BUSINESS RISK, FINANCIAL RISK, AND LIQUIDITY MANAGEMENT ON U.S. FARMS – EVIDENCE FROM SELECTED STATES

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Title

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The Supervisory Committee certifies that this ***disquisition*** complies with North Dakota State University's regulations and meets the accepted standards for the degree of

MASTER OF SCIENCE

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ABSTRACT

Risk management is pivotal to agribusiness decision-making, and researchers have developed various models to disentangle factors underlying farmers' risk decisions. This thesis argues that an appropriate model should consider farmers' leverage decisions altogether with liquidity decisions given that liquidity is another major constraint facing farm businesses. We incorporate current ratio into the classical risk balancing model. Our theoretical derivations generate two propositions: (1) an increase in business risk will cause current assets to increase, and (2) an increase in the expected return to assets will cause current assets to decrease. Using five income categories and three panel data models, regression results provide evidence supportive of the first proposition, but contradictory to the second proposition. We concluded that contradictory results for the second proposition may stem from a poor proxy variable for the expected return to assets. Besides, we tested the traditional risk balancing hypothesis and found evidence for risk balancing.

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Finally, I would like to thank my family and friends for their unconditional support.

DEDICATION

I dedicate this thesis to the department of Agribusiness and Applied Economics at North Dakota State University for giving me a chance pursue my master's degree.

I also dedicate this thesis and give special thanks to my academic adviser, Dr. Xudong Rao, who has supported and encouraged me throughout the process. I will always appreciate all he has done and taught to me during my years at the North Dakota State University.

I dedicate this work to my father, Hilal Allahverdiyev, and mother, Leyla Allahverdiyeva. A special feeling of gratitude to my loving parents whose words of encouragement and push for tenacity have meant and continue to mean so much to me.

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1. INTRODUCTION

1.1. Background

Agriculture is inherently a risky enterprise. Farmers are exposed to important exogenous risks, for example, small changes in production or price risks can considerably affect farming practices and costs, or variation in weather, plant diseases, and pest infestations can lead to a decline in crop yields or quality. Besides, farming is frequently jeopardized by financial risks, involving borrowing capital and ability to pay back a debt. Thus, having a thorough view of risk in farming is crucial. Each farmer has a different tolerance level in terms of risk exposure, and this affects how and with what instruments each farmer manages risky situations. For instance, a risk averse farmer would be willing to earn a lower average return for less uncertainty. Moreover, determining sources of risk in agriculture helps farm managers and others to come up with effective risk mitigating strategies. It is therefore vital to fathom risks and uncertainty that an individual farmer faces in order to tailor farm policies to these individuals' needs.

For farmers, risk comes in many forms, and the uncertainties inherent in markets, production processes, prices, government policies, and weather conditions can trigger great fluctuations in farm profitability and expected income levels. Hardaker et al. (2015) classified types and sources of risk in agriculture into two categories: business and financial risks. Production, price or market, institutional, and personal risks together comprise business risks, and leverage and credit risks are associated with financial risks. It is equally important to identify the driving force behind each of these risks and try to mitigate these risks to bolster agricultural production and support farmers. Financial and business risks and the relationship between these two, often referred as risk balancing, will be the focus of this paper, and the analysis will seek to provide empirical evidence of how changes in one affects the other.

The risk balancing hypothesis, which attracted significant attention in the 1980s, establishes a relationship between financial, business, and total risks. Exogenous factors that affect a level of business risks are considered to encourage offsetting adjustments in leverage positions. A myriad of studies has been conducted to deepen the understanding of risk balancing behavior in the agricultural sector. Several aspects of risk balancing behavior of farmers have been explained in theoretical studies, and empirical studies have tried to build on the theoretical foundation to reveal the mechanism through which risk balancing behavior relates to farm-related decisions. As a theory, risk balancing asserts that each farmer has a target level of total tolerable risk, and once changes in the economic and political environment increase (decrease) the level of business risk a particular farmer faces, he or she will try to adjust financial risks to not exceed (or fall below) the desirable level of risk. Risk balancing behavior of farmers affects not only business decisions, but also financial decisions; therefore, business risk and financial risk should be studied together to understand behavioral responses of farmers to an ever-changing risky environment.

To analyze efficacy and effectiveness of agricultural policies, explaining behavioral responses to changes in risk conditions is a central part of agricultural policy evaluation. Without evidence of farm-level risk balancing, policy makers aiming to mitigate total farm risk may motivate farmers to take on even more risk. Besides providing insights into policy analysis, risk balancing hypothesis assists in better comprehending the implications of economic and sectoral changes and strategic balancing behavior that farmers will be likely to exhibit.

Furthermore, liquidity management plays an important role in the management of farm capital structure. One of the top priorities of farmers is to ensure that they have affordable and reliable access to a sufficient amount of cash to meet short-term cash needs. In any agricultural business, liquidity is of major significance, and it may even become more critical depending on the commodity they produce, the agricultural processes they implement, and the way how they market their commodities. Conversely, if farm businesses do not manage their liquidity well, then they may experience disruptions in their operations, incur solvency problems, or even go bankrupt in some cases. Despite the importance of liquidity in farm businesses, there has not been sufficient discussion on how farmers should adjust their liquidity positions in response to changes in business risk. Thus, in this thesis, we will explore the potential relationship between farm liquidity and business risk. In order to study this relationship, an appropriate theoretical framework will first be developed to reflect farm liquidity decisions in regard to fluctuations in business risk. Since current ratio, defined as current assets over current liabilities, provide an intuitive and common caliber of liquidity positions for agricultural business owners, we will be using current ratio as a measure of liquidity to explore how farmers adjust current ratio when business risk changes.

1.2. Objectives

1.2.1. Objective 1

To contribute to the existing risk balancing literature by integrating decision makers' liquidity choices into the classical risk balancing hypothesis.

This is the main goal of the thesis. We incorporate the current ratio into the Dupont Identity. Next, we conduct a comparative statics analysis based on the optimal current ratio derived from the expanded specification of the Dupont Identity.

1.2.2. Objective 2

To understand how decision makers adjust their liquidity positions in response to fluctuations in business risk.

This is the second central objective of the thesis. First, we theoretically interpret how changes in business risk affect liquidity decisions. Secondly, using panel data, we develop the appropriate measure of business risk and liquidity, and we estimate panel regression models to obtain empirical results.

1.2.3. Objective 3

To explore the relationship between businesses' liquidity positions and expected return to assets and interpret how changes in expectations affect liquidity decisions.

Similarly, we follow up with the theoretical model to show the relationship between firms' liquidity positions and expected return to assets. Then, we empirically test the relationship between expected returns to assets and liquidity choices.

1.2.4. Objective 4

To test the relationship between financial risk and business risk, commonly regarded as the risk balancing hypothesis.

We check our theoretical derivations to confirm that they conform with the existing literature. Afterwards, a good measure of financial risk and business risk is obtained to verify the risk balancing hypothesis.

2. LITERATURE REVIEW

The original risk balancing framework was postulated by Gabriel and Baker back in 1980 in the seminal paper named "Concepts of business and financial risk". The authors developed a conceptual framework to explain the correlation between business risk (BR) and financial risk (FR) in the risk behavior of farmers. In their paper, Gabriel and Baker (1980) described business risk as any risk that is encountered at the operational level and assumed to be independent of the way the farm is financed. BR is generally reflected in the variability of net operating income or net cash flows; thus, they argued that one sound way of measuring BR is the coefficient of variation of net operating income or cash flows. Further, they indicated that financial structure of farm represents farm financial risk which originates from fixed financial debt servicing obligations. The sum or product of BR and FR comprise the total farm-level risk (TR). Additionally, the original risk balancing framework assumes that farmers have a maximum tolerable level of risk that constraints TR. Therefore, when exogeneous factors interfere with BR, farmers respond to that by increasing or decreasing the level of FR in a way that TR does not exceed tolerable level of risk.

Barry, Baker, and Sanint (1981) further analyzed the fundamental theory behind farmers' credit risks to interpret the role farm credit plays in the formulation and management of farm structure. The authors expand the mean-variance portfolio model to incorporate risk attributes for costs of leverage and conduct a comparative statics analysis for an expected utility-maximizing farm portfolio that controls for these attributes of financial risk. Although the authors admit that the mean-variance portfolio model is commonly contested for its broad assumptions, they remind that its extensive use and its unequivocal measures of risk give rigid grounds for estimating the portfolio effects of farm financial risk. Empirical evidence showed that higher borrowing costs arising from higher farm business risks led to lower farm leverage (Barry et al., 1981).

Additionally, Barry et al. (1981) argued that the relatively high variability of fund availability from rural banks contributed to credit risks that farmers face, thus resulting in lower levels of farm leverage.

After Gabriel and Baker (1980) proposed the original risk balancing model, several theoretical extensions have been put forward in support of the risk balancing hypothesis. Collins (1985) used an alternative method, i.e. an expected utility mean-variance portfolio model, to stress that the risk balancing behavior put forward by Gabriel and Baker (1980) is consistent with their hypothesis. In his paper, Collins starts with the simple DuPont identity, where rp is the net expected return of the portfolio, A is assets, and E is equity, and states it as: ROE=r_p/A·A/E. Since leverage (δ) is the ratio of debt to assets, δ=D/A, he rewrites the DuPont as ROE=r_p/A·1/(1-δ). After including interest payments and the effect of debt on ROE, Collins chooses the negative exponential utility function and conducts the expected utility maximization. The author demonstrates that Gabriel and Baker's (1980) hypothesis that a decline in business risk (σ_A^2) would produce an increase in financial risk (δ) (∂FR/∂BR=(∂δ^*)/(∂σ_A^2)=-λ/[R ̅_A-Kδ]) is valid. Besides, Collins (1985) suggests that policies aimed at increasing expected farm income may induce farmers to take on more business or financial risks.

Turvey and Baker (1989) adapted Collins's (1985) expected utility model to include the farm's capital structure into optimal hedging strategies. They demonstrated that hedging depends on the level of leverage; particularly, the higher the leverage ratio, the higher the absolute amount of commodity hedged. The theoretical model they developed can also be used to predict the impact of government policies on farmers' hedging decisions. Therefore, Turvey and Baker (1989) claimed that governmental policies aimed at decreasing or mitigating farm business risk may also reduce the hedging levels for farmers.

Featherstone, Moss, Baker, and Preckel (1988) showed that income augmenting and risk reducing policies may lead to farm financial vulnerability which may increase the probability of partial or total equity loses for farmers. They showed that income augmenting and risk reducing policies end up raising the optimal leverage ratio, the variance of the rate of return on equity, the expected rate of return on equity, and the expected utility. Thus, the authors named these characteristics as the “risk balancing paradox”.

Moss, Shonkwiler, and Ford (1990) base their model on the Collins’ (1985) theoretical specification and apply an autoregressive conditional heteroskedastic (ARCH) model to estimate the effect of the expected return on assets, the cost of additional debt, and the riskiness of an enterprise on the level of debt in U.S. agriculture. The data obtained from the USDA over the period from 1950 to 1896 indicate that a decline in the variance or riskiness of expected total farm returns would trigger an increase in real debt in the farm, providing support for the original risk balancing hypothesis.

Ahrendsen et al. (1994) provided an empirical test of expected utility model, and they also extended the theoretical model to include depreciation, economies of scale, taxes, wealth, and investment tax credits. Their study utilized firm-level data on dairy farms in North Carolina between 1976 and 1986. Their conclusions presented an empirical support not only for the risk balancing model (Barry et al., 1981), but also for the expected utility model (Collins, 1985). The results implied that the policies that cause farmers’ income increase or farm business risk decrease are likely to increase farm financial risk through capital structure adjustments; however, this strategic adjustment process occurs at a relatively sluggish pace.

Further on, Jensen and Langemeier (1996) use firm-level panel data from Kansas Farm Management Association (KFMA) between 1973 and 1988 to test the unconstrained utility maximization model and examined the relationship between the determinants of optimal leverage and the expected utility of returns. They extend the Collins' (1985) model to include social security taxes, state and federal income taxes, returns to unpaid labor and management, and long-term capital gains. Comparative statistics findings are consistent with the economic theory and reinforced the link between the optimal level of leverage for agricultural firms and tax policy, risk, growth rate of assets, and farm profitability. Hence, their unconstrained utility maximization model also points out a plausible association between farm business risks and farm leverage levels.

While evaluating the validity of risk balancing as a risk reducing mechanism, Escalante and Barry (2001) took advantage of a multi-period quadratic programming model to interpret Illinois grain farms' risk management strategies, such as diversification, risk buffering, crop specialization, and marketing activities. Under risk neutrality and increasing degrees of risk aversion, the synchronic relationship between risk management strategies and risk balancing is found to exert its impact on the optimal level of farm leverage (Escalante & Barry, 2001).

As an alternative method to analyze the risk balancing behaviors of farmers, Escalante and Barry (2003) employed a correlation analysis to better comprehend the impetus of reverse strategic adjustments in farm capital structure in response to changing business environment. The study incorporated the trade-off between business and financial risk into the strategic adjustment process and identified the relevance of demographic factors and business growth strategies with respect to the risk balancing process. By using longitudinal farm-level data from Illinois grain farms, Escalante and Barry (2003) found evidence of risk balancing in more than 50 percent of the farms. Increased farm income risk was revealed to have significant implications for strategic adjustments in long-term farm capital structure.

In addition, Escalante and Rejesus (2008) explored the risk balancing behaviors of representative U.S. grain farms by using simulation optimization techniques. Under constant absolute risk aversion (CARA) and increasing relative risk aversion (IRRA) behavior assumptions, the results were less consistent compared to those under decreasing absolute risk aversion (DARA) and constant relative risk aversion (CRRA). The DARA-CRRA model predicted that the financial risk ratio solutions considerably diminish as the risk aversion decreases (Escalante & Rejesus, 2008).

Ifft, Kuethe, and Morehart (2013) investigated the link between farm debt use and crop insurance with the data obtained from the USDA Agricultural Resource Management Survey (ARMS). The results illustrated that the farms with relatively higher leverage preferred to buy federal crop insurance (FCI) more than otherwise. Ifft et al. (2013) also found out that farms that purchased FCI had a higher default risk. Specifically, 78 percent of farms that did not participate in FCI had a less than 1 percent probability of bankruptcy. On the contrary, farms that were part of FCI had a 68 percent farm default probability rate.

Uzea, Poon, Sparling, and Weersink (2014) carried out a study to explore whether the Canadian business risk management (BRM) programs had succeeded in reducing farm-level risk and whether risk balancing behavior had interfered with the objective of Canadian agricultural policies. They conducted the correlation coefficient analysis and found out that the risk balancing behavior is more prevalent among larger farms compared to smaller ones, and the risk reducing aspect of BRM policies encourages bigger farms to undertake more financial risk, raising the likelihood of bankruptcy. Despite implications of the study, the authors argued that deeper scrutiny is required to confirm that BRM policies indeed lead to higher probability of bankruptcy. Last but not least, Uzea et al. (2014) mentioned that their analysis lacks farmers' balance sheet information to control for the effect of expected capital gains and data on crop insurance payments. However, the study still provides the preliminary evidence on risk balancing behavior in Canada.

Ifft, Kuethe, and Morehart (2015) evaluated the effect of federal crop insurance (FCI) on farm debt use to figure out whether federal crop enrollment motivate any risk balancing behavior from farmers perspective. The authors used the Agricultural Resource Management Survey (ARMS) data to study the underlying processes that relate these two phenomena and how strong is the correlation between them. The estimates suggested that farms with a greater total area used in production are more likely to enroll in the federal crop insurance program. Besides, the level of education that each farmer had affected the participation rates. Ifft et al. (2015) confirmed that, as the total farm revenues diminish, the probability of purchasing crop insurance declines. Interestingly, the results further implied that the FCI enrollment is associated with an almost $22,000 growth in short-term debt and $16,000 rise in non-real estate long-term debt; however, these results were statistically significant at only the 10 percent confidence level. Generally, these results were in conformance with lenders who accept crop insurances as collateral for operating loans. In some cases, the FCI participation is a prerequisite to qualify for farm debt, and if this requirement is a determining part of the relationship between debt use and FCI, then farmers may display risk balancing behavior to a smaller extent than anticipated by the results.

Ifft and Jodlowski (2017) examined the relationship between the U.S. federal crop insurance program and farmers' credit use through various channels. Over the past decades, empirical studies have found out a strong relationship between the federal crop insurance program and short-term debt; however, this relationship is not consistent across all farm types. The relationship between crop insurance and access to credit is still unknown to researchers, and much remains to be understood. Initially, the authors applied state-of-art econometric approaches to detect any causal relationship between crop insurance and credit use. Secondly, the study looked at the relationship between crop insurance and lending terms, such as interest rates or lender choice. Finally, the authors differentiated among various types of farm characteristics and looked at the causality between loans used by different types of farms and crop insurance program. Ifft and Jodlowski (2017) used cross-sectional nation-wide farm level survey obtained from the Agricultural Resource Management Survey (ARMS) and conducted a cross-sectional analysis to benefit from the full scale of ARMS data; nevertheless, in the next stages, they reduced the sample size to more robustly determine the relationship between crop insurance program and operating loans. They found that both crop insurance program and coverage increase short-term debt use, and this result was consistent across the various models, excluding the premium paid cross-sectional model. Nevertheless, the effect of short-term debt increases was not economically significant to boost farm leverage. One important finding of the study was that crop insurance does not spawn regulatory risk, meaning enrolling in crop insurance did not induce more indebted farms to borrow more operating loans. The analysis also did not find any evidence to support the hypothesis that the crop insurance program facilitates the access to credit. Lastly, there was no indication that crop insurance lowers the cost of credit (J. Ifft & Jodlowski, 2017).

The risk reducing policies have become the focal point of farm support policies in EU's most recent Common Agricultural Policy (CAP) agenda (Cafiero, Capitanio, Cioffi, & Coppola, 2007). The authors argued that relevant risk factors and their implications for farmers' welfare must be carefully considered and evaluated in the context of European agricultural policy. According to the paper, in order to reveal potential risk reducing sides of farm policies and their welfare effects, the focus should be concentrated on consequences of different risks that farmers encounter on farm households' consumption, not on current income. Since farm households' consumption entail all sources of income, including off-farm employment, investments, and government support, farmers' exposure to risk should also be studied from household perspective (Cafiero et al., 2007).

Optimal farm policies revolve around the prevalent aspect of risk management policies and risk environment that a typical farmer experiences, thus leading to a need to determine farmers' risk exposure in the first place (Kimura, Antón, & Lethi, 2010). Nevertheless, if farm support or other risk management policies are in place to subsidize or cover some of the farm risks, then the stimulus to buffer against other risks abates. The conclusion deduced from simulated results implied that, as a result of a single farm payment (SFP) in UK, certainty equivalent (CE) of farm income increases and the coefficient of variation decreases by 19% (Kimura et al., 2010). Nevertheless, the CV does not decline through the variance – the reduction is rather the result of the additional level of income, and the SFP has an adverse effect on a crop diversification strategy (Kimura et al., 2010). Crop yield premiums exhibited a substantial crowding out effect by stimulating farmers to grow crops which produce higher returns with higher risks, thus offsetting the risk reducing effect of insurance premiums (Kimura et al., 2010).

The relationship between agricultural risk management policies and liquidity reserves is neglected to a great extent (Pedersen & Olsen, 2013). Debt capacity and credit reserves of Danish farmers increased substantially throughout 1996-2009, and debt capacity almost doubled. The authors recommended that banks and mortgage institutions should take into consideration the shift in a debt possibility frontier while screening credit applications, and this shift would provide a better debt structure in Danish agriculture in future. In terms of risk balancing, the findings imply that improving access to credit may call for development of market risk managements strategies (Pedersen & Olsen, 2013).

de Mey et al. (2014) conducted an empirical study in the EU-15 countries to reveal risk balancing behavior of EU farmers. The authors established the theoretical model and defined business risk (BR), total risk (TR), financial risk (FR), and TR constraint in mathematical terms, similar to the definition of these variables by Gabriel and Baker (1980). de Mey et al. (2014) did not find any contradictory evidence in Europe against the original risk balancing framework (Gabriel & Baker, 1980). In fact, over 50 percent of farms demonstrated risk balancing behavior. They also implied that risk reducing or income augmenting agricultural policies might encourage higher levels of borrowing among farm operators. Provided that these strategic adjustments are strong enough, they may abate the intended purpose of these policies (de Mey et al., 2014).

de Mey et al. (2016) studied farm household risk balancing behavior of Swiss farmers using Swiss Farm Accountancy Data Network data. The authors analyzed farm-level and off-farm decisions as a strategic response to fluctuations in business risk. Specifically, they embedded farm household choices into the original risk balancing framework by acknowledging that factors that cause changes in business risk might not only alter farm financial risk, but also induce household buffering actions such as lowering consumption or seeking more off-farm income sources. Ultimately, the authors found that household risk balancing strategies are more common among small farms than among large farms, a conclusion that appeared to follow the original risk balancing framework (Gabriel & Baker, 1980). De Mey et al. (2016) declared that when analysis focuses solely on farm-level analyses, risk balancing behavior of farm households cannot be predicted; thus, implications of agricultural policies in Europe cannot be predicted. The authors asserted that policy makers have a broad range of alternative policy instruments, in addition to policies aimed directly at lowering farm business risk, to enable farm households to manage farm risks and/or expand their household risk buffering capacities. This consideration would especially be relevant for small farm households (De Mey et al., 2016). Since Switzerland is a country where farmers have had rather stable farm income with a myriad of governmental support schemes and off-farm income opportunities, having a strong household risk balancing response is not a realistic case. The authors proclaim that it would be more reasonable to expect a stronger risk balancing behavior with less favorable economic conditions since greater fluctuations in business risks would trigger larger farm level financial and buffering responses.

One specific unanticipated response to income augmenting or risk mitigating support schemes could be their crowding-out effect (Wauters et al., 2015). For instance, Coble, Heifner, and Zuniga (2000) looked at the relationship between crop insurance and hedging strategies of farmers to figure out if there is a negative relationship between the two. They revealed that revenue insurance depressed hedging rates among farmers relative to yield insurance. As insurance levels rose above 70%, the crowding-out effect on hedging tended to surge (Coble et al., 2000). In addition, risk reducing policies may impel farmers to cultivate more risky crops (Turvey, 2012). The analysis indicated that farmers actively altered the variety of crops they grow depending on the type of insurance and subsidy programs. Turvey (2012) emphasized that farm support policies without subsidies lead to identical outcomes with the uninsured scheme, and the wealth effect that distorts markets is induced by incremental subsidy responses. Finally, risk reducing or income augmenting policies and financial assistance to farms produce detrimental environmental externalities, such as reduced biodiversity (Di Falco & Perrings, 2005). They showed that a risk averse farmer, ceteris paribus, would choose a larger variety of crops than a risk neutral farmer. Nevertheless, risk reducing strategies or income augmenting targeting specific type of crops may alter farmers behavior. For instance, if the subsidy intended for few crops, farmers will grow these few, leading to the negative and statistically significant link between crop biodiversity and risk reducing strategies (Di Falco & Perrings, 2005).

3. METHODOLOGY

3.1. Theoretical Framework

A farm's financial activities include, but not limited to, financing and debt management, liquidity management, and utilizing credit as a source of liquidity. These activities are critical to farm management and production. A farm ought to provide funds for production, growth, and overall operations using equity capital, debt capital, or a particular combination of debt and equity. Therefore, the liquidity risk is an added element of risk which plays a strategic role in farm management. Very few studies have jointly considered liquidity risk, business risk, and financial risk and evaluated their interrelated impact on one another. An appropriate model should be developed to consider farmers' liquidity decisions altogether with their leverage decisions given that liquidity is another major constraint facing farm businesses. In this section, we develop a theoretical framework in which we expand the classical risk balancing model to incorporate the current ratio and explore the relationship between business risk, expected return to assets, and farm liquidity.

The financial and economic research has widely utilized the expected value-variance (EV) framework to facilitate risk analysis. Originating from Markowitz's (1952) explanation of investors' financial asset diversification, the expanded specifications of the EV approach were developed by Tobin (1958) to incorporate risk-free assets and later by Sharpe (1964), Lintner (1965), and Fama (1976) to introduce the risk pricing of capital assets. By assisting the decision-making process when the objective function of a decision maker is already known, the EV method has contributed significantly to revealing the relationship between variables and determining the course of change in variables of interest relative to other factors affecting the decision-making process. Following the literature developed by Collins (1985), this section extends the mean-variance portfolio model to incorporate the current ratio and explore the relationship among business risk, expected return, and farm liquidity. We start with the Dupont Identity, decompose ROE in terms of financial risk, business risk, and current ratio, and conduct a comparative static analysis to reveal the relationship between the variables of interest. The Dupont Identity states that

$$ROE = \frac{r_p}{Total\ Assets} \times \frac{Total\ Assets}{Average\ Shareholder\ Equity} \tag{3. 1}$$

where r_p is the net expected return to the portfolio of enterprises. In the next step, we express total assets as the sum of current and noncurrent assets, then multiply and divide the current asset to equity ratio by current liabilities in order to incorporate current ratio into the Dupont Formula:

$$ROE = \frac{r_p}{Total\ Assets} \times \left[\frac{Current\ Assets}{Average\ Shareholder\ Equity} + \frac{Noncurrent\ Assets}{Average\ Shareholder\ Equity}\right] \tag{3. 2}$$

$$ROE = \frac{r_p}{Total\ Assets} \times \left[\frac{Current\ Assets}{Average\ Shareholder\ Equity} \times \frac{Current\ Liabilities}{Current\ Liabilities} + \frac{Noncurrent\ Assets}{Average\ Shareholder\ Equity}\right] \tag{3. 3}$$

By reorganizing the terms, we get

$$ROE = \frac{r_p}{Total\ Assets} \times \left\{\frac{Current\ Assets}{Current\ Liabilities} \times \frac{Current\ Liabilities}{Average\ Shareholder\ Equity} + \frac{Noncurrent\ Assets}{Average\ Shareholder\ Equity}\right\} \tag{3. 4}$$

or simply

$$ROE = \frac{r_p}{A} \times \left[\frac{CA}{CL} \times \frac{CL}{E} + \frac{NCA}{E}\right] \tag{3. 5}$$

where A, CA, NCA, CL, and E represent total assets, current assets, noncurrent assets, current liabilities, and average shareholder equity respectively. It should be mentioned that three new components appear in this expanded specification of the Dupont Identity. Current liabilities over current assets, $\frac{CA}{CL}$, represents a firm's liquidity position and provides insight about whether a firm can meet its short-term debt obligations. Although varying from one industry to another, a current ratio lower than 1 generally means that a firm may be susceptible to suboptimal asset transactions, while a current ratio of 1 or greater is deemed to be financially secure. The second one, $\frac{CL}{E}$ – current liabilities to net worth ratio, represents the short-term debt coverage and measures an ability of a firm to cover its short-term debt with equity. As a rule of thumb, the current liabilities to net worth ratio should not exceed 60% since it reflects a level of security for creditors and the larger the ratio, the less security there is for creditors. Moreover, $\frac{NCA}{E}$ is the ratio of noncurrent assets to net worth which measures how much of a company's investment are frozen in the form of low liquid noncurrent assets. The rule of thumb states that the optimal value for the noncurrent assets to net worth ratio is 1.25 or less and that the greater values represent low liquidity and vulnerability to unexpected shifts in business environment.

Assuming that i is the anticipated rate of change in asset values, the effect of asset inflation on the expected rate of return on assets is $\frac{i \times A}{A}$ or i (Collins, 1985). Integrating the effect of asset inflation, the gross anticipated rate of return to assets can be stated as $\tilde{R}_A = \frac{r_p}{A} + i$, which is a normally distributed random variable with mean $\bar{R}_A$ and variance σ_A^2; that is, $\tilde{R}_A \sim N(\bar{R}_A, \sigma_A^2)$. Moreover, the leverage ratio, which is regarded as a measure of financial risk, is the ratio of debt to assets and can be specified as $\delta = \frac{D}{A}$. With an interest rate of r and debt of D, the effect of debt on the rate of return on assets is $-\frac{r \times D}{A}$ or $-r\delta$ (Collins, 1985). Therefore, if $\tilde{R}_E$ is the net rate of return to equity, (3.5) can be stated as

$$\tilde{R}_E = \{\tilde{R}_A - r \times \delta\} \times \left[\frac{CA}{CL} \times \frac{CL}{E} + \frac{NCA}{E}\right]$$

(3. 6)

The leverage ratio can be expressed as

$$\delta = 1 - \frac{1}{\left[\frac{CA}{CL} \times \frac{CL}{E} + \frac{NCA}{E}\right]}$$

(3. 7)

$$Proof: \delta = \frac{D}{A} = \frac{A-E}{A} = 1 - \frac{E}{A} = 1 - \frac{1}{\frac{A}{E}} = 1 - \frac{1}{\left[\frac{CA}{CL} \times \frac{CL}{E} + \frac{NCA}{E}\right]}$$

(3. 8)

To continue our analysis, in (3.6), we replace (3.7) and get

$$\tilde{R}_E = \left\{\tilde{R}_A - r \times \left[1 - \frac{1}{\left[\frac{CA}{CL} \times \frac{CL}{E} + \frac{NCA}{E}\right]}\right]\right\} \times \left[\frac{CA}{CL} \times \frac{CL}{E} + \frac{NCA}{E}\right]$$

(3. 9)

which has an expected value of

$$\bar{R}_E = \left\{\bar{R}_A - r \times \left[1 - \frac{1}{\left[\frac{CA}{CL} \times \frac{CL}{E} + \frac{NCA}{E}\right]}\right]\right\} \times \left[\frac{CA}{CL} \times \frac{CL}{E} + \frac{NCA}{E}\right]$$

(3. 10)

and the variance of

$$\sigma_E^2 = \left[\frac{CA}{CL} \times \frac{CL}{E} + \frac{NCA}{E}\right]^2 \times \sigma_A^2$$

(3. 11)

The expected utility maximization problem can be set out as

$$Max\ V(\bar{R}_E) = \bar{R}_E - \frac{\rho}{2} \times \sigma_E^2$$

(3. 12)

where ρ is the farm owner's risk preference coefficient. Substituting the expected value and the variance gives us

$$Max\ V(\bar{R}_E) = \left\{\bar{R}_A - r \times \left[1 - \frac{1}{\left[\frac{CA}{CL}\times\frac{CL}{E}+\frac{NCA}{E}\right]}\right]\right\} \times \left[\frac{CA}{CL} \times \frac{CL}{E} + \frac{NCA}{E}\right] - \frac{\rho}{2} \times \left[\frac{CA}{CL} \times \frac{CL}{E} + \frac{NCA}{E}\right]^2 \times \sigma_A^2$$

(3. 13)

By using (3.13), we can explore the direction of change in farm liquidity in relation to business risk (σ_A^2) and the expected return to assets ($\bar{R}_A$). In order to come up with the optimal current ratio $\left(\frac{CA^*}{CL}\right)$ from (3.13), the first-order condition with respect to $\frac{CA}{CL}$ should be taken. This would implicitly require the assumption that the decision maker can change either or both CA and CL so that $\frac{CA}{CL}$ is changed to its optimal level. However, since we have $\frac{CL}{E}$ on the right-hand side, the FOC w.r.t $\frac{CA}{CL}$ would assume that $\frac{CL}{E}$ is constant, which would be contradictory. Thus, in order to come up with the optimal current ratio $\left(\frac{CA^*}{CL}\right)$ from (3.13), we assume that CL is kept constant, so that CA is the only changing variable here. The constant current liabilities assumption is restricting; specially, when farmers face uncertain future and unpredictable changes more often recently, such as the China-United States trade war or the COVID-19 pandemic, along with their significant supply chain disruptions, unstable prices, or negative effects on labor supply. Nevertheless, holding current liabilities fixed or treating it as explicitly given is consistent with the agricultural practices – most of the time current liabilities can be predicted well ahead. Farmers usually seek to plan their production in advance and stay resilient through change from both personal and business perspective, allowing them to forecast production costs and ultimately current liabilities.

