Consumption-Based Risk Measures of Kansas Farm Households

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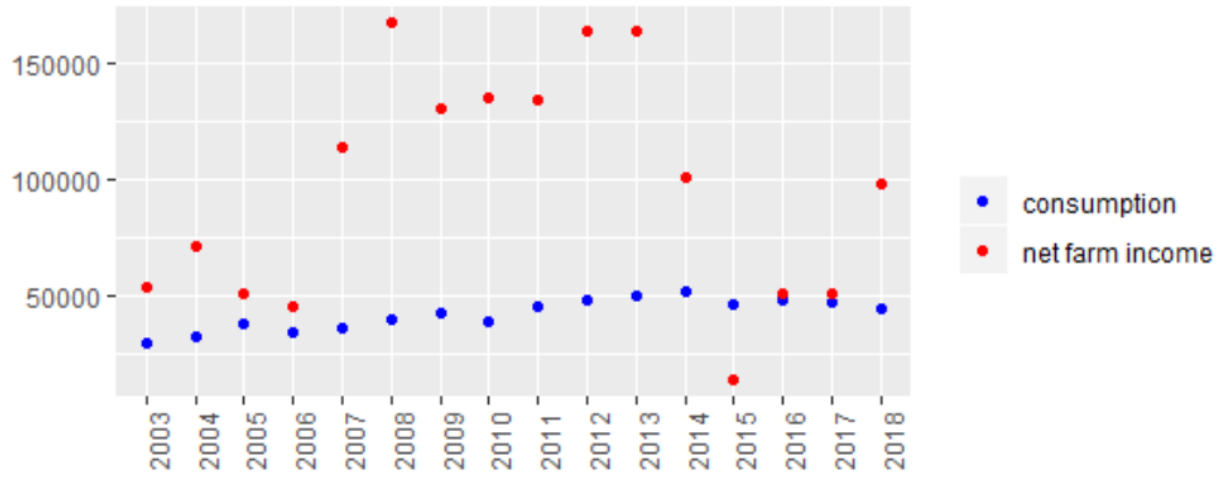
Abstract

Farm incomes are known to be very volatile but that volatility does not appear to affect consumption expenditures, this raises questions about how detrimental farm income volatility actually is to the health and welfare of the farm household. This article estimates consumption betas (Breeden, 1979) of farm and off-farm incomes. We find evidence that farm incomes are not significantly risky and largely do not contribute to consumption volatility, off-farm incomes however are found to be a powerful risk management tool and are useful in smoothing household consumption. Examination of consumption betas of individual farm households indicates that an aging farm operator faces a decreasing ability to smooth consumption by manipulating their off-farm incomes.

Introduction

Between 1996 and 2013 median between-year change in farm income was a whopping 160% of median farm income (Key et al., 2018). The high variability in farm incomes lead many to consider farming a risky activity, with much time and money spent on researching and implementing policy aimed at reducing this variability. Empirically however, we do not see these variations in farm incomes manifesting into variances in farm households' consumption, which may imply that a farm household's well-being is not as negatively impacted by the variation in farm income as traditional non-consumption based risk measures would lead one to believe. When using consumption as the measure of household welfare the appropriate risk measure of an income stream is one which measures the impact that income volatility has on consumption volatility; the consumption beta as derived by Breeden (1979) is one such measure. In this study we examine the riskiness of farm and off-farm incomes by estimating their consumption betas using data from the Kansas Farm Management Association on 62 family owned farms from 2003 to 2018.

Figure 1: Aggregate net farm income and consumption for a sample of Kansas Farms.



A number of previous studies on farm household consumption have consistently shown that the marginal propensity to consume farm incomes is very low, at about 2% (Carriker et al., 1993; Langemeier and Patrick,

1990; Whitaker, 2009). This low consumption of farm incomes at the margin combined with evidence that the farm household is not liquidity constrained and consumes as predicted by the life-cycle income hypothesis (Langemeier and Patrick, 1993) strongly supports the idea that farm household consumption is not significantly impacted by the magnitude of farm income volatility. Borrowing and lending as well as investing and disinvesting allows the farm household to seamlessly transition cash flows from one period to another, and it is this mechanism that enables the farm household to maintain a relatively smooth consumption rate in spite of variances in realized incomes. The action of borrowing and lending prevents income variability from translating into consumption variability as long as the farm household is not credit constrained. If income volatility does not affect the farm household's consumption of goods and services, one could argue that income variability has minimal affect on farm household well-being.

An important risk management tool commonly used by farm households is the manipulation of hours worked off-farm by the farm operator and their spouse (Mishra and Goodwin, 1998). Off-farm labor is a significant portion of total household income and has contributed to median farm household income exceeding that of nonfarm household's since the late 1990's (Mishra and Chang, 2012; Todd and Whitt, 2019). As evidenced by marginal propensity to consume off-farm income at a far higher rate than that of farm incomes, it would appear that the manipulation of hours worked off-farm is an effective tool at smoothing farm household consumption (Carriker et al., 1993). By estimating the consumption beta of off-farm incomes we can directly measure the degree to which they may reduce risk.

Our results show that farm incomes move independently of household consumption and therefore the uncertainty of farm incomes present negligible risk to the farm households welfare. We also find evidence that supports the use of off-farm labor incomes as a powerful risk management tool by allowing the household to offset would-be low income and consumption years with increases in hours worked off the farm. We posit that the accessibility of borrowing and lending and the ability to invest and disinvest from the farm enterprise allows the farm household to smooth their consumption, and it is this smoothing which is responsible for our economically and statistically insignificant risk parameters for farm incomes, and leads us to conclude that the farm household's welfare is largely unaffected by the variance of farm income. Additionally, upon examining the consumption betas of individual farm households we find that age and household size are important in determining the magnitude of the risk reducing affect of non-farm incomes.

Empirical Model & Methods

Because of the existence of heterogeneity in consumption patterns and the possibility that aggregation hides within-household variation, we believe it is undesirable to use aggregate consumption data. Just as

it is incorrect to use aggregate or market portfolio data in the context of measuring the risk impact of adding an asset to a specific agent's portfolio, we believe it is incorrect to use aggregate consumption data when measuring the risk of farm and off-farm incomes by their correlation to changes in that households consumption. We utilize data on individual farm household consumption in order to measure the risk of that same farm household's income streams. By estimating risk measures from the perspective of the individual that owns and operates that farm we are departing from previous studies which estimate risk measures that are directly relevant only to some representative agent. To our knowledge, the estimation of individual consumption-based risk parameters has not been done before, and all previous studies using a consumption-based risk parameter have utilized aggregated data. We believe that individual data is far superior to aggregates in this context. Additionally, some work analyzing farm household consumption uses an imputed proxy for consumption such as farm withdrawals (Lence, 2000). We use reported household consumption data rather than an accounting measure proxy which may be muddled by withdrawals for the purpose of reallocation and diversification or other non-consumption uses.

In their seminal paper on what became known as the Consumption - Capital Asset Pricing Model Breeden (1979) shows that the risk premium of an asset must be proportional to the consumption betas of the asset and the market portfolio:

$$\mu_a - rf = \frac{\beta_{a,C}}{\beta_{M,C}}(\mu_M - rf) \tag{1}$$

where $\beta_{j,C} = cov(cg, r_j)/cov(cg)$ is the consumption beta, cg is the percentage change in consumption, and r_j is the returns of asset j.

By mathematical definition the "C-CAPM beta" (the quotient of consumption betas) of the market portfolio is 1, and the risk premium of an asset is determined by multiplying the market's risk premium by the ratio of the assets covariance with consumption to the markets covariance with consumption. While rescaling the consumption betas such that the consumption beta of the market portfolio is 1 is useful for asset pricing and examining the riskiness of an asset relative to the market portfolio, it also eliminates useful information about the absolute magnitudes of risk. By estimating consumption betas and not rescaling them we are able to examine the possibility that certain farm household characteristics might affect the magnitudes of the consumption betas without affecting their relative sizes. Not rescaling the consumption beta also maintains a very simple and intuitive interpretation; given a one percent change in consumption the asset returns β percent. In future work one might also use un-rescaled consumption betas to examine the possibility that absolute levels of risk have changed over time even if relative risk has not.

Not rescaling the consumption betas is also necessary when estimating risk parameters for individual households in order to insure the correct interpretation of those coefficients. There is a possibility of the

correlation between market returns and consumption being negative while the correlation between another assets returns and consumption is positive, therefore the market portfolio would be risk reducing and the other asset risk increasing - but the usual interpretation of the rescaled consumption betas would lead one to conclude that the asset is actually risk reducing. Therefore, to know whether an individual asset is risk reducing or risk increasing to an individual household, we must analyze the consumption betas comprising the C-CAPM individually. Thus we estimate the following equations:

$$\beta_r = \frac{cov(cg, r)}{var(cg)} \tag{2}$$

where r is return on equity with depreciation expense added back to net farm income

$$\beta_w = \frac{cov(cg, wg)}{var(cg)} \tag{3}$$

where wg is the percentage change in off-farm labor income

As is common in the C-CAPM literature, we utilize three lagged values of the independent and dependent variables as instruments for consumption growth, and alternate specifications for the instruments have no significant affect on our results. Because of the lumpiness of farm incomes, the arbitrary definition of a fiscal year, and the possibility that consumption decisions in the planting season are based on budgeting the prior year's earnings, we also estimate these models by matching current-year income with next-year consumption. We estimate a common risk parameter for the whole sample by pooling the time series of all farm households together and clustering standard errors by farm household. We also estimate unique consumption beta parameters for each individual farm household. We then test if various farm household characteristics such as operator age, number of household members, acreage, or net worth, have any significant impact on the consumption beta of farm or off-farm incomes, as shown below:

$$\beta_{i,j} = a + \mathbf{B}\Psi + \epsilon \tag{4}$$

where $\mathbf{B}$ is a vector of regression coefficients and $\mathbf{\Psi}$ is a vector of farm household characteristics.

Results and Analysis

The results of both models estimating a single common risk parameter for farm incomes yielded coefficients that are not statistically different from zero and economically small in size. While it is possible that this is simply an uninteresting null result and that for one reason or another the data does not fit our specification,

this is also precisely what we would expect if farm households were exhibiting effective consumption smoothing. If consumption growth were constant it does not matter what random vector we regress against it, the parameter would always be statistically insignificant because it is in fact zero. Therefore, we may conclude that the risk parameters for farm incomes are rightfully estimated to be insignificantly different from zero, farm returns and household consumption appear to be statistically independent, and this implies that farm returns do not pose significant risk to that farm households consumption.

Of the two models estimating a single common risk parameter for off-farm incomes, only the model using current-year income and next-year consumption has a statistically significant coefficient of -0.094, which is significant to the 10% confidence level. This negative risk parameter indicates that off-farm incomes are risk reducing, and off-farm incomes increase in response to and offset what would be low consumption. The literature has that farm households utilize off-farm labor as a risk management tool, and the results of this study indicate that off-farm labor is effective at reducing risk.

Table 1: consumption betas

Consumption Betas		
	(1)	(2)
	r	wg
cg	0.00736	0.0768
	(0.00652)	(0.0868)
_cons	0.0848***	1.019***
	(0.0103)	(0.0881)
N	939	939
R^2	0.001	0.002
Standard errors in parentheses		
* $p < .1$, ** $p < .05$, *** $p < .01$		

Consumption Betas - Forward Consumption		
	(1)	(2)
	r	wg
cg	0.00723	-0.0942*
	(0.00635)	(0.0543)
_cons	0.0893***	1.203***
	(0.0110)	(0.0713)
N	814	814
R^2	0.001	0.004
Standard errors in parentheses		
* $p < .1$, ** $p < .05$, *** $p < .01$		

Regression analysis with the consumption betas of farm incomes as dependent variables again supports that the models with current-year income and next-year consumption fit the data better, as evidenced by the notably higher R-squared values. The coefficient on total acres is negative and statistically significant to the 5% level in one model. The coefficient on the age of the farm operator is not statistically significant in either model to the 5% level. The coefficient on number of persons in the household is negative in one model and positive in the other and statistically significant to the 1% level in both cases. The coefficient on net-worth is negative and statistically significant to the 1% level in both models, indicating that wealthier households

have farm incomes which are relatively less risky to them - presumably because it is easier for wealthier households to borrow and lend without constraint in order to smooth their consumption. The coefficient for return on equity less depreciation is negative and statistically significant to the 5% level, implying that more profitable farms are less risky and their households may experience less consumption volatility. We believe the disparity of sign between the two models for the number of household members is caused by using a dataset which includes an observation for every farm household year. By including multiple observations of the same farm household combined with the fact that the number of household members does not have much between-year variation may result in an overstated statistical significance. Because of the contradicting results, we cannot conclude whether the number of persons in a household is positively or negatively related to the consumption beta of farm incomes.

Using the off-farm income consumption betas as the dependent variable we again find that the current-year income and next-year consumption to generate the consumption betas creates parameters that better fit the data, as measured by R-squared. The coefficient for acres is positive and statistically significant at the 1% level in one model. We see contradicting signs between the two models for the coefficient on age, and while both parameters are statistically significant we are not convinced one way or another that age is positively or negatively related to the consumption beta of off-farm income - though in theory, age may limit the ability of the farm operator to work off-farm. The coefficient for number of household members is negative and statistically significant at the 1% level in one model, this result could be explained by the number of household members being correlated to the willingness and intensity that off-farm labor hours are manipulated in response to low farm incomes. The coefficient on net worth also yields contradictory results between the two models, with one being positive and the other being negative and statistically significant in both cases. The practical magnitude of the coefficient on net worth is relatively small, with a net worth of $1,000,000 translating into an effect of 0.13 on the consumption beta of off-farm income. The coefficient for return on equity less depreciation is negative and statistically significant to the 5% level in one model, this result indicates that more profitable farms have off-farm incomes which are less risky as measured by their consumption beta.

One way of ensuring that the statistical significance of certain variables are not overstated is to replicate our analysis of farm and off-farm income consumption betas with only one observation per farm household and using mean values. When using one observation per farm household the only parameters which are statistically significant in explaining farm income consumption betas are mean net worth of the household over the years in which that household was observed, which is negative and significant at the 10% level in both specifications. The coefficient on mean net worth implies that the riskiness of farm incomes decreases as the wealth of the household increases, this result is intuitive as additional wealth would imply an increased

Table 2: Analysis of consumption betas

	(1) r_beta	(2) w_beta
acres	-0.00000476*	-0.00000873
	(0.00000267)	(0.0000258)
age	0.000678*	-0.0138***
	(0.000392)	(0.00386)
persons	0.0130***	-0.269***
	(0.00283)	(0.0541)
W	-2.48e-08***	0.000000141***
	(3.66e-09)	(3.41e-08)
r	-0.0578**	0.101
	(0.0263)	(0.252)
_cons	-0.0255	1.474***
	(0.0262)	(0.308)
N	874	874
R^2	0.062	0.081

Standard errors in parentheses
* $p < .1$, ** $p < .05$, *** $p < .01$

	(1) r_beta_fwd	(2) w_beta_fwd
acres	-0.00000916**	0.0000965***
	(0.00000415)	(0.0000271)
age	0.000922*	0.0253***
	(0.000489)	(0.00393)
persons	-0.0116***	0.0178
	(0.00328)	(0.0220)
W	-5.35e-08***	-0.000000234***
	(9.21e-09)	(7.00e-08)
r	-0.0948**	0.297*
	(0.0444)	(0.159)
_cons	0.0549**	-1.617***
	(0.0273)	(0.266)
N	616	616
R^2	0.101	0.117

Standard errors in parentheses
* $p < .1$, ** $p < .05$, *** $p < .01$

ability to use assets in order to smooth consumption. In explaining the consumption beta of off-farm incomes only the coefficient on the mean age of the farm operator over the years in which that household was observed is significant, which is positive and statistically significant at the 5% level. The coefficient on mean age is also practically large at 0.032, this result implies that the risk reducing effect of off-farm income diminishes as the operator ages - possibly because either the ability or the willingness of the farm operator to manipulate their off-farm labor hours in order to smooth consumption diminishes as they age.

Table 3: Analysis of consumption betas - means specification

	(1) r_beta	(2) w_beta
acresbar	-0.00000661	0.00000474
	(0.0000170)	(0.000159)
agebar	0.000345	-0.0202
	(0.00159)	(0.0172)
personsbar	0.0198	-0.383
	(0.0141)	(0.288)
Wbar	-3.14e-08*	0.000000170
	(1.78e-08)	(0.000000146)
rbar	-0.186	-0.0435
	(0.169)	(1.749)
_cons	-0.00530	2.155
	(0.109)	(1.461)
N	62	62
R^2	0.100	0.114

Standard errors in parentheses
* $p < .1$, ** $p < .05$, *** $p < .01$

	(1) r_beta_fwd	(2) w_beta_fwd
acresbar	0.000000972	0.000150
	(0.0000245)	(0.000134)
agebar	0.000281	0.0326**
	(0.00220)	(0.0160)
personsbar	-0.0144	0.0299
	(0.0167)	(0.102)
Wbar	-9.03e-08*	-0.000000286
	(4.59e-08)	(0.000000385)
rbar	-0.371	0.471
	(0.341)	(0.863)
_cons	0.134	-2.132**
	(0.131)	(1.045)
N	42	42
R^2	0.151	0.150

Standard errors in parentheses
* $p < .1$, ** $p < .05$, *** $p < .01$

Conclusions

While farm incomes are highly variable that uncertainty does not necessarily translate into risk from the perspective of the farm household. The ability of the farm household to borrow and lend, and invest and disinvest from the farm enterprise, allows the farm household the ability to effectively smooth their consumption. As long as the farm is not unable to borrow, or unable to forgo the replacement of farm assets, or is otherwise liquidity constrained, the uncertainty in farm incomes does not necessarily represent a risk to the households consumption and welfare. In effect, borrowing and lending acts as a buffer mechanism which prevents uncertainty from turning into risk, as long as the household does not become liquidity constrained.

Given that individuals derive utility from the consumption of goods and services and not simply by earning income, a correct risk measure is one which captures the relationship between income volatility and consumption volatility, such as the consumption beta (Breeden, 1979). We have estimated the appropriate parameters that represent the risk of farm and off-farm incomes to the consumption of that same farm

household. Our estimates show that farm incomes do not move significantly with changes in household consumption, and therefore pose no more risk to the household's consumption problem than any other random income stream. Our results show that farm households are able to manipulate their off-farm labor hours in response to changes in consumption such that off-farm incomes are powerful risk management tools. After examining the individual consumption betas of many farms we find evidence that net worth is significant in reducing the riskiness of farm incomes, and that result is robust across multiple different specifications. This study combined with the existing literature on farm household consumption at the margin shows that the welfare of the farm household is not significantly affected by farm income volatility and at the same time is greatly benefited by the ability to flexibly earn off-farm income.

Viewing farm risk as a consumption problem rather than an income variability problem we can come to policy suggestions that are quite different than those that are currently in place. Instead of reducing the variance of farm incomes with crop and revenue insurance or other counter-cyclical payments to fill in the income troughs of bad years in order to reduce the variability of farm incomes, one may be able to better the welfare of the farmer more cheaply, and without raising the mean of farm incomes, by improving the accessibility of credit. By improving the ability of the farmer to borrow the farmer would be better able to smooth their consumption, and reduce the risk that farm incomes pose to their welfare. Our results however, and the prior literature on farm household liquidity, shows that that intervention may not be needed.

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