A BEST-WORST SCALING APPROACH TO UNDERSTAND THE RISK MANAGEMENT PREFERENCES OF SASKATCHEWAN GRAIN AND OILSEED FARMERS

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Abstract

Farm managers must continuously manage risk in their farm business if they are to remain competitive and successful in their farm business operations. Although various risk management strategies can be adopted to reduce the uncertainties farmers face, the choice of a risk management strategy is influenced by the unique characteristics of the farm or the farm manager. Therefore, assuming a relationship between a particular risk and the strategy to be adopted may not necessarily be valid across heterogeneous decision makers. Using data from a 2017 survey, the risk management practices of grain and oilseed farmers in Saskatchewan is examined using a count-based approach of best-worst scaling and latent class cluster analysis. The results indicate there is considerable diversity among strategies producers perceive important.

Keywords: Risk, Risk Management, Best-Worst Scaling, Latent Class Cluster, Grain and Oilseed Producers

Introduction

Farm managers face various risks and uncertainties throughout the growing season relating to production, marketing, financial, and institutional factors (Guerin & Guerin, 1994). For example, farm operators are confronted with volatile input and output price variations, unpredictable weather conditions and changes in technology used in their farming business. Prior work has shown price volatility and radical changes can lead to fluctuations in farm profitability (Mahnken & Hadrich, 2018). According to Howden (2016), farmers in Saskatchewan face a set of production and economic risks ranging from drought, excess moisture, frost, hail, pest, and disease, increasing costs of operation, low margins, and high fixed costs, which lead to fluctuations in farm income and threatens the sustainability of the agricultural industry. These risks, if not properly managed, could inhibit the ability of the farm manager to meet production and financial goals.

Work on risk management in agriculture has been ongoing for many years (Thompson et al. 2019; Aditto et al. 2012; Sulewski & Kłoczko-Gajewska, 2014; Koesling et al., 2004; Patrick et al., 1985). Prior studies have found that strategies such as forward contracting, spreading sales, and diversification can lead to improved outcomes (Mishra, El-Osta, & Sandretto, 2004). In the Canadian context, off-farm employment was shown to be an important tool to manage income variability for small- to medium-sized farms (Jetté-Nantel, Freshwater, Katchova, & Beaulieu, 2011). Several other studies have found that crop insurance, futures contracting, vertical integration, spreading of sales, diversification, off-farm investments, producing at low cost, and maintaining financial reserves are among the strategies employed by farmers to manage and reduce risks (Ahsan & Roth, 2010; Hall et al., 2003; Harwood et al., 1999). With the number of choices available to farmers, the decision of which strategy to adopt may reflect individual preference for a strategy based on their own level of comfort as well as the match to the risk they face.

The purpose of this paper is to analyze how farm, structural and managerial characteristics influence the perceived importance of particular risk management strategies in dealing with farm risk. Exploring data collected through a 2017 survey of Saskatchewan grain and oilseed producers, we use a best-worst scaling approach and latent class clustering methods to analyze how structural and managerial characteristics

of the farm business affect farmer perception of risk management strategies. The best-worst questions were designed from sixteen risk management strategies relating to production, marketing and financial strategies to manage risk.

Producers reported use of risk management strategies

Empirical studies have examined the risk management strategies farmers rely on to mitigate the varied risks they face (Aditto et al., 2012; Flaten et. al., 2005; Kahan, 2013). However, the literature on risk management tools reveals differences in the risk management strategies adopted by farmers. These tools could include crop diversification, use of marketing experts (Nguyen et al., 2005), the prevention of pests and diseases (Melyukhina, 2011a), the use of production contracts and crop insurance (Bard et al., 2003) as well as off-farm income (Ramaswami et al., 2008).

Unterschultz (2000) investigated how market risk is managed in Western Canada and reported that futures, forward contracts, and options are among the strategies adopted by farmers to manage short-run market risk, especially by grain farmers. Off-farm income was also reported as important risk management strategy for Canadian farmers (Unterschultz, 2000).

It is evident from the literature on farmers reported use of risk management strategies that there are differences in the perceived importance of the various risk management strategies adopted by farmers depending on the type of product, region or the farmer or unavailability of risk management strategies to different farmers. While we can observe several different tools being utilized across locations and contexts, it is still difficult to understand the relative importance of the various risk strategies within a single location. Understanding the perceived importance of different risk management tools (financial, marketing, production, etc.) may help policy makers develop tools that producers find useful in managing risks.

Study Design

A survey of Saskatchewan grain and oilseed producers was carried out to investigate the perception of producers with regards to the importance of the various risk management

strategies. The survey was designed to solicit information on farm operations, risk attitude and their perceived ability to control risk and their most significant risk management strategies. The study employed the count-based approach of Case 1 best-worst scaling design used to study the importance of sets of incentives in a manner that permits discrimination through trade-off of attributes. Case 1 BWS is considered more appropriate when the researcher is interested in the relative values associated with each of a list of objects (Flynn & Marley, 2014). The design was used to examine the importance of the various risk management strategies relative to each other. The next paragraphs of the sections outline the design of the best worst scaling and how it was implemented in this study.