By controlling for current liabilities, the FOC w.r.t $\frac{CA}{CL}$ is equivalent to the FOC w.r.t CA. In this case, the decision maker can change current assets by adjusting (i) noncurrent assets or (ii) average shareholder equity, or (iii) both. In the (i) scenario, we express $NCA = TA - CA$ and implicitly assume that TA and E are not changing. Substituting for NCA in (3.13) yields

$$Max\ V(\bar{R}_E) = \left\{\bar{R}_A - r \times \left[1 - \frac{1}{\left[\frac{CA}{CL} \times \frac{CL}{E} + \frac{TA-CA}{E}\right]}\right]\right\} \times \left[\frac{CA}{CL} \times \frac{CL}{E} + \frac{TA-CA}{E}\right] - \frac{\rho}{2} \times \left[\frac{CA}{CL} \times \frac{CL}{E} + \frac{TA-CA}{E}\right]^2 \times \sigma_A^2 \quad (3.\ 14)$$

and FOC w.r.t CA cannot be taken because CA cancels out from (3.14). This also suggests that we don't have to worry about scenario (iii). As a result, the only meaningful change in current assets is realized by adjusting average shareholder equity (ii). In this scenario, we express $E = CA + NCA - TL$ and implicitly assume that NCA is not changing. Substituting for E in (3.13) leads to

$$Max\ V(\bar{R}_E) = \left\{\bar{R}_A - r \times \left[1 - \frac{1}{\left[\frac{CA}{CL} \times \frac{CL}{CA+NCA-TL} + \frac{NCA}{CA+NCA-TL}\right]}\right]\right\} \times \left[\frac{CA}{CL} \times \frac{CL}{CA+NCA-TL} + \frac{NCA}{CA+NCA-TL}\right] - \frac{\rho}{2} \times \left[\frac{CA}{CL} \times \frac{CL}{CA+NCA-TL} + \frac{NCA}{CA+NCA-TL}\right]^2 \times \sigma_A^2 \quad (3.\ 15)$$

and the first-order condition with respect to CA results in

$$\frac{\partial V(\bar{R}_E)}{\partial CA} = \frac{TL \times \{CA \times [\rho \times \sigma_A^2 + r - \bar{R}_A] + \rho \times \sigma_A^2 \times NCA + TL \times [\bar{R}_A - r] + NCA \times r - NCA \times \bar{R}_A\}}{[CA+NCA-TL]^3} = 0 \quad (3.\ 16)$$

implying that $[CA + NCA - TL] \neq 0$ or $E \neq 0$. Solving (3.16) yields

$$CA^* = -\frac{\rho \times \sigma_A^2 \times NCA + TL \times [\bar{R}_A - r] + NCA \times r - NCA \times \bar{R}_A}{[\rho \times \sigma_A^2 + r - \bar{R}_A]} \quad (3.\ 17)$$

Based on the optimal current assets from (3.17), we can conduct a comparative statics analysis and determine how farm liquidity responds to changes in business risk and the expected return to assets. Comparative statics of $\frac{\partial CA^*}{\partial \sigma_A^2}$ and $\frac{\partial CA^*}{\partial \bar{R}_A}$ gives us:

$$\frac{\partial CA^*}{\partial \sigma_A^2} = \frac{\rho \times TL \times [\bar{R}_A - r]}{[\rho \times \sigma_A^2 + r - \bar{R}_A]^2} \tag{3. 18}$$

$$\frac{\partial CA^*}{\partial \bar{R}_A} = -\frac{\rho \times TL \times \sigma_A^2}{[\bar{R}_A - \rho \times \sigma_A^2 - r]^2} \tag{3. 19}$$

Two propositions can be purported from (3.18) and (3.19). First, (3.18) is positive as long as the decision maker is risk averse ($\rho > 0$) and the interest rate of debt does not exceed the rate of return to assets from operations and capital gains. It implies that when the decision maker can only adjust the firm's liquidity position via shareholders' equity, an increase in business risk will cause current assets to increase, which will correspondingly increase current ratio $\left(\frac{CA}{CL}\right)$. Situations like this include, farmers (1) reduce their family living withdrawal from their farm business, or (2) put their family savings into their farm business, and thus use that additional equity to finance their current assets in face of increased business risk. Secondly, (3.19) is negative as long as the decision maker is risk averse ($\rho > 0$). It implies that when the decision maker can only adjust the firm's liquidity position via shareholders' equity, an increase in the expected return to assets will cause current assets to decrease, which will correspondingly decrease current ratio $\left(\frac{CA}{CL}\right)$.

The model developed in this study also supports Gabriel and Baker's (1980) hypothesis that a decrease in business risk would induce an increase in financial risk. To show that, we define leverage, δ, as the financial risk and express δ as in (3.7), then the denominator becomes associated with the financial risk. For simplicity, we can say that

$$\omega = \left[\frac{CA}{CL} \times \frac{CL}{E} + \frac{NCA}{E}\right]$$

(3. 20)

Then, we substitute for ω in (3.13) and get

$$Max\ V(\bar{R}_E) = \left\{\bar{R}_A - r \times \left[1 - \frac{1}{\omega}\right]\right\} \times \omega - \frac{\rho}{2} \times \omega^2 \times \sigma_A^2$$

(3. 21)

The first-order condition yields

$$\frac{\partial V(\bar{R}_E)}{\partial \omega} = \bar{R}_A - r - \rho \times \sigma_A^2 \times \omega = 0$$

(3. 22)

and the optimal ω^* can be specified as

$$\omega^* = \frac{\bar{R}_A - r}{\rho \times \sigma_A^2}$$

(3. 23)

The second order condition requires

$$\frac{\partial^2 V(\bar{R}_E)}{\partial \omega^2} = -\rho \times \sigma_A^2 < 0$$

(3. 24)

which is met if a person is risk averse ($\rho > 0$). Differentiating ω^* w.r.t. σ_A^2,

$$\frac{\partial \omega^*}{\partial \sigma_A^2} = -\frac{\bar{R}_A - r}{\rho \times [\sigma_A^2]^2}$$

(3. 25)

The sign of (3.25) is negative as long as the second-order condition is met and the interest rate of debt does not exceed the rate of return to assets from operations and capital gains. Thus, the model supports Gabriel and Baker's (1980) assertion that a decline in business risk (σ_A^2) would produce an increase in financial risk (ω).

3.2. Data

3.2.1. Data Source

To test the relationship between business risk, financial risk, expected return to assets, and farm liquidity, we used the FINBIN database that is compiled and maintained by the University of Minnesota. The FINBIN data contains confidential and cross-validated data on farm financial and production activities. To collect the FINBIN data, professional agricultural consultants work with each farmer who participate in the FINBIN survey to validate that information is authentic. Moreover, farm management programs adhere to predefined reporting techniques to ensure that data are consistent. Initially, FINPACK implements a series of checks to validate that accounts balance at the individual level. Besides, as the data transferred into database, FINBIN detects outliers. Outliers are either validated with farmers or removed from the database. For the purpose of this study, we obtained the FINBIN data that have been aggregated at the state level for 12 U.S. states for the period 1995-2019[1]. Specifically, we consolidated the following 13 financial reports accessible on the FINBIN website:

- Financial Summary
- Financial Standards Measures
- Summary Farm Income Statement
- Profitability Measures

[1] 12 states included in the dataset are Illinois, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, Pennsylvania, South Carolina, South Dakota, Utah, and Wisconsin.

- Liquidity and Repayment Capacity Measures
- Balance Sheet at Market Values
- Balance Sheet at Cost Values
- Statement of Cash Flows
- Crop Production and Marketing Summary
- Farm Operator and Labor Information
- Nonfarm Summary
- Farm Income Statement
- Financial Summary Excluding Deferred Liabilities

In this way, our unbalanced panel sample contains 177 observations. In the dataset, North Dakota, Minnesota, and Nebraska have observations for the entire period 1995-2019. However, observations for remaining states have missing years. Specifically, observations for South Carolina are solely available for 2 years, i.e. 2005 and 2017. Illinois and Pennsylvania each have 4 years of data present in the dataset. Moreover, Illinois, Ohio, and South Caroline have missing observations in some years that might cause potential problems while estimating variables that require continuous data.

3.2.2. Variable Definition

Since the FINBIN data include various financial reports, the first challenge comes from different definitions of income. In the risk balancing literature, researchers have used numerous measures of income to define business risk and financial risk. For instance, Gabriel and Baker (1980) recommends the use of either the net operating income or net cash flow to calculate business risk, but Collins' (1985) definition of business risk includes the return on assets. Moreover, Wauters (2015) uses expected operational cash flow, while Aderajew (2020) estimates business risk as the standard deviation of farm profitability. Since a consensus about which measures of income better reflects farmers' risk preference does not exist, we use multiple income measures and estimate results separately for each one of them. Five income measures used in this study are as follows: gross cash farm income; earnings before interest, taxes, depreciation, and amortization (EBITDA); gross revenues accrual; net cash farm income; net farm income from operations.

Undoubtedly, five income candidates differ in terms of their conceptual construct; however, farmers, in most cases, base their decision on only one measure of income, and this measure of income changes from one farmer to another. For example, gross cash farm income is the total amount of all receipts from the exchange of crops, livestock, and farm-related goods and services. Net cash farm income is equal to gross cash farm income after all cash expenses have been subtracted. Likewise, revenue recognized from the sale of a good or service, but for which cash payment has not been collected is regarded as gross revenues accrual. Calculation of these three income candidates is fairly straightforward, and farmers can easily identify them to make a financial or business decision. Conversely, estimating EBITDA and net farm income from operations require the knowledge of non-cash items like depreciation, amortization, taxes, or overheads; therefore, these income measures may be overlooked by farmers and may not be considered to manage or mitigate risks.

Speaking of our variables, *business risk* (σ_A^2) is calculated as the coefficient of variation of income over a 3-year rolling window. The inclusion criterion for each state is that continuous whole-farm data had to be available for at least 3 consecutive years. The number of observations for business risk thus drops from 177 to 137 for all income measures except EBITDA, for which the viable number of observations is 131. The reason why EBITDA differs from other income measures is inherent in the dataset itself. To take Ohio as an example, four observations from 1999 to 2002 are missing for EBITDA. Since business risk calculated over a 3-year period, the calculation omits the two observations before 1999, causing business risk calculated based on EBITDA to be 131 instead of 137.

We define *financial risk* to be a ratio of interest paid over the difference between income and interest paid. It should be emphasized that since net cash farm income and net farm income from operations already account for interest paid in their calculations in the dataset, the denominator of the formula has been adjusted accordingly for these two measures of income to avoid a double deduction. Moreover, the values greater than 1 and less than 0 for financial risk have been dropped since those values for financial risk does not make any sense in the estimation process.

Since our theoretical framework postulates that the expected return to assets is negatively correlated with current assets, we need to come up with a way of estimating the expected return to assets to empirically test this proposition. In practice, people form their expectations of returns to asset in different ways, and academic studies have proposed different mechanisms to approximate expected returns to asset. Some studies calculate the average of historical return to asset values to project people's expectations, or some kind of weighted averages of past values. Other studies have include questions explicitly asking respondents for their expectations. In our study, to unveil the link between current assets and expected return to assets, we define the *mean return to assets* by taking the average of three-year lag of return to assets. The intuitive explanation for the variable *mean return to assets* would be that expectation of future returns might be formed on past returns, and the best we can hope is to capture some part of variability in the expected return to assets.

Furthermore, *current ratio* will be used to study the relationship with business risk and reveal farmers' liquidity preferences. The variable *subsidies* is the natural log of government payments per acre, reflecting how government payments may impact farmers risk preference. As an example, de Mey et al. (2013) included subsidies as a farm related independent variable in their exploration of risk balancing behavior. Ifft et al. (2015) analyzed effects of the federal crop insurance, which was taken as equivalent to government subsidies, to reveal whether it stimulates any risk balancing behavior. *Experience* variable represents the average number of years farming, and a quadratic term of experience has also been created to detect potential decreasing or increasing marginal effects. Lastly, to capture additional risk loving or risk averse behavior, we include *farm profitability* specified as income measures over total farm assets. Interestingly, two measures of total farm assets exist in the dataset: one is based on market values, the other is on cost values. To elucidate, the cost valuation or the book valuation of an asset records the original purchase price of an asset and adjusts it for any subsequent changes. The market valuation of an asset reports the price at which the asset can be sold on an open, competitive market. Since market and cost values of assets may differ from each other appreciably, the implication of these valuation methods for our model is that empirical results may change depending on whether we use market-based farm profitability or cost-based farm profitability. As a result, we have 12 different farm profitability variables that we will test in our regression models. Dependent and independent variables and their measurements are summarized in Table 1.

Table 1. Variables and Measurements

Variables	Variable Name	Variable Description	Unit of Measurement	Combinations
Business Risk	BR	Coefficient of Variation of Income	Ratio	Five Income Categories
Financial Risk	FR	Interest Paid Divided by Income after Interest Expenses Have Been Deducted	Ratio	Five Income Categories
Mean Return to Assets	MeanRoA	Average of Three-year Lag of Return to Assets	Ratio	Market and Cost Values
Current Ratio	CR	Current Assets over Current Liabilities	Ratio	None
Subsidies	Subsidies	Logarithm of Government Payments over Total Crop Acres	Ratio	None
Experience	Experience	Average Number of Years Farming	Years	None
Farm Profitability	FarmProfitability	Ratio of Income over Total Farm Assets	Ratio	Five Income Categories and Market and Cost Values

3.3. Estimation Model

The empirical model for our study will take the methodology from existing literature on risk balancing. To study the risk balancing behavior, several estimation techniques have been used by different researchers. For example, Escalante and Barry (2001) used simulation/optimization models to substantiate the theoretical coaction between risk balancing and risk mitigation strategies. Besides, Escalante and Barry (2003) implemented correlation relationship analysis to explore the risk balancing behavior as farmers' strategic capital adjustments. Turvey and Kong (2009) utilized linear regression analysis to show strong proof of negative correlation between financial risk and business risk. Wu et al. (2014) applied conditional quantile regression to study the optimal farm capital structure and factors affecting farmers' financing decisions. More recently, Aderajew (2020) estimated a model with a fixed effects panel-regression to analyze the role of latent heterogeneity in risk balancing framework.

The empirical models explored in this study will vary in a few dimensions: (1) to reveal risk balancing behavior and liquidity implications for farmers, we use three different panel data estimation techniques, i.e. random effects, one-way fixed effects, and two-way fixed effects models; (2) to better capture farmers risk preferences, we include different combinations of variables based on (i) income and wealth and (ii) market and cost values. Taking advantage of these dimensions, we intend to examine the relationship between current ratio and business risk, current ratio and the expected return to assets, and financial risk and business risk. Our first set of estimated equations will be random effects (3.26), one-way fixed effects (3.27), and two-way fixed effects (3.28) models to reveal the relationship between current ratio and business risk, viz.:

$$CR_{i,t} = \beta_1 BR_{i,t} + \beta_2 FarmProfitability_{i,t} + \beta_3 Subsidies_{i,t} + \beta_4 Experience_{i,t} + \beta_5 Experience_{i,t}^2 + \chi_i + \varepsilon_{i,t} \tag{3.26}$$

$$CR_{i,t} = \beta_1 BR_{i,t} + \beta_2 FarmProfitability_{i,t} + \beta_3 Subsidies_{i,t} + \beta_4 Experience_{i,t} + \beta_5 Experience_{i,t}^2 + \alpha_i + \varepsilon_{i,t} \tag{3.27}$$

$$CR_{i,t} = \beta_1 BR_{i,t} + \beta_2 FarmProfitability_{i,t} + \beta_3 Subsidies_{i,t} + \beta_4 Experience_{i,t} + \beta_5 Experience_{i,t}^2 + \alpha_i + \Gamma_t + \varepsilon_{i,t} \tag{3.28}$$

where i and t are index state and year, respectively; χ_i are state-specific random effects; α_i are state-specific fixed effects; Γ_t are year dummies; and $\varepsilon_{i,t}$ are error terms.

Similarly, the linkage between current ratio and the expected return to assets will be estimated as follows:

$$CR_{i,t} = \beta_1 MeanRoA_{i,t} + \beta_2 FarmProfitability_{i,t} + \beta_3 Subsidies_{i,t} + \beta_4 Experience_{i,t} + \beta_5 Experience_{i,t}^2 + \chi_i + \varepsilon_{i,t} \quad (3.\ 29)$$

$$CR_{i,t} = \beta_1 MeanRoA_{i,t} + \beta_2 FarmProfitability_{i,t} + \beta_3 Subsidies_{i,t} + \beta_4 Experience_{i,t} + \beta_5 Experience_{i,t}^2 + \alpha_i + \varepsilon_{i,t} \quad (3.\ 30)$$

$$CR_{i,t} = \beta_1 MeanRoA_{i,t} + \beta_2 FarmProfitability_{i,t} + \beta_3 Subsidies_{i,t} + \beta_4 Experience_{i,t} + \beta_5 Experience_{i,t}^2 + \alpha_i + \Gamma_t + \varepsilon_{i,t} \quad (3.\ 31)$$

With regards to the relationship between financial risk and business risk, we will have two slightly different sets of regression models: (i) the first one will regress financial risk on current year business risk, (ii) the second set of models will test the relationship between financial risk and one-year lagged business risk. Some studies affirm that it takes time for farms to respond to changes in business risk; thus, we will also examine the lead-lag effect between financial risk and business risk.

The first set of models are:

$$FR_{i,t} = \beta_1 BR_{i,t} + \beta_2 FarmProfitability_{i,t} + \beta_3 Subsidies_{i,t} + \beta_4 Experience_{i,t} + \beta_5 Experience_{i,t}^2 + \chi_i + \varepsilon_{i,t} \quad (3.\ 32)$$

$$FR_{i,t} = \beta_1 BR_{i,t} + \beta_2 FarmProfitability_{i,t} + \beta_3 Subsidies_{i,t} + \beta_4 Experience_{i,t} + \beta_5 Experience_{i,t}^2 + \alpha_i + \varepsilon_{i,t} \quad (3.\ 33)$$

$$FR_{i,t} = \beta_1 BR_{i,t} + \beta_2 FarmProfitability_{i,t} + \beta_3 Subsidies_{i,t} + \beta_4 Experience_{i,t} + \beta_5 Experience_{i,t}^2 + \alpha_i + \Gamma_t + \varepsilon_{i,t}$$

(3. 34)

The second series are as follows:

$$FR_{i,t} = \beta_1 BR_{i,t-1} + \beta_2 FarmProfitability_{i,t} + \beta_3 Subsidies_{i,t} + \beta_4 Experience_{i,t} + \beta_5 Experience_{i,t}^2 + \chi_i + \varepsilon_{i,t}$$

(3. 35)

$$FR_{i,t} = \beta_1 BR_{i,t-1} + \beta_2 FarmProfitability_{i,t} + \beta_3 Subsidies_{i,t} + \beta_4 Experience_{i,t} + \beta_5 Experience_{i,t}^2 + \alpha_i + \varepsilon_{i,t}$$

(3. 36)

$$FR_{i,t} = \beta_1 BR_{i,t-1} + \beta_2 FarmProfitability_{i,t} + \beta_3 Subsidies_{i,t} + \beta_4 Experience_{i,t} + \beta_5 Experience_{i,t}^2 + \alpha_i + \Gamma_t + \varepsilon_{i,t}$$

(3. 37)

4. EMPIRICAL RESULTS

4.1. Summary Statistics

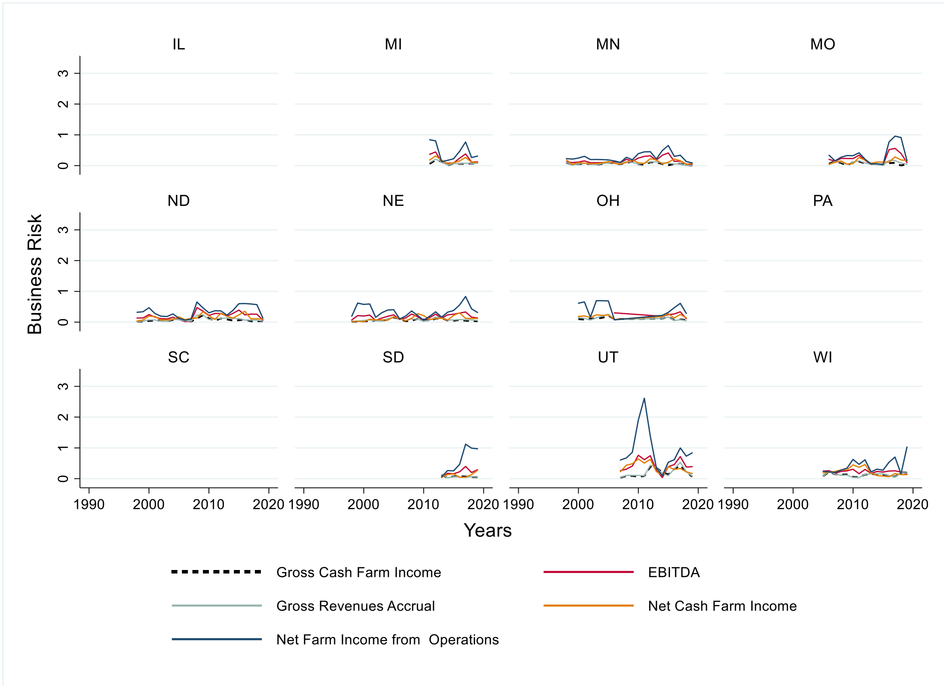

Figure 1. Time Trend of Business Risk by State, Based upon Five Alternative Income Measures

Figure 1 illustrates how business risk measures calculated using five income categories vary in each state during the period 1990-2019. Business risk in this study is calculated as the coefficient of variation in income in three consecutive years, as most of the empirical studies on risk balancing have adopted. For Illinois, four nonconsecutive observations are available for years 2011, 2012, 2014, and 2015 in the dataset, and only two observations exist for South Caroline, i.e. 2005 and 2017. Therefore, business risk cannot be calculated for Illinois and South Caroline. Additionally, although four years of consecutive data are present in the dataset for Pennsylvania between 2016 and 2019, only one observation for business risk can be measured, and it cannot be reflected in Figure 1. As the figure shows, business risk based on gross cash farm income and gross revenues accrual resemble each other closely, and business risk based on EBITDA, net cash farm income, and net farm income from operations differ appreciably from one another in their time trend. Along with its differences through the medium of income categories, business risk further shows varying trend in each state, suggesting that the temporal changes in business risk depend on factors both at the national level and the state level. For example, comparing Nebraska, Minnesota, and North Dakota, it is evident that business risk in Nebraska has been unstable since the end of 1990s through 2019, but it only started to noticeably fluctuate after 2008 in Minnesota and North Dakota. Such a situation can arise from the state level factors, such as weather, commodity prices, capital and markets, cost of land, transport, etc., affecting business risk in Nebraska, but not in Minnesota and North Dakota. Similarly, the more volatile business risk in Minnesota and North Dakota after 2008 may be resembling the similar state level factors that affect agricultural activity in both states, and business risk consequently.

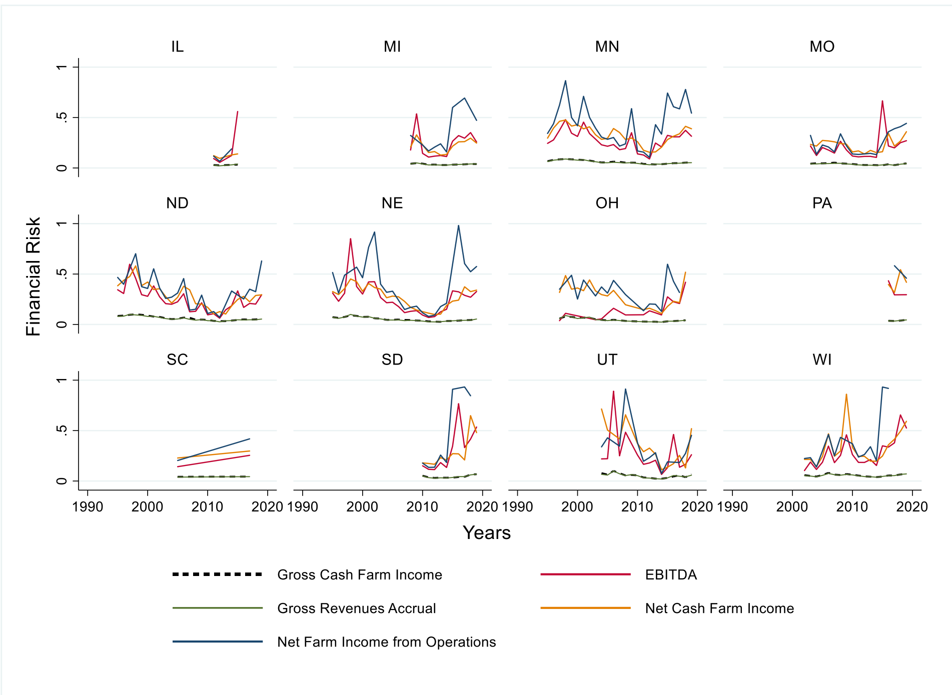

Figure 2. Time Trend of Financial Risk by State, Based upon Five Alternative Income Measures

Figure 2 exhibits the time trend of financial risk based on five alternative income measures in each state. Although there are small variations in some states, financial risk calculated using gross cash farm income and gross revenues accrual almost overlap with each other and follow the same trend. It should be underlined that the financial risk based on net farm income from operations has been more volatile than the financial risk based on other income measures. The non-uniform patterns of financial risk in Figure 5 reveal how the different definitions of income can reveal different effects for the same measure of risk. It is, therefore, imperative to use different income categories to model our hypotheses and to compare the empirical results to deduce whether income measures alter decision makers' risk balancing behavior.

Figure 3 and Figure 4 illustrate the variability of farm profitability calculated using market and cost values over time. These two figures both indicate that farm profitability have three different patterns. Firstly, farm profitability estimated using gross cash farm income and gross revenues accrual follow a similar flow over time in all states. The second trend group consists of EBITDA and net farm income from operations, and they display analogous progress throughout years in all states except Ohio. Lastly, farm profitability premised on net cash farm income exhibits a unique time pattern.

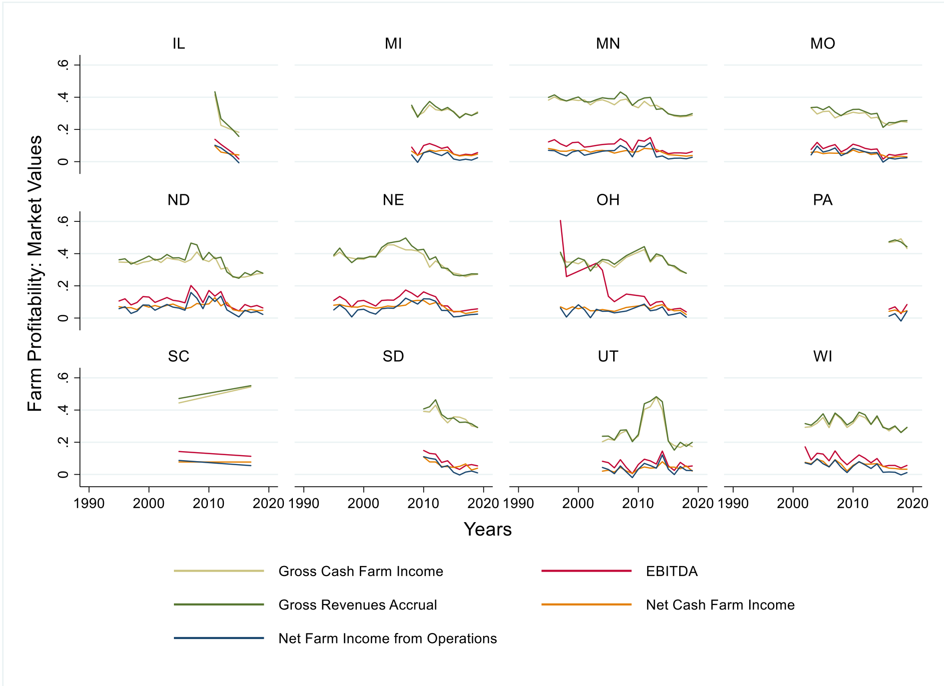

Figure 3. Time Trend of Market Farm Profitability by State, Based upon Five Alternative Income Measures

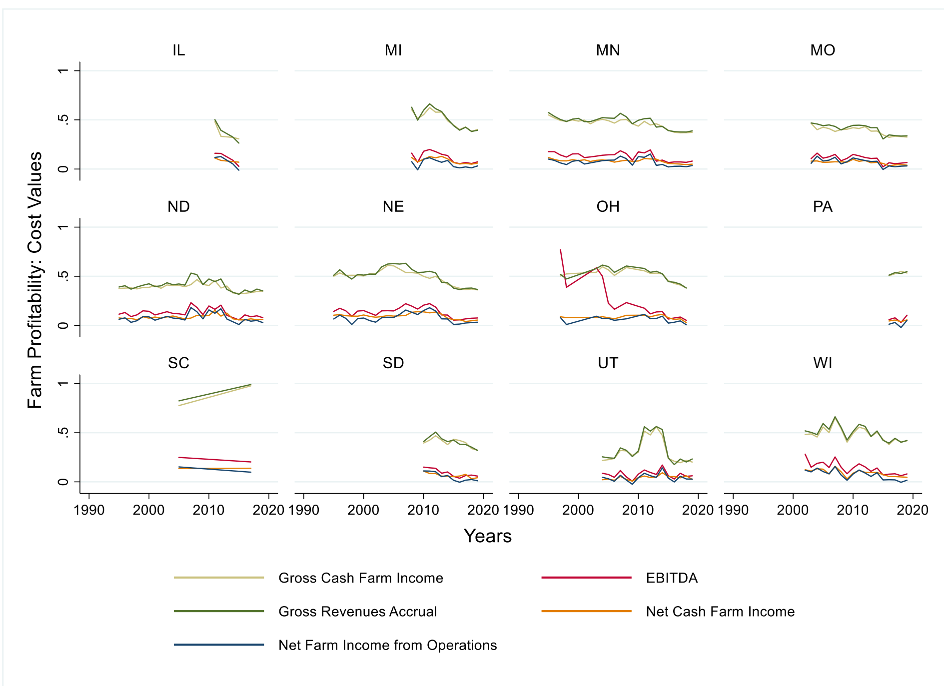

Figure 4. Time Trend of Cost Farm Profitability by State, Based upon Five Alternative Income Measures

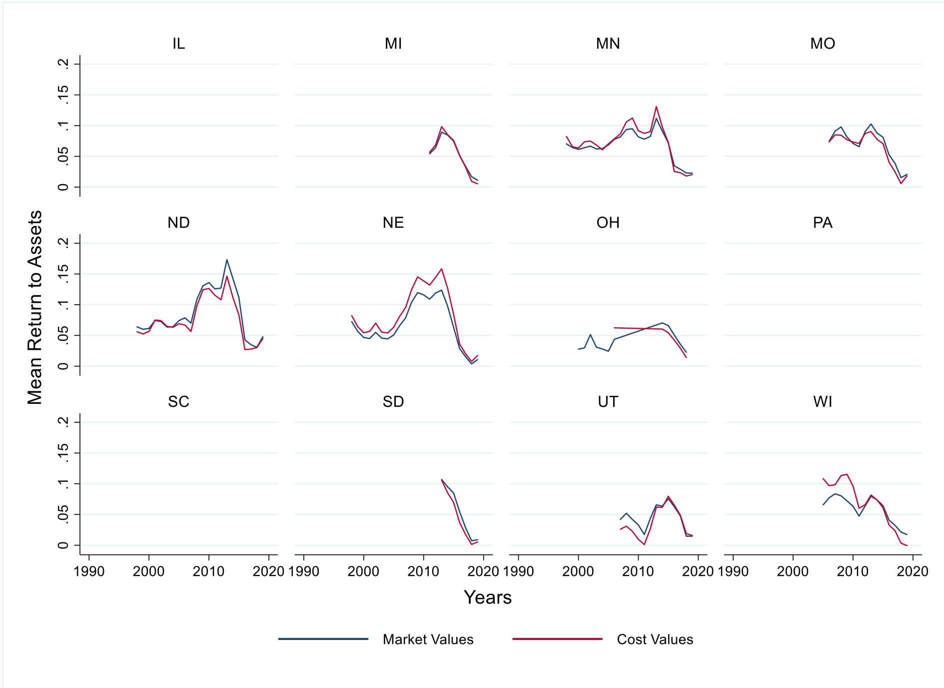

Figure 5. Time Trend of Mean Returns to Assets by State, Based upon Market and Cost Values

Figure 5 shows how market and cost values of mean return to assets vacillate in the dataset. It can be inferred that mean return to assets have distinct time trends in each state; however, market and cost values does not deviate from each other significantly. It is apparent from the five figures in this section that there are some similarities and differences among the states. To illustrate, the time trend of financial risk estimated using gross cash farm income and gross revenues accrual in Figure 2 exhibits the same pattern in all states, but the time trend of financial risk estimated using EBITDA, net cash farm income, or net farm income from operations differs appreciably among states. This comparison based on five income categories implies the importance of more in-depth discussion about the concept of income in farm economy. Some national and state level factors jointly affect all categories of farm income, and it can be interpreted as factors leading to overall increase in farm income. More effective irrigation, better fertilizer application, intensity of cultivation, or capital efficiency can be examples of such factors. On the other hand, some national and state level factors only affect specific income categories but not others. For instance, a change in interest rates, whether at the national or state level, would substantially affect the net farm income since interest receivables and interest payables are taken into account while calculating the net farm income. However, a change in interest rates would hardly, if at all, affect EBITDA or gross revenues. It should be noted that we are concerned with the direct effect of an interest rates on farm income. Government subsidies, income tax rates, and depreciation practices can also be examples of factors that only disturb specific income categories. Therefore, future studies need to focus on not only the national level and the state level factors, but also the effect of these factors on different income categories to better reflect risk balancing behavior of farmers.

Additionally, Table 2, Table 3, Table 4, Table 5, and Table 6 present summary statistics for our variables. For example, average experience is 24.3 years with a minimum of 17.1 and a maximum of 34.3, the average current ratio is about 1.97 changing between 0.98 and 4.14.

Table 2. Summary Statistics for Business Risk

Variable	Observations	Mean	Std. Dev.	Min.	Max.
Gross Cash Farm Income	137	0.0902	0.0694	0.0023	0.4278
EBITDA	131	0.2273	0.1420	0.0192	0.7618
Gross Revenues Accrual	137	0.1009	0.0766	0.0046	0.5274
Net Cash Farm Income	137	0.1685	0.1160	0.0127	0.6420
Net Farm Income from Operations	137	0.4501	0.4230	0.0360	3.2763

Table 3. Summary Statistics for One-Year Lagged Business Risk

Variable	Observations	Mean	Std. Dev.	Min.	Max.
Gross Cash Farm Income	126	0.0922	0.0707	0.0023	0.4278
EBITDA	120	0.2312	0.1436	0.0192	0.7618
Gross Revenues Accrual	126	0.1040	0.0781	0.0046	0.5274
Net Cash Farm Income	126	0.1714	0.1197	0.0127	0.6420
Net Farm Income from Operations	126	0.4301	0.3465	0.0360	2.6128

Table 4. Summary Statistics for Financial Risk

Variable	Observations	Mean	Std. Dev.	Min.	Max.
Gross Cash Farm Income	177	0.0507	0.0181	0.0227	0.1003
EBITDA	171	0.2496	0.1476	0.0379	0.8907
Gross Revenues Accrual	177	0.0491	0.0178	0.0201	0.1003
Net Cash Farm Income	175	0.2895	0.1287	0.0948	0.8610
Net Farm Income from Operations	154	0.3592	0.2128	0.0658	0.9823

Table 5. Summary Statistics for Farm Profitability (Market and Cost Values)

Variable	Observations	Mean	Std. Dev.	Min.	Max.
Market: Gross Cash Farm Income	177	0.3313	0.0666	0.1678	0.5442
Market: EBITDA	173	0.0963	0.0605	0.0053	0.6061
Market: Gross Revenues Accrual	177	0.3430	0.0724	0.1509	0.5516
Market: Net Cash Farm Income	177	0.0589	0.0205	0.0065	0.1271
Market: Net Farm Income from Operations	177	0.0500	0.0334	-0.0197	0.1592
Cost: Gross Cash Farm Income	173	0.4438	0.1032	0.1951	0.9769
Cost: EBITDA	173	0.1301	0.0870	0.0067	0.7695
Cost: Gross Revenues Accrual	173	0.4595	0.1099	0.1762	0.9902
Cost: Net Cash Farm Income	173	0.0791	0.0288	0.0083	0.1589
Cost: Net Farm Income from Operations	173	0.0667	0.0437	-0.0250	0.1819

Table 6. Summary Statistics for Remaining Variables

Variable	Observations	Mean	Std. Dev.	Min.	Max.
Current Ratio	177	1.9732	0.5572	0.98	4.14
Mean Returns to Assets: Market	137	0.0631	0.0324	0.0037	0.1733
Mean Returns to Assets: Cost	131	0.0652	0.0369	-0.0007	0.1583
Subsidies	177	3.6502	0.7584	0.4042	5.9918
Experience	177	24.2853	3.7170	17.1	34.3
$Experience^2$	177	603.4698	183.3086	292.41	1176.49

4.2. Empirical Estimation

We estimate four sets of models to analyze the relationship between four pairs of variables: (1) current ratio and business risk; (2) current ratio and expected returns; (3) financial risk and business risk; and (4) financial risk and one-year lagged business risk. As mentioned in the previous sections, farmers' responses to business risk shocks require a comparatively long period of time; thus, we regress financial risk on one-year lagged business risk to show a lead-lag relationship between financial risk and business risk. The main reason why we cannot include longer lags of business risk is the limited number of observations in our dataset. However, two or longer lags of business risk can also be included in this model with more comprehensive dataset in hand.

Moreover, since our panel data includes 12 states and each state has different state level factors affecting farm income and farming practices, it is self-evident that there will be fixed or non-random effects affecting our empirical results. Therefore, in addition to the random effect model, we will estimate a one-way fixed effect model to control for these state-specific fixed effects and improve final results. In conjunction with random and one-way fixed effects models, we will further apply a two-way fixed effect estimation method to adjust for time-specific effects. For each set of the models, we compare results from three panel data estimation techniques, i.e. random effects, one-way fixed effects, and two-way fixed effects models, to reveal statistically significant evidence.

4.2.1. Current Ratio on Business Risk

Regression outputs that estimate the relationship between current ratio and business risk are presented in five tables, and each table displays one of five income categories. To begin with, Table 7 exhibits the regression results for (3.26), (3.27), and (3.28) when the income category is set to gross cash farm income. There are six models in the table: the first three columns represent the models when the farm profitability is calculated based on market values, and the last three columns display models with cost-based farm profitability. With that in mind, business risk appears to have a statistically significant effect at the 5% significance level for random effects (1) and one-way fixed effects (2) models with market farm profitability, and the coefficients are 1.768 and 1.816 respectively. When the market profitability is estimated using cost values, the coefficients for business risk decreases to 1.621 and 1.625 for RE (4) and one-way FE (5) models accordingly, but the statistical significance increases from 5% to 1%. For the two-way FE models, coefficient estimates for business risk are still positive at 0.924 and 0.769 for market (3) and cost (6) farm profitability values respectively, but none of them are statistically significant at the 10%.

Table 7. Regression Results for Current Ratio: Gross Cash Farm Income

Income Measure: Gross Cash Farm Income	(1)	(2)	(3)	(4)	(5)	(6)
Variable	RE	One-way FE	Two-way FE	RE	One-way FE	Two-way FE
Business Risk	1.768**	1.816**	0.924	1.621***	1.625***	0.769
	(0.867)	(0.561)	(0.638)	(0.553)	(0.437)	(0.576)
Farm Profitability: Market	-0.283	0.522	-1.165			
	(0.388)	(0.902)	(1.679)			
Farm Profitability: Cost				1.255	1.228	-0.396
				(0.858)	(0.912)	(1.631)
Subsidies	-0.214**	-0.184*	0.140	-0.192**	-0.175*	0.162
	(0.0881)	(0.0838)	(0.123)	(0.0842)	(0.0812)	(0.125)
Experience	-0.0517	0.224	0.0539	0.122	0.197	0.0473
	(0.336)	(0.360)	(0.117)	(0.350)	(0.375)	(0.158)
$Experience^2$	0.00209	-0.00437	-0.000880	-0.00159	-0.00340	-0.000750
	(0.00691)	(0.00722)	(0.00273)	(0.00716)	(0.00754)	(0.00359)
Constant	2.699	-0.491	0.519	0.0125	-0.819	0.295
	(4.069)	(4.597)	(1.295)	(4.430)	(4.793)	(1.694)
Observations	137	137	137	134	134	134
R-squared		0.160	0.628		0.201	0.632
Number of States	10	10	10	10	10	10

Robust standard errors in parentheses. Notes: ***, **, * denote significance at 1%, 5% and 10% level, respectively. Coefficients of year dummies have not been reported for simplicity in two-way fixed effects models.

From Table 7, market-based farm profitability has a negative effect on current ratio around -0.283 for RE model (1). Although the coefficient of market farm profitability seems to be positive for one-way FE model (2), it becomes negative once we include year dummies for two-way FE model (3). Apropos of cost-based farm profitability, the coefficients are positive at about 1.255 and 1.228 for RE (4) and one-way FE (5) models respectively, but it is negative for two-way FE (6) model. i.e. -0.396. Despite their economic effect, none of the farm profitability coefficients are statistically significant. For both of farm profitability measures, the variable subsidies has a statistically significant negative coefficient under in RE models in (1) and (4) and in one-way fixed effect models in (2) and (5) in Table 7. However, coefficients of subsidies show positive effects in two-way FE models in (3) and (6), but they are not statistically significant. Experience has a consistent positive impact on current ratio with decreasing marginal effect for all models, except RE model (1) with market-based farm profitability.

Table 8. Regression Results for Current Ratio: EBITDA

Income Measure: EBITDA	(1)	(2)	(3)	(4)	(5)	(6)
Variable	RE	One-way FE	Two-way FE	RE	One-way FE	Two-way FE
Business Risk	0.228	0.232	-0.380	0.177	0.172	-0.439**
	(0.348)	(0.340)	(0.234)	(0.320)	(0.316)	(0.178)
Farm Profitability: Market	6.483***	6.768***	7.658***			
	(0.820)	(0.883)	(1.323)			
Farm Profitability: Cost				5.342***	5.405***	6.772***
				(0.748)	(0.751)	(0.999)
Subsidies	-0.137*	-0.136	0.0936	-0.128	-0.126	0.0812
	(0.0823)	(0.0830)	(0.0640)	(0.0840)	(0.0836)	(0.0540)
Experience	0.269	0.329	0.0950	0.258	0.297	0.0787
	(0.349)	(0.350)	(0.0940)	(0.310)	(0.323)	(0.0786)
$Experience^2$	-0.00465	-0.00600	-0.00219	-0.00432	-0.00516	-0.00166
	(0.00702)	(0.00691)	(0.00198)	(0.00617)	(0.00633)	(0.00159)
Constant	-1.821	-2.557	-0.472	-1.824	-2.333	-0.397
	(4.393)	(4.508)	(1.284)	(3.973)	(4.236)	(1.086)
Observations	131	131	131	131	131	131
R-squared		0.392	0.753		0.438	0.786
Number of States	10	10	10	10	10	10

Robust standard errors in parentheses. Notes: ***, **, * denote significance at 1%, 5% and 10% level, respectively. Coefficients of year dummies have not been reported for simplicity in two-way fixed effects models.

Table 8 presents the estimated coefficients for (3.26), (3.27), and (3.28) when the income measure is EBITDA. Business risk exhibits positive effect on current ratio for RE (1) (4) and one-way FE models (2) (5), but coefficients are not statistically significant. Interestingly, business risk has negative effects on current ratio for two-way FE models (3) (6), and the coefficient of business risk in cost-based farm profitability model (6) is statistically significant at 5%. Farm profitability based on both market and cost values have positive coefficients which are statistically significant at 1%. Subsidies has negative coefficients for RE and one-way FE models and positive ones for two-way FE models, but only one of them in (1) presents statistical significance at 10%. Experience has a consistent positive impact on current ratio with decreasing marginal effects, but it does not show any statistical significance.

Table 9. Regression Results for Current Ratio: Gross Revenues Accrual

Income Measure: Gross Revenues Accrual	(1)	(2)	(3)	(4)	(5)	(6)
Variable	RE	One-way FE	Two-way FE	RE	One-way FE	Two-way FE
Business Risk	1.479**	1.276**	0.355	1.165***	1.074**	0.246
	(0.748)	(0.466)	(0.459)	(0.406)	(0.341)	(0.453)
Farm Profitability: Market	0.281	1.407	-0.304			
	(0.385)	(0.924)	(1.470)			
Farm Profitability: Cost				1.584**	1.662*	0.211
				(0.761)	(0.815)	(1.481)
Subsidies	-0.205**	-0.160*	0.173	-0.175**	-0.155*	0.181
	(0.0866)	(0.0831)	(0.143)	(0.0836)	(0.0827)	(0.148)
Experience	-0.148	0.247	0.0854	0.108	0.197	0.0585
	(0.324)	(0.359)	(0.131)	(0.330)	(0.354)	(0.161)
$Experience^2$	0.00413	-0.00467	-0.00154	-0.00128	-0.00327	-0.000936
	(0.00663)	(0.00718)	(0.00290)	(0.00677)	(0.00711)	(0.00354)
Constant	3.583	-1.226	-0.237	-0.0315	-1.144	-0.170
	(3.913)	(4.576)	(1.614)	(4.149)	(4.521)	(1.876)
Observations	137	137	137	134	134	134
R-squared		0.182	0.614		0.238	0.626
Number of States	10	10	10	10	10	10

Robust standard errors in parentheses. Notes: ***, **, * denote significance at 1%, 5% and 10% level, respectively. Coefficients of year dummies have not been reported for simplicity in two-way fixed effects models.

For gross revenues accrual, the results for (3.26), (3.27), and (3.28) are shown in Table 9. Business risk is positively correlated to current ratio in all models; moreover, RE and one-way FE models show statistical significance at 5% in (1), (2), and (5) and at 1% in (4) in Table 9, while two-way FE models are not statistically significant. Market- and cost-based farm profitability also have positive coefficients except market farm profitability in two-way FE model (3), and only two of the coefficients are statistically significant, i.e. at 5% in (4) and at 10% in (5) models in Table 9. In RE and one-way FE models, subsidies have statistically significant negative coefficients, while those of two-way FE models are positive and not statistically significant. Experience has positive coefficients with decreasing marginal effects in all models except market farm profitability RE model (1), in which the coefficient is negative with increasing marginal effects, and none of these shows statistical significance.

Table 10. Regression Results for Current Ratio: Net Cash Farm Income

Income Measure: Net Cash Farm Income	(1)	(2)	(3)	(4)	(5)	(6)
Variable	RE	One-way FE	Two-way FE	RE	One-way FE	Two-way FE
Business Risk	0.575*	0.537*	-0.299**	0.438	0.402	-0.393**
	(0.333)	(0.286)	(0.119)	(0.271)	(0.244)	(0.159)
Farm Profitability: Market	13.20***	14.12***	10.70***			
	(1.824)	(1.959)	(2.314)			
Farm Profitability: Cost				10.69***	10.96***	8.494***
				(1.689)	(1.759)	(2.039)
Subsidies	-0.0531	-0.0454	0.197***	-0.0497	-0.0396	0.197***
	(0.0638)	(0.0598)	(0.0457)	(0.0613)	(0.0571)	(0.0472)
Experience	0.353	0.453	0.218	0.319	0.383	0.157
	(0.323)	(0.341)	(0.173)	(0.284)	(0.318)	(0.163)
Experience^2	-0.00627	-0.00847	-0.00446	-0.00544	-0.00673	-0.00295
	(0.00642)	(0.00653)	(0.00345)	(0.00560)	(0.00607)	(0.00323)
Constant	-3.419	-4.672	-2.416	-3.170	-4.055	-1.846
	(4.101)	(4.480)	(2.269)	(3.696)	(4.267)	(2.154)
Observations	137	137	137	134	134	134
R-squared		0.448	0.737		0.498	0.766
Number of States	10	10	10	10	10	10

Robust standard errors in parentheses. Notes: ***, **, * denote significance at 1%, 5% and 10% level, respectively. Coefficients of year dummies have not been reported for simplicity in two-way fixed effects models.

Table 10 displays regression results for (3.26), (3.27), and (3.28) when the income measured based on net cash farm income. It can be seen from Table 10 that business risk is positively correlated to current ratio in RE models in (1) and (4) and one-way FE models in (2) and (5) in Table 10, but the coefficient is negative in two-way FE models in (3) and (6). Surprisingly, coefficients in (3) and (6) models exhibit statistical significance at 5%, while those in (1) and (2) are only statistically significant at 10%. The estimates for farm profitability are all positive and statistically significant at 1%. Similarly, coefficients of experience are all positive with decreasing marginal effects, but they do not demonstrate statistical significance. Subsidies has positive coefficients being 0.197 in both (3) and (6) models, they are statistically significant at 1%. However, subsidies impact current ratio negatively with no statistical significance in RE and one-way FE models, i.e. (1), (2), (4), and (5) in Table 10.

Empirical results for (3.26), (3.27), and (3.28) when income criterion is specified as net farm income from operations is presented in Table 11. The fact that business risk has negative coefficients for all models in Table 11 is intriguing. Except the model in (1), coefficients of business risk show statistical significance at different levels. Once more, farm profitability has positive coefficients in all models, and all of them are statistically significant at 1%. In RE and one-way FE models, i.e. (1), (2), (4), and (5) in Table11, subsidies exhibit negative coefficients, but no statistical significance. Subsidies has positive coefficients in two-way FE models, and they are statistically significant at 5% and 1% in (3) and (6) respectively. Experience has positive effect on current ratio with diminishing marginal effects in all models and with 10% and 5% statistical significance in (3) and (6) models accordingly.

Table 11. Regression Results for Current Ratio: Net Farm Income from Operations

Income Measure: Net Farm Income from Operations	(1)	(2)	(3)	(4)	(5)	(6)
Variable	RE	One-way FE	Two-way FE	RE	One-way FE	Two-way FE
Business Risk	-0.119	-0.158*	-0.242**	-0.142**	-0.171**	-0.234***
	(0.0775)	(0.0772)	(0.0832)	(0.0659)	(0.0743)	(0.0628)
Farm Profitability: Market	6.999***	7.844***	7.015***			
	(0.778)	(1.031)	(1.447)			
Farm Profitability: Cost				6.043***	6.197***	6.261***
				(0.619)	(0.679)	(0.979)
Subsidies	-0.0774	-0.0837	0.120**	-0.0777	-0.0781	0.112***
	(0.0594)	(0.0492)	(0.0422)	(0.0566)	(0.0512)	(0.0341)
Experience	0.143	0.325	0.192*	0.237	0.307	0.179**
	(0.328)	(0.278)	(0.0976)	(0.285)	(0.262)	(0.0763)
Experience^2	-0.00198	-0.00619	-0.00412*	-0.00399	-0.00567	-0.00375*
	(0.00664)	(0.00554)	(0.00208)	(0.00581)	(0.00527)	(0.00172)
Constant	-0.271	-2.203	-1.233	-1.349	-2.111	-1.140
	(3.995)	(3.510)	(1.240)	(3.502)	(3.293)	(0.918)
Observations	137	137	137	134	134	134
R-squared		0.480	0.748		0.514	0.777
Number of States	10	10	10	10	10	10

Robust standard errors in parentheses. Notes: ***, **, * denote significance at 1%, 5% and 10% level, respectively. Coefficients of year dummies have not been reported for simplicity in two-way fixed effects models.

Overall, signs and statistical significance of coefficients of business risk when income measure is set to gross cash farm income, EBITDA, gross revenues accrual, and net cash farm income conform with our theoretical propositions from (3.18) with some exceptions. Nevertheless, results from Table 11 in which income category is net farm income from operations contradict our theoretical derivations by having negative coefficients for business risk and implying a negative relationship between current ratio and business risk. This contrasting result when the income category set to net farm income from operations may stem from the national or state level factors affecting one income category but not others. As it is mentioned in previous sections, future studies need to focus more on different income categories and explore how empirical results may change among various income categories.

4.2.2. Current Ratio on Mean Returns

Estimated results for (3.29), (3.30), and (3.31) will be presented under this section in a similar way as in the previous section. One important distinction is that our main interest variable, i.e. mean returns to assets, is calculated in two ways using market and cost values being similar to that of farm profitability. Initially, Table 12 presents estimated coefficients when income measure is gross cash farm income. Mean returns to assets are positive and statistically significant at the 1% significance level in RE and one-way FE models, i.e. (1), (2), (4), and (5). The estimated coefficient in (3) and (6) are positive, but just one in (6) has statistical significance at 5%. Other independent variables do not show statistical significance at any level. Experience has positive effect on current ratio with diminishing marginal effects in all models, but farm profitability and subsidies do not have a consistent pattern for its coefficients.

Table 12. Regression Results for Current Ratio: Gross Cash Farm Income

	Market Values			Cost Values		
Income Measure: Gross Cash Farm Income	(1)	(2)	(3)	(4)	(5)	(6)
Variable	RE	One-way FE	Two-way FE	RE	One-way FE	Two-way FE
Mean Returns to Assets	7.988***	8.243***	5.945	7.003***	7.132***	6.446**
	(1.663)	(1.833)	(4.795)	(1.214)	(1.261)	(2.619)
Farm Profitability	-0.556	0.125	-0.428	0.493	0.467	0.201
	(0.496)	(0.586)	(1.190)	(0.740)	(0.694)	(1.186)
Subsidies	0.0186	0.0274	0.179	-0.0336	-0.0290	0.128
	(0.0484)	(0.0609)	(0.111)	(0.0736)	(0.0726)	(0.0969)
Experience	0.117	0.338	0.124	0.331	0.370	0.143
	(0.291)	(0.238)	(0.137)	(0.221)	(0.208)	(0.139)
$Experience^2$	-0.00128	-0.00629	-0.00248	-0.00574	-0.00660	-0.00284
	(0.00591)	(0.00475)	(0.00280)	(0.00449)	(0.00420)	(0.00295)
Constant	-0.456	-3.111	-0.914	-3.087	-3.596	-1.277
	(3.626)	(3.071)	(1.757)	(2.967)	(2.830)	(1.666)
Observations	137	137	137	131	131	131
R-squared		0.378	0.661		0.431	0.705
Number of States	10	10	10	10	10	10

Robust standard errors in parentheses. Notes: ***, **, * denote significance at 1%, 5% and 10% level, respectively. Coefficients of year dummies have not been reported for simplicity in two-way fixed effects models.

Table 13 illustrates empirical relationship between current ratio and mean returns to assets when EBITDA is used as income measure. Our interest variable, mean returns to assets, has positive coefficients in all models and indicate statistical significance at the 1% level in (1), (2), (4), and (5) and 10% in (6). Farm profitability is positive and statistically significant at the 1% in all models, while experience has decreasing marginal effects with positive coefficients, but no statistical significance. The variable subsidies have negative coefficients in RE and one-way FE models, but positive ones in two-way FE models.

Table 13. Regression Results for Current Ratio: EBITDA

	Market Values			Cost Values		
Income Measure: EBITDA	(1)	(2)	(3)	(4)	(5)	(6)
Variable	RE	One-way FE	Two-way FE	RE	One-way FE	Two-way FE
Mean Returns to Assets	6.902***	7.189***	5.660	5.144***	5.214***	4.074*
	(1.449)	(1.516)	(4.230)	(0.959)	(0.998)	(2.150)
Farm Profitability	2.363***	3.126**	3.421**	3.793***	3.848***	6.003***
	(0.621)	(1.073)	(1.352)	(0.756)	(0.733)	(1.060)
Subsidies	-0.0209	-0.00583	0.118	-0.0367	-0.0333	0.0512
	(0.0650)	(0.0637)	(0.0825)	(0.0722)	(0.0714)	(0.0597)
Experience	0.0729	0.291	0.0525	0.337	0.373	0.124
	(0.290)	(0.249)	(0.121)	(0.213)	(0.214)	(0.0936)
$Experience^2$	-0.000296	-0.00501	-0.00123	-0.00577	-0.00654	-0.00264
	(0.00584)	(0.00503)	(0.00265)	(0.00424)	(0.00420)	(0.00178)
Constant	-0.159	-2.795	-0.174	-3.299	-3.825	-1.040
	(3.625)	(3.189)	(1.798)	(2.826)	(2.898)	(1.324)
Observations	134	134	134	131	131	131
R-squared		0.494	0.726		0.572	0.804
Number of States	10	10	10	10	10	10

Robust standard errors in parentheses. Notes: ***, **, * denote significance at 1%, 5% and 10% level, respectively. Coefficients of year dummies have not been reported for simplicity in two-way fixed effects models.

Table 14 exhibits regression outputs when the income is measured using gross revenues accrual. Mean returns to assets have positive coefficients in all models and demonstrate statistical significance at 1% in and 5% in (1), (2), (4), and (5) and 5% in (6). Farm profitability and experience have positive effects on current ratio, but none of their coefficients is statistically significant in any models. Estimated coefficients for subsidies are positive for all models using market values with no statistical significance, but those of cost values are negative in (4) and (5) and positive in (6).

Table 14. Regression Results for Current Ratio: Gross Revenues Accrual

	Market Values			Cost Values		
Income Measure: Gross Revenues Accrual	(1)	(2)	(3)	(4)	(5)	(6)
Variable	RE	One-way FE	Two-way FE	RE	One-way FE	Two-way FE
Mean Returns to Assets	7.574***	7.868***	6.238	6.618***	6.717***	6.681**
	(1.623)	(1.797)	(4.780)	(1.303)	(1.359)	(2.556)
Farm Profitability	0.136	0.950	0.220	0.979	1.001	0.691
	(0.508)	(0.714)	(1.200)	(0.699)	(0.688)	(1.247)
Subsidies	0.0149	0.0343	0.185	-0.0256	-0.0191	0.121
	(0.0546)	(0.0633)	(0.108)	(0.0766)	(0.0756)	(0.100)
Experience	0.0705	0.359	0.134	0.325	0.368	0.139
	(0.297)	(0.251)	(0.154)	(0.216)	(0.211)	(0.142)
$Experience^2$	-0.000262	-0.00659	-0.00274	-0.00554	-0.00643	-0.00276
	(0.00601)	(0.00497)	(0.00307)	(0.00438)	(0.00423)	(0.00293)
Constant	-0.138	-3.723	-1.277	-3.296	-3.907	-1.425
	(3.704)	(3.242)	(1.986)	(2.890)	(2.872)	(1.739)
Observations	137	137	137	131	131	131
R-squared		0.397	0.660		0.458	0.711
Number of States	10	10	10	10	10	10

Robust standard errors in parentheses. Notes: ***, **, * denote significance at 1%, 5% and 10% level, respectively. Coefficients of year dummies have not been reported for simplicity in two-way fixed effects models.

For net cash farm income category, empirical results are summarized in Table 15. Mean returns to assets are positive and statistically significant at 1% for RE and one-way FE models. With regard to two-way FE models, although economic effect of mean returns to assets weakens compared to RE and one-way FE models and are not statistically significant, they are still positive. Regression results produced positive and statistically significant coefficients for farm profitability at 1%. The variable subsidies has positive and statistically significant coefficients in two-way FE models. Speaking of RE and one-way FE models, its coefficients are positive for market values and negative for cost values with no statistical significance. Lastly, experience has positive coefficients with decreasing marginal effects.

Table 15. Regression Results for Current Ratio: Net Cash Farm Income

	Market Values			Cost Values		
Income Measure: Net Cash Farm Income	(1)	(2)	(3)	(4)	(5)	(6)
Variable	RE	One-way FE	Two-way FE	RE	One-way FE	Two-way FE
Mean Returns to Assets	5.293***	4.767***	1.733	3.927***	3.998***	2.683
	(1.565)	(1.404)	(4.468)	(1.082)	(1.088)	(2.555)
Farm Profitability	7.102***	9.879***	10.21***	7.566***	7.665***	7.461***
	(2.245)	(1.583)	(1.582)	(1.882)	(1.779)	(1.624)
Subsidies	0.0169	0.0235	0.201***	-0.0131	-0.00768	0.164***
	(0.0502)	(0.0492)	(0.0444)	(0.0565)	(0.0533)	(0.0500)
Experience	0.217	0.435	0.225	0.375	0.412	0.172
	(0.300)	(0.281)	(0.169)	(0.231)	(0.236)	(0.143)
Experience^2	-0.00331	-0.00805	-0.00464	-0.00653	-0.00728	-0.00333
	(0.00602)	(0.00543)	(0.00337)	(0.00458)	(0.00459)	(0.00289)
Constant	-2.066	-4.703	-2.619	-3.922	-4.469	-2.004
	(3.780)	(3.654)	(2.213)	(3.050)	(3.176)	(1.891)
Observations	137	137	137	131	131	131
R-squared		0.501	0.737		0.552	0.774
Number of States	10	10	10	10	10	10

Robust standard errors in parentheses. Notes: ***, **, * denote significance at 1%, 5% and 10% level, respectively. Coefficients of year dummies have not been reported for simplicity in two-way fixed effects models.

Table 16 presents regression results for net farm income from operations. Mean returns to assets has positive coefficients at 1% for RE and one-way FE models at around 5.6 for market values and around 4.7 for cost values. For two-way FE models, the coefficients are positive and only significant in (6). Farm profitability is positive and statistically significant at 1% in all models. Experience has positive coefficient with decreasing marginal effect in all models, but its coefficients are statistically significant at 10% in only cost-based models from (4) to (6).

Table 16. Regression Results for Current Ratio: Net Farm Income from Operations

	Market Values			Cost Values		
Income Measure: Net Farm Income from Operations	(1)	(2)	(3)	(4)	(5)	(6)
Variable	RE	One-way FE	Two-way FE	RE	One-way FE	Two-way FE
Mean Returns to Assets	5.621***	5.631***	4.360	4.699***	4.740***	4.094*
	(1.188)	(1.174)	(3.678)	(0.899)	(0.929)	(2.123)
Farm Profitability	5.770***	6.285***	6.996***	4.732***	4.777***	5.854***
	(0.566)	(0.655)	(1.142)	(0.527)	(0.539)	(0.957)
Subsidies	0.0330	0.0294	0.133**	-0.00586	-0.00422	0.0838*
	(0.0521)	(0.0539)	(0.0495)	(0.0616)	(0.0604)	(0.0432)
Experience	0.230	0.340	0.177	0.341*	0.369*	0.190*
	(0.260)	(0.223)	(0.123)	(0.203)	(0.195)	(0.0885)
$Experience^2$	-0.00371	-0.00627	-0.00387	-0.00607	-0.00670	-0.00400*
	(0.00523)	(0.00442)	(0.00245)	(0.00414)	(0.00394)	(0.00179)
Constant	-2.071	-3.282	-1.426	-3.171	-3.567	-1.472
	(3.225)	(2.835)	(1.738)	(2.583)	(2.534)	(1.241)
Observations	137	137	137	131	131	131
R-squared		0.586	0.752		0.613	0.792
Number of States	10	10	10	10	10	10

Robust standard errors in parentheses. Notes: ***, **, * denote significance at 1%, 5% and 10% level, respectively. Coefficients of year dummies have not been reported for simplicity in two-way fixed effects models.

To conclude, mean returns to assets has a positive effect on current ratio for all of income measures in all our models. Regression results in this section does not provide empirical evidence for our theoretical proposition from (3.19) which states that expected return on assets have a negative effect on current ratio. It might be the case that farmers' expectations are formed by current business environment, and mean returns to assets, as a result, is not a good proxy for expected return on assets; thus, the theory and the empirical results contradict each other. On the other hand, it is also possible that a negative relationship between current ratio and expected return on assets simply does not exist.

4.2.3. Financial Risk on Business Risk

We explore the relationship between financial risk and business risk in this section to test and to validate Gabriel and Baker's (1980) risk balancing hypothesis. Table 17 sums up estimated coefficients in (3.32), (3.33), and (3.34) when income measure is gross cash farm income. We can notice the empirical evidence for risk balancing: coefficients of business risk are negative in all models, and coefficients in RE and one-way FE models, i.e. (1), (2), (4), and (5), are statistically significant at 1%. Cost-based farm profitability has negative coefficients, and one in two-way FE model (6) displays statistically significance at 1%. Subsidies is positive and statistically significant at 1% in RE and one-way FE models. Experience is positive with diminishing marginal effects in two-way FE models, and it is statistically significant at 5% and 1% in (3) and (6) respectively.

Table 17. Regression Results for Financial Risk: Gross Cash Farm Income

Income Measure: Gross Cash Farm Income	(1)	(2)	(3)	(4)	(5)	(6)
Variable	RE	One-way FE	Two-way FE	RE	One-way FE	Two-way FE
Business Risk	-0.0778***	-0.0782***	-0.00497	-0.0718***	-0.0710***	-0.00672
	(0.0242)	(0.0236)	(0.00489)	(0.0216)	(0.0198)	(0.00690)
Farm Profitability: Market	0.0132	0.00727	-0.0689***			
	(0.0507)	(0.0521)	(0.00744)			
Farm Profitability: Cost				-0.00835	-0.0109	-0.0605***
				(0.0280)	(0.0317)	(0.00694)
Subsidies	0.00997***	0.00998***	-0.00205	0.00863***	0.00921***	-0.00165
	(0.00200)	(0.00254)	(0.00189)	(0.00167)	(0.00255)	(0.00162)
Experience	-0.00167	-0.00931	0.00410**	0.00137	-0.0106	0.00639***
	(0.00996)	(0.0167)	(0.00173)	(0.00792)	(0.0174)	(0.00129)
$Experience^2$	-1.91e-05	0.000117	-8.37e-05**	-8.08e-05	0.000138	-0.000138***
	(0.000194)	(0.000312)	(3.42e-05)	(0.000157)	(0.000322)	(2.55e-05)
Constant	0.0661	0.173	0.0770**	0.0420	0.199	0.0555**
	(0.127)	(0.224)	(0.0251)	(0.105)	(0.236)	(0.0218)
Observations	137	137	137	134	134	134
R-squared		0.360	0.936		0.350	0.936
Number of States	10	10	10	10	10	10

Robust standard errors in parentheses. Notes: ***, **, * denote significance at 1%, 5% and 10% level, respectively. Coefficients of year dummies have not been reported for simplicity in two-way fixed effects models.

Regression results for financial risk when EBITDA is the income category are summarized in Table 18. Business risk has positive coefficients with 1% statistical significance level in (1); (2); (4); and (5), with 5% level in (3), and 10% in (6). Market- and cost-based farm profitability are negatively correlated to financial risk at 1% significance level. Subsidies has positive estimates for RE and one-way FE models and negative ones for two-way FE models, but they are not statistically significant. Experience does not maintain a consistent economic effect in any models.

Table 18. Regression Results for Financial Risk: EBITDA

Income Measure: EBITDA	(1)	(2)	(3)	(4)	(5)	(6)
Variable	RE	One-way FE	Two-way FE	RE	One-way FE	Two-way FE
Business Risk	-0.231***	-0.205***	-0.180**	-0.225***	-0.180***	-0.147*
	(0.0556)	(0.0511)	(0.0629)	(0.0543)	(0.0547)	(0.0759)
Farm Profitability: Market	-2.329***	-2.556***	-2.905***			
	(0.386)	(0.434)	(0.381)			
Farm Profitability: Cost				-1.773***	-1.967***	-2.248***
				(0.212)	(0.238)	(0.180)
Subsidies	0.0322	0.0231	-0.0277	0.0370	0.0205	-0.0279
	(0.0223)	(0.0297)	(0.0284)	(0.0246)	(0.0293)	(0.0274)
Experience	0.0101	-0.0627	0.0649	-0.000894	-0.0497	0.0710
	(0.0633)	(0.143)	(0.0504)	(0.0465)	(0.135)	(0.0510)
$Experience^2$	-0.000465	0.000907	-0.00116	-0.000233	0.000582	-0.00137
	(0.00127)	(0.00266)	(0.000908)	(0.000947)	(0.00250)	(0.000919)
Constant	0.425	1.413	0.132	0.536	1.300	0.0959
	(0.796)	(1.933)	(0.716)	(0.613)	(1.841)	(0.709)
Observations	130	130	130	130	130	130
R-squared		0.462	0.785		0.492	0.789
Number of States	10	10	10	10	10	10

Robust standard errors in parentheses. Notes: ***, **, * denote significance at 1%, 5% and 10% level, respectively. Coefficients of year dummies have not been reported for simplicity in two-way fixed effects models.

Table 19 displays empirical estimates when the income is set to gross revenues accrual. Once more, business risk and financial risk are negatively correlated in all models. Estimates are statistically significant at 1% level in (1); (4); and (5) and at 5% level in (2). Coefficients of arm profitability are negative in all models; nonetheless, they only demonstrate statistical significance in two-way FE models. Subsidies is positive and statistically significant at 1% in RE and one-way FE models; however, experience is positive and statistically significant at 1% with decreasing marginal effects in two-way FE models.

Table 19. Regression Results for Financial Risk: Gross Revenues Accrual

Income Measure: Gross Revenues Accrual	(1)	(2)	(3)	(4)	(5)	(6)
Variable	RE	One-way FE	Two-way FE	RE	One-way FE	Two-way FE
Business Risk	-0.0594***	-0.0572**	-0.00245	-0.0579***	-0.0509***	-0.000728
	(0.0195)	(0.0176)	(0.00475)	(0.0185)	(0.0147)	(0.00459)
Farm Profitability: Market	-0.00921	-0.0243	-0.0727***			
	(0.0334)	(0.0335)	(0.00467)			
Farm Profitability: Cost				-0.0144	-0.0281	-0.0615***
				(0.0197)	(0.0207)	(0.00432)
Subsidies	0.00892***	0.00890***	-0.00221	0.00787***	0.00829***	-0.00193
	(0.00203)	(0.00251)	(0.00174)	(0.00186)	(0.00249)	(0.00145)
Experience	0.00158	-0.0104	0.00458**	0.00441	-0.0108	0.00670***
	(0.00832)	(0.0175)	(0.00161)	(0.00675)	(0.0176)	(0.00109)
$Experience^2$	-8.07e-05	0.000137	-9.00e-05**	-0.000140	0.000139	-0.000142***
	(0.000166)	(0.000327)	(3.24e-05)	(0.000137)	(0.000326)	(2.16e-05)
Constant	0.0336	0.200	0.0724**	0.00775	0.212	0.0529**
	(0.105)	(0.233)	(0.0227)	(0.0901)	(0.237)	(0.0170)
Observations	137	137	137	134	134	134
R-squared		0.347	0.941		0.352	0.942
Number of States	10	10	10	10	10	10

Robust standard errors in parentheses. Notes: ***, **, * denote significance at 1%, 5% and 10% level, respectively. Coefficients of year dummies have not been reported for simplicity in two-way fixed effects models.

Estimated model for financial risk when net cash farm income is the income category can be spotted in Table 20. Business risk has negative coefficients in all models, except (6). In (6) model, i.e. two-way FE model with cost-based farm profitability, the coefficient of business risk is 0.00145 with no statistical significance. Farm profitability is negative and statistically significant at 1% in all models. Subsidies is around 0.04 in RE models and shows significance at 10% level.

Table 20. Regression Results for Financial Risk: Net Cash Farm Income

Income Measure: Net Cash Farm Income	(1)	(2)	(3)	(4)	(5)	(6)
Variable	RE	One-way FE	Two-way FE	RE	One-way FE	Two-way FE
Business Risk	-0.108	-0.0994	-0.0543	-0.0710	-0.0600	0.00145
	(0.0979)	(0.0984)	(0.0689)	(0.103)	(0.102)	(0.0524)
Farm Profitability: Market	-3.884***	-4.057***	-5.049***			
	(0.954)	(0.978)	(1.023)			
Farm Profitability: Cost				-2.944***	-3.111***	-3.755***
				(0.562)	(0.601)	(0.563)
Subsidies	0.0441*	0.0414	-0.00364	0.0427*	0.0382	-0.00169
	(0.0250)	(0.0278)	(0.0271)	(0.0258)	(0.0277)	(0.0233)
Experience	-0.0351	-0.0678	0.0119	-0.0243	-0.0521	0.0326
	(0.0589)	(0.0864)	(0.0237)	(0.0520)	(0.0816)	(0.0205)
$Experience^2$	0.000384	0.000969	-0.000221	0.000129	0.000583	-0.000752
	(0.00112)	(0.00160)	(0.000457)	(0.000979)	(0.00151)	(0.000446)
Constant	0.981	1.449	0.672	0.875	1.309	0.459
	(0.809)	(1.195)	(0.372)	(0.745)	(1.147)	(0.301)
Observations	136	136	136	133	133	133
R-squared		0.491	0.827		0.527	0.836
Number of States	10	10	10	10	10	10

Robust standard errors in parentheses. Notes: ***, **, * denote significance at 1%, 5% and 10% level, respectively. Coefficients of year dummies have not been reported for simplicity in two-way fixed effects models.

Table 21 illustrates regression output for (3.32), (3.33), and (3.34) when income measure is net farm income from operations. Surprisingly, for business risk and financial risk based on net farm income from operations, the regression results imply a positive relationship in RE and one-way FE model at around 0.01 with no statistical significance. Farm profitability is negative and statistically significant at 1% in all models. Subsidies has positive coefficients, while experience is negatively correlated to financial risk in all models.

Table 21. Regression Results for Financial Risk: Net Farm Income from Operations

Income Measure: Net Farm Income from Operations	(1)	(2)	(3)	(4)	(5)	(6)
Variable	RE	One-way FE	Two-way FE	RE	One-way FE	Two-way FE
Business Risk	0.0130	0.00739	-0.0284	0.0132	0.0131	-0.0324
	(0.0259)	(0.0355)	(0.0288)	(0.0251)	(0.0369)	(0.0359)
Farm Profitability: Market	-5.226***	-5.278***	-5.109***			
	(0.783)	(0.793)	(0.755)			
Farm Profitability: Cost				-4.153***	-4.172***	-4.376***
				(0.418)	(0.419)	(0.464)
Subsidies	0.0368*	0.0293	0.0105	0.0349	0.0254	0.0198
	(0.0219)	(0.0227)	(0.0210)	(0.0245)	(0.0236)	(0.0176)
Experience	-0.106	-0.232	-0.103	-0.105	-0.202	-0.0733
	(0.111)	(0.140)	(0.106)	(0.0960)	(0.140)	(0.123)
Experience^2	0.00178	0.00409	0.00187	0.00173	0.00344	0.00125
	(0.00217)	(0.00264)	(0.00192)	(0.00187)	(0.00263)	(0.00223)
Constant	2.018	3.721*	2.251	2.050*	3.397	1.904
	(1.396)	(1.840)	(1.389)	(1.221)	(1.858)	(1.616)
Observations	121	121	121	119	119	119
R-squared		0.637	0.791		0.668	0.809
Number of States	10	10	10	10	10	10

Robust standard errors in parentheses. Notes: ***, **, * denote significance at 1%, 5% and 10% level, respectively. Coefficients of year dummies have not been reported for simplicity in two-way fixed effects models.

In general, regression results provide empirical evidence for risk balancing behavior when the income measure is set to gross cash farm income, EBITDA, gross revenues accrual, and net cash farm income. It is only net farm income from operations that, when used as income base for financial risk and business risk, the risk balancing hypothesis does not hold. Indeed, the same discrepancy prevailed for our theoretical proposition from (3.18): when the income base was net farm income from operations, regression results imply a negative relationship between current ratio and business risk.

4.2.4. Financial Risk on One-year Lagged Business Risk

Regression results for the models in (3.35), (3.36), and (3.37) are reported in this section. Table 22 exhibits estimates when the gross cash farm income is the base for calculating financial risk and 1-year lagged business risk. I can be seen from the table that lagged business risk is negative and statistically significant at 1% in all models. Cost-based farm profitability is negative and only significant at 1% in two-way FE model. Subsidies is positive and significant at 1% in RE and one-way FE models, while coefficients of experience are positive and statistically significant at 5% and 1% level in two-way FE models, i.e. (3) and (6) respectively.

Table 22. Regression Results for Financial Risk: Gross Cash Farm Income

Income Measure: Gross Cash Farm Income	(1)	(2)	(3)	(4)	(5)	(6)
Variable	RE	One-way FE	Two-way FE	RE	One-way FE	Two-way FE
Lagged Business Risk	-0.0673***	-0.0679***	-0.0220***	-0.0664***	-0.0625***	-0.0209***
	(0.0152)	(0.0160)	(0.00437)	(0.0137)	(0.0151)	(0.00393)
Farm Profitability: Market	0.00669	0.00336	-0.0605***			
	(0.0470)	(0.0476)	(0.00744)			
Farm Profitability: Cost				-0.00630	-0.00911	-0.0547***
				(0.0238)	(0.0315)	(0.00418)
Subsidies	0.0100***	0.0109***	-0.00115	0.00830***	0.0105***	-0.00109
	(0.00131)	(0.00183)	(0.00164)	(0.00118)	(0.00191)	(0.00121)
Experience	0.000819	-0.00382	0.00544**	0.00446	-0.00488	0.00710***
	(0.00756)	(0.0138)	(0.00174)	(0.00543)	(0.0145)	(0.00144)
Experience^2	-6.07e-05	2.70e-05	-0.000112***	-0.000139	4.50e-05	-0.000151***
	(0.000148)	(0.000255)	(3.26e-05)	(0.000109)	(0.000264)	(2.79e-05)
Constant	0.0310	0.0900	0.0529*	0.00218	0.111	0.0395*
	(0.0976)	(0.187)	(0.0240)	(0.0743)	(0.200)	(0.0199)
Observations	126	126	126	124	124	124
R-squared		0.319	0.938		0.320	0.936
Number of States	9	9	9	9	9	9

Robust standard errors in parentheses. Notes: ***, **, * denote significance at 1%, 5% and 10% level, respectively. Coefficients of year dummies have not been reported for simplicity in two-way fixed effects models.

Estimates for (3.35), (3.36), and (3.37) when EBITDA is the underlying income measure are presented in Table 23. Lagged business risk indicates a negative relationship to financial risk in all models with statistical significance at 1% and 5% in RE and one-way FE models accordingly. Market- and cost-based farm profitability are also negatively linked to financial risk with statistical significance at 1% in all models. The coefficients of subsidies are positive for RE and one-way FE models and negative for two-way FE models. Experience is positive in all models, excluding the model in (4).

Table 23. Regression Results for Financial Risk: EBITDA

Income Measure: EBITDA	(1)	(2)	(3)	(4)	(5)	(6)
Variable	RE	One-way FE	Two-way FE	RE	One-way FE	Two-way FE
Lagged Business Risk	-0.209***	-0.162**	-0.0967	-0.209***	-0.137**	-0.0771
	(0.0283)	(0.0538)	(0.0659)	(0.0298)	(0.0519)	(0.0518)
Farm Profitability: Market	-2.175***	-2.285***	-2.637***			
	(0.383)	(0.431)	(0.349)			
Farm Profitability: Cost				-1.682***	-1.795***	-2.131***
				(0.251)	(0.292)	(0.212)
Subsidies	0.0406*	0.0340	-0.0444	0.0433	0.0270	-0.0493
	(0.0244)	(0.0358)	(0.0405)	(0.0275)	(0.0350)	(0.0388)
Experience	0.00942	0.0131	0.0788*	-0.00448	0.0195	0.0832*
	(0.0492)	(0.108)	(0.0399)	(0.0349)	(0.105)	(0.0413)
Experience^2	-0.000405	-0.000334	-0.00134	-0.000112	-0.000525	-0.00150*
	(0.000998)	(0.00200)	(0.000720)	(0.000713)	(0.00193)	(0.000742)
Constant	0.354	0.247	-0.206	0.508	0.232	-0.192
	(0.643)	(1.486)	(0.670)	(0.508)	(1.456)	(0.675)
Observations	119	119	119	119	119	119
R-squared		0.444	0.756		0.473	0.768
Number of States	9	9	9	9	9	9

Robust standard errors in parentheses. Notes: ***, **, * denote significance at 1%, 5% and 10% level, respectively. Coefficients of year dummies have not been reported for simplicity in two-way fixed effects models.

Table 24 shows the regression output when income criterion is gross revenues accrual. Lagged business risk is statistically significant at 1% and has negative coefficients in all models. Although farm profitability based on market and cost values have negative estimates in all models, coefficients demonstrate statistical significance at 1% only in two-way FE models. On the contrary, positive estimates of subsidies are statistically significance at 1% level in RE and one-way FE models.

Table 24. Regression Results for Financial Risk: Gross Revenues Accrual

Income Measure: Gross Revenues Accrual	(1)	(2)	(3)	(4)	(5)	(6)
Variable	RE	One-way FE	Two-way FE	RE	One-way FE	Two-way FE
Lagged Business Risk	-0.0584***	-0.0592***	-0.0223***	-0.0593***	-0.0572***	-0.0195***
	(0.0107)	(0.0112)	(0.00316)	(0.0118)	(0.0107)	(0.00338)
Farm Profitability: Market	-0.00717	-0.0175	-0.0606***			
	(0.0310)	(0.0308)	(0.00743)			
Farm Profitability: Cost				-0.0116	-0.0194	-0.0505***
				(0.0184)	(0.0212)	(0.00314)
Subsidies	0.00943***	0.0107***	-0.00132	0.00832***	0.0104***	-0.00136
	(0.00140)	(0.00187)	(0.00119)	(0.00138)	(0.00185)	(0.000883)
Experience	0.00296	-0.00328	0.00648***	0.00440	-0.00373	0.00782***
	(0.00612)	(0.0136)	(0.00115)	(0.00531)	(0.0139)	(0.000921)
Experience^2	-0.000102	1.96e-05	-0.000128***	-0.000135	2.59e-05	-0.000161***
	(0.000122)	(0.000252)	(2.27e-05)	(0.000108)	(0.000253)	(1.78e-05)
Constant	0.00958	0.0876	0.0363*	0.00163	0.0980	0.0257*
	(0.0788)	(0.183)	(0.0165)	(0.0722)	(0.191)	(0.0129)
Observations	126	126	126	124	124	124
R-squared		0.320	0.949		0.341	0.947
Number of States	9	9	9	9	9	9

Robust standard errors in parentheses. Notes: ***, **, * denote significance at 1%, 5% and 10% level, respectively. Coefficients of year dummies have not been reported for simplicity in two-way fixed effects models.

Table 25 illustrates estimated coefficients when the income base is net cash farm income. Lagged business risk and financial risk are negatively correlated with each other in all models, and the negative relationship also persists between farm profitability and financial risk with the coefficients of farm profitability having statistical significance at 1%. Subsidies and experience do not have consistent patterns of their economic effect, i.e. coefficients change their signs from one model to another.

Table 25. Regression Results for Financial Risk: Net Cash Farm Income

Income Measure: Net Cash Farm Income	(1)	(2)	(3)	(4)	(5)	(6)
Variable	RE	One-way FE	Two-way FE	RE	One-way FE	Two-way FE
Lagged Business Risk	-0.148***	-0.131*	-0.0636	-0.133***	-0.0845	-0.0201
	(0.0461)	(0.0687)	(0.0741)	(0.0481)	(0.0739)	(0.0825)
Farm Profitability: Market	-3.110***	-3.804***	-5.188***			
	(0.827)	(1.008)	(1.049)			
Farm Profitability: Cost				-2.312***	-2.949***	-3.894***
				(0.473)	(0.643)	(0.598)
Subsidies	0.0555***	0.0493	-0.00172	0.0586***	0.0467	-0.00264
	(0.0214)	(0.0313)	(0.0301)	(0.0222)	(0.0306)	(0.0265)
Experience	0.00348	-0.0453	0.0221	-0.00324	-0.0276	0.0456*
	(0.0263)	(0.0704)	(0.0244)	(0.0242)	(0.0684)	(0.0220)
$Experience^2$	-0.000348	0.000608	-0.000403	-0.000205	0.000189	-0.000976*
	(0.000531)	(0.00129)	(0.000498)	(0.000467)	(0.00125)	(0.000489)
Constant	0.407	1.076	0.504	0.467	0.907	0.262
	(0.370)	(1.015)	(0.407)	(0.377)	(0.992)	(0.357)
Observations	125	125	125	123	123	123
R-squared		0.478	0.814		0.516	0.824
Number of States	9	9	9	9	9	9

Robust standard errors in parentheses. Notes: ***, **, * denote significance at 1%, 5% and 10% level, respectively. Coefficients of year dummies have not been reported for simplicity in two-way fixed effects models.

Table 26 demonstrates empirical results for net farm income from operations as income base. The coefficients of lagged business risk are negative in RE and one-way FE models; however, once year dummies are included and the model controls for year-specific fixed effect in (3) and (6), the estimates become positive. Market and cost farm profitability have negative coefficients with statistical significance at 1% level. Subsidies has a negative effect on financial risk in all models, while experience influences financial risk positively with diminishing marginal effects. Neither subsidies, nor experience demonstrates statistical significance in any models.

Table 26. Regression Results for Financial Risk: Net Farm Income from Operations

Income Measure: Net Cash Farm Income	(1)	(2)	(3)	(4)	(5)	(6)
Variable	RE	One-way FE	Two-way FE	RE	One-way FE	Two-way FE
Lagged Business Risk	-0.0310	-0.0186	0.0321	-0.0341	-0.0169	0.0103
	(0.0297)	(0.0313)	(0.0344)	(0.0272)	(0.0283)	(0.0311)
Farm Profitability: Market	-5.166***	-5.190***	-5.023***			
	(0.835)	(0.857)	(0.762)			
Farm Profitability: Cost				-4.123***	-4.119***	-4.318***
				(0.458)	(0.464)	(0.389)
Subsidies	0.0408	0.0358	0.0170	0.0389	0.0305	0.0209
	(0.0303)	(0.0327)	(0.0367)	(0.0316)	(0.0322)	(0.0326)
Experience	-0.0692	-0.138	-0.0505	-0.0610	-0.106	-0.00763
	(0.103)	(0.137)	(0.0817)	(0.0856)	(0.142)	(0.0981)
$Experience^2$	0.00106	0.00238	0.000988	0.000878	0.00170	0.000110
	(0.00203)	(0.00258)	(0.00145)	(0.00169)	(0.00266)	(0.00175)
Constant	1.556	2.454	1.308	1.488	2.110	0.824
	(1.314)	(1.840)	(1.127)	(1.107)	(1.903)	(1.360)
Observations	111	111	111	110	110	110
R-squared		0.615	0.772		0.652	0.791
Number of States	9	9	9	9	9	9

Robust standard errors in parentheses. Notes: ***, **, * denote significance at 1%, 5% and 10% level, respectively. Coefficients of year dummies have not been reported for simplicity in two-way fixed effects models.

Ultimately, empirical results for one-year lagged business risk supports the risk balancing hypothesis, and the estimated coefficients are negative in almost all of our models with some exceptions. The difference between the current-year business risk and one-year lagged business risk is that coefficients of one-year lagged business risk are still negative when the income base is net farm income from operations, while those of current-year business risk are positive.

5. SUMMARY AND CONCLUSIONS

Risk plays a pivotal role in farm operational and financial management. The Risk Balancing Hypothesis (RBH) establishes a theoretical relationship between financial, business, and total risks and posits that policies (e.g. federal crop insurance, income augmenting policies, etc.) aimed at reducing business risk may encourage farmers' offsetting adjustments in leverage positions, thus increasing farm financial risk and balancing total farm risks. A myriad of studies has been conducted to empirically detect the existence and extent of risk balancing behavior in the agricultural sector. Some studies confirmed farmers' risk balancing behavior in practice, although some other studies have reported economically and statistically insignificant effects.

This thesis research argues that an appropriate model should consider farmers' leverage decisions altogether with their liquidity decisions given that liquidity is another major constraint facing farm businesses. In that spirit, we expand the classical risk balancing model to incorporate current ratio as a liquidity measure and explore the relationship between business risk and farm liquidity. In our theoretical framework, we conduct a comparative statics analysis based on the optimal current ratio derived from the expanded specification of the Dupont Identity. Under a set of moderate assumptions, we conclude that when the decision maker (a farm manager in our case) can only adjust the farm's liquidity position via shareholders' equity, (1) an increase in business risk will cause current assets to increase, which will correspondingly increase current ratio $\left(\frac{CA}{CL}\right)$, and (2) an increase in the expected return to assets will cause current assets to decrease, which will correspondingly decrease current ratio $\left(\frac{CA}{CL}\right)$.

Risk balancing is essentially an individual-level phenomenon. Until recently, cross-sectional analysis of risk balancing behavior of farmers had been prevalent, although more studies start to use farm-level panel data, which help researchers control for farm and farmer specific unobserved factors. Therefore, based upon the theoretical model, to test the relationship between business risk, financial risk, expected return to assets, and farm liquidity, we use the FINBIN database that is compiled and maintained by the University of Minnesota. In this way, we hope to contribute to the ongoing explorations of risk balancing behavior and provide evidence for farm policy makers.

Our dataset includes five income measures, i.e., gross cash farm income; earnings before interest, taxes, depreciation, and amortization (EBITDA); gross revenues accrual; net cash farm income; net farm income from operations. In the risk balancing literature, there is no consensus on which income measure better reflects farmers risk preferences. Therefore, in an attempt to fill this gap and also to explore the effect of income measures in the risk balancing setting, we estimated our regression models using five alternative income measures and reported estimated coefficients for each income measure. The results indicated that the signs, economic effects, and statistical significances of regression coefficients change when we use different income measures.

Our empirical results indicate that there is a positive relationship between current ratio and business risk. Out of six alternative income categories, results from five of them, estimated using random effects, one-way fixed effects, and two-way fixed effects models, indicate that when business risk increases decision makers prefer to increase their liquidity as a cushion against increased risks, validating our theoretical derivations. However, when net farm income from operations is used as an income measure, business risk reports negative coefficients in all models. Contradictory results may be stemming from the national or state level factors affecting one income category but not others.

The relationship between expected returns to assets and current ratio does not provide empirical evidence for our theoretical derivations. The regression coefficients are positive and indicate that decision makers increase their liquidity when they expect a higher mean returns to assets. Contradictory results can be the result of many factors. It could be the case that expectations are formed by current business environment, so the average returns to assets is not a good proxy for expected return on assets. Alternatively, although we showed that current ratio and expected returns are negatively correlated in theory, the relationship between current ratio and expected returns simply does not exist in practice. Besides, contradictory empirical results may also stem from the fact that banks provide working capital loans to farm businesses to finance their short-term operational needs. By having access to working capital loans, decision makers do not need to adjust their farm capital structure to cope with the changes in expected returns, causing the relationship between current ratio and expected returns to deviate from the theoretical proposition laid out in the paper.

Moreover, we test the risk balancing hypothesis and find empirical evidence for four income categories, i.e. gross cash farm income, EBITDA, gross revenues accrual, and net cash farm income. It is only net farm income from operations that, when used as the income base for financial risk and business risk, the risk balancing hypothesis does not hold. We also demonstrate that when financial risk is regressed on one-year lagged business risk, estimated coefficients for one-year business risk are negative in almost all of our models. The difference between lead-lead models and lead-lag models is that coefficients of lead-lag models are still negative when the income base is net farm income from operations.

With regard to limitations of our study, since FINBIN dataset contains only aggregate state-level data, it limits our capacity in several ways. The first one of them is that we could not include individual level variables in our models. As it has been noted, risk balancing and liquidity management is an individual-level phenomenon. Therefore, it is critical to have control variables that account for individual-level effects affecting empirical results. Secondly, we were not able to explore more robust econometric models requiring farmer-level observations to test effects of business risk on current ratio and of expected returns on current ratio. Moreover, we did not examine more in-depth theoretical models, such as capital structure theories. For instance, an empirical application of pecking order theory could be studied simultaneously with the relationship between current ratio and business risk in a way that provides valuable insights into managers' liquidity decisions and the capital structure of their businesses.

With more comprehensive data in hand, future research should empirically test the theoretical derivations from this thesis. Specifically, the negative relationship between current assets and business risk and the positive correlation between current ratio and expected returns should be explored more comprehensively. There is also a need to elaborate more on different income categories and analyze how empirical results may change among various income categories. Besides, effects of national level factors and state level factors on different income categories should also be scrutinized to better reflect risk balancing behavior.

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