York Dairy Farms, 1999-2008. (N=1,165)

	Two-way FE		Cross-Section FE	
Variable	Estimate	t-value	Estimate	t-value
Intercept	-2,684.76***	-4.34	-2,079.27***	-2.89
	(619.2)		(718.6)	
equitypcow	0.06108***	4.56	0.077911***	5.00
	(0.0134)		(0.0156)	
oplaborcow	259.182	0.72	13.63315	0.03
	(361.9)		(480.2)	
logcow	345.5163***	3.58	182.3042*	1.73
	(96.6115)		(105.2)	
Firm Effects	-417 to 1,771	134 sign.[†]	-299 to 2,144	172 sign.[†]
	(N/A)		(N/A)	
Year 1999	460.7794***	7.04		
	(65.4157)			
Year 2000	76.91896	1.21		
	(63.8133)			
Year 2001	345.656***	5.71		
	(60.5054)			
Year 2002	-136.828**	-2.35		
	(58.2659)			
Year 2003	-178.878***	-3.12		
	(57.3099)			
Year 2004	322.5802***	5.98		
	(53.9819)			
Year 2005	137.3242***	2.78		
	(49.3397)			
Year 2006	-332.011***	-6.92		
	(47.9693)			
Year 2007	649.05***	14.92		
	(43.4967)			
F-stat. no fixed effects	8.18***		2.55***	
R^2	0.6976		0..4220	
Adjusted R^2	0.6186		0.2781	

[a] Note that *, **, *** denote statistical significance at the 0.10, 0.05, and 0.01 levels.

[b] Standard errors are in parenthesis.

[†] Statistical significance at the 0.05 level.

Table 3. Parameter Estimates for Random Coefficient Models of 230 New York Dairy Farms, 1999-2008. (N=1,165)

	Random Int. and Logcow		Random Int. and Logcow	
Variable	Estimate	t-value	Estimate	t-value
Intercept	-778.47***	-2.85	-690.14***	-2.62
	(273.03)		(262.98)	
equitypcow	0.04878***	6.93	0.04523***	6.52
	(0.007042)		(0.006937)	
oplaborcow	322.74	1.23	230.94	0.94
	(261.79)		(244.78)	
logcow	166.59***	4.06	153.2***	3.93
	(40.9843)		(38.9652)	
Year 1999	313.63***	6.33	330.11***	6.66
	(49.5524)		(49.5572)	
Year 2000	-57.3386	-1.18	-41.8213	-0.86
	(48.7859)		(48.7737)	
Year 2001	234.36***	5.03	247.93***	5.03
	(49.1819)		(49.3315)	
Year 2002	-237.5***	-4.84	-226.49***	-4.6
	(49.119)		(49.2836)	
Year 2003	-261.94***	-5.29	-256.55***	-5.16
	(49.4937)		(49.6824)	
Year 2004	257.94***	5.36	262.18***	5.43
	(48.0794)		(48.2987)	
Year 2005	99.1028**	2.16	105.71**	2.29
	(45.8224)		(46.0762)	
Year 2006	-351.75***	-7.75	-349.02***	-7.64
	(45.3962)		(47.9693)	
Year 2007	643.27***	15.02	642.64***	14.9
	(42.8268)		(43.1283)	
-2 Res. Log Likelihood	17,101.5		17,121.2	

[a] Note that *, **, *** denote statistical significance at the 0.10, 0.05, and 0.01 levels.
[b] Standard errors are in parenthesis.

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Appendix I. Histograms of Pooled Data: 230 New York Dairy Farms 1999-2008 (N=1,165).

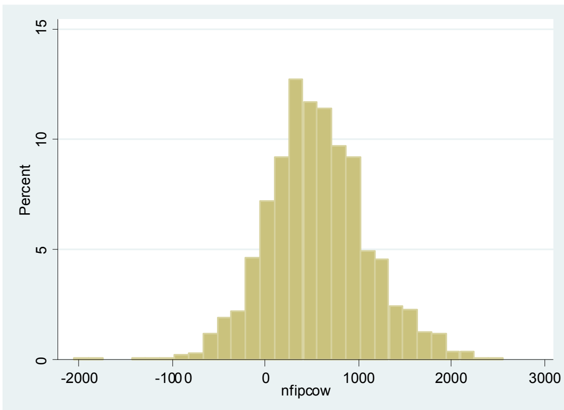

Figure 1. Dist. of nfipcow

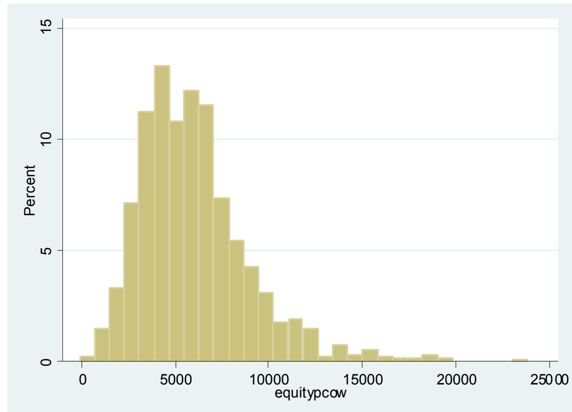

Figure 2. Dist. of equitypcow

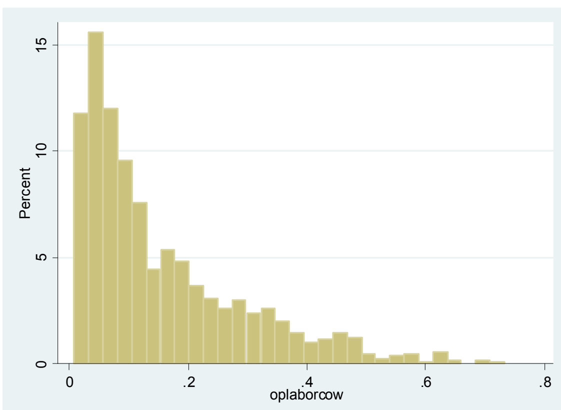

Figure 3. Dist. of oplaborcow

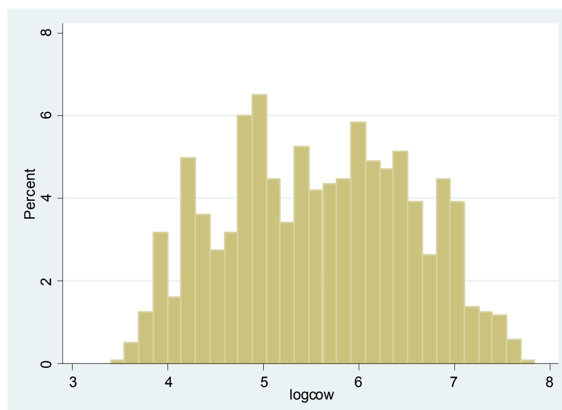

Figure 4. Dist. of logcow

Appendix II: Histograms of Parameter Estimates: 230 New York Dairy Farms 1999-2008 (N=1,165).

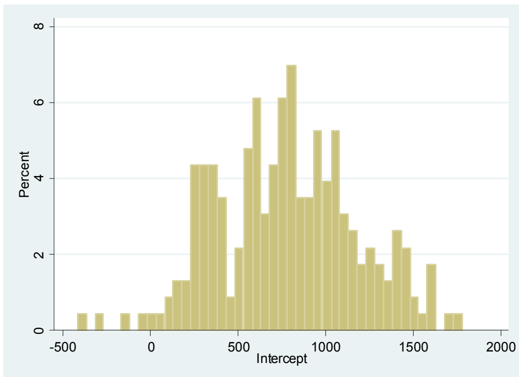

Figure 1. Dist. of Firm Effects 2-Way

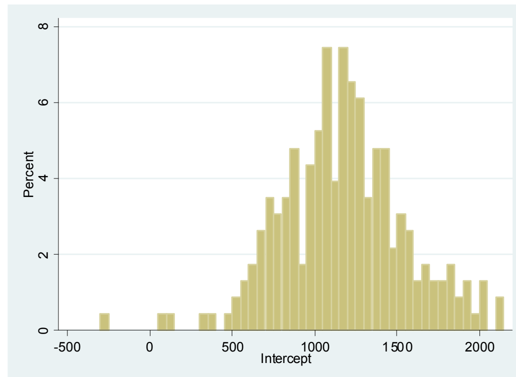

Figure 2. Dist. of Firm Effects 1-Way

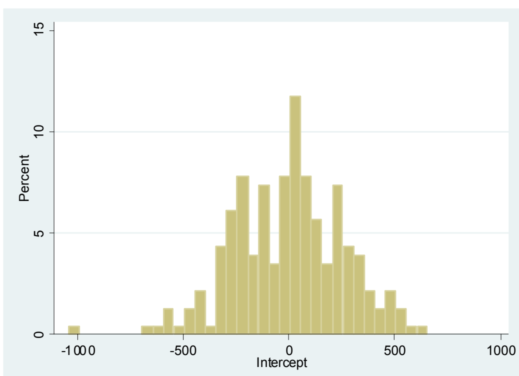

Figure 3. Dist. of Firm Effects

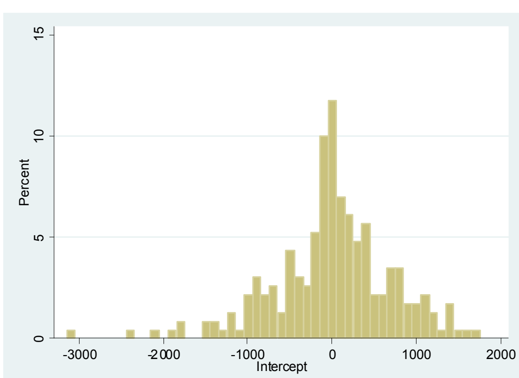

Figure 4. Dist. of Firm Effects

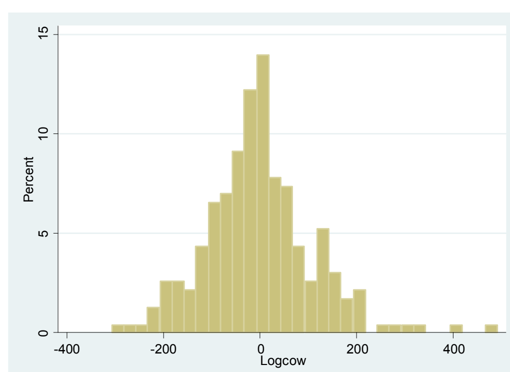

Figure 5. Dist. of Herd Size Effects