As indicated earlier, the best-worst scaling approach allows respondents to select the "best" and the "worst" from a series of scenarios presented to them. Unlike other approaches, the best worst scaling presumes some underlying subjective dimension such as "degree of importance" or "degree of interest" through which the location of some set of objects along this dimension is measured (Auger et al., 2004; Atta & Micheels, 2019). In this study, the degree of importance of the risk management strategies is considered as the underlying dimension and the risk management strategies are considered the objects being measured along this dimension. Respondents are presented with a series of repeated choice sets of attributes (the risk management strategies) which they are required to choose the "best" and "worst" attributes in each choice set. Respondents are given the opportunity to select the two items in a choice set that maximize the difference between them on an underlying scale of significance (Erdem and Rigby, 2013; Atta & Micheels, 2019). The selection of the "bests" and "worsts" from each scenario are then summed and transformed to best worst scores which is used to decide the relative importance of each attribute in the choice sets based on the number of times it is selected as "best" or "worst" (Atta & Micheels, 2019).

Louviere & Woodworth (1991) pointed out that, one of the important considerations when designing best worst survey is to ensure all identified items and possible comparisons appear in equivalent number of times in the choice sets. Moreover, the survey should be designed to ensure that the combinations of items is done in a way where each item is shown an equal number of times and each *pair* of items is shown an equal number of times. In this study, we used the 2^K factorial design, which ensured that each attribute is orthogonal and appears an equal number of times (Coltman et al., 2011) to the design the best worst questions. We applied the design to

sixteen risk management strategies identified based on literature which generated sixteen choice sets. There were four items in each choice set, and across all choice sets each risk management strategy appeared four times and was paired with each other once. Respondents were tasked to select from each choice set presented, their best and worst risk strategy from the series of repeated choice sets. Example of a Case 1 design used in this study is provided in Table 1.

Table 1 : Example of case 1 choice set

Most Important (Tick one)	**Of these risk management strategies, which will you consider as the most and least important to manage risk in your farm operation**	**Least Important (Tick one)**
☐	Getting market information	☐
☐	Spreading sales	☐
☐	Diversification	☐
☐	Producing at low cost	☐

Collection of data for the study

Primary data were collected through an online survey of Saskatchewan grain and oilseed farmers selected from a producer database of Insightrix, a market research company. In all, 600 complete responses were received at the end of the survey. Two screening questions were used to ensure respondents were not only grain and oilseed producers, but also play a major role in making decisions concerning farm operations (Atta & Micheels, 2019). To conceal the identity of respondents, a unique identification codes were assigned to each participant. This was also

necessary to maintain anonymity and avoid duplication of responses. Table 2 presents the demographic characteristics of the respondents and other farm business information of their operations.

Table 2: Socio-Economic Characteristics of Respondents

Socio-economic characteristics of respondents	N	Min	Max	Mean/percentage	Std. deviation	Comparative Census statistics
Age	577	19	91	53.1	14.1	55[+]
Gender						
Male	463			77.2		75.1[+]
Female	137			22.8		24.9[+]
Education						
No education	4			0.7		21.7*
High School / Voc	239			39.8		
College	142			23.7		78.3*
University	169			28.2		
Graduate School	46			7.7		
Experience						
Less than 10 years	82			13.7		
11-20 years	96			16.0		
21-30 years	92			15.3		
31-40 years	156			26.0		
Over 40 years	174			29.0		
Gross sales						
Less than $250k	243			47.4		
250k-$499k	94			18.3		
$500k-$749k	44			8.6		

$750k-$999	37	7.2
$1000k and above	95	18.5

The average age of survey respondents was 53 which is almost the same as the average age of Saskatchewan farm operators. The 2016 census of agriculture reported the average age of Saskatchewan farm operators to be 55 (Statistics Canada, 2016). Male farm operators constitute the majority of participants (77.2%) which is similar to Statistics Canada data on male farm operators in the province (75.1%). Participants that had a high school, vocational or technical education were 39.8%, 23.7% had college education, 28.2% had university education and about 7.7% had graduate level education. About 55% of participants had over 30 years of farm experience and majority of respondents have gross sales of less than $500,000 which could be classified as small to medium-sized farm operators. Only 18.5% of participants reported a gross sale of over 1 million.

Data Analysis

According to Loose & Lockshin (2013), to estimate the best worst scores at the individual level, the number of times an item is selected as best, or worst are added up across all choice sets and the difference between the "worst" and "bests" is taken. Hence, to determine the perception of producers as regards the level of importance of the risk management strategies, the number of times the strategy was selected as least important was subtracted from the number of times it was chosen as most important for all 16 risk management strategies. These calculations produced the individual level scale for each of the risk management strategies.

According to Loose & Lockshin (2013), to determine the aggregate level relative importance of the attribute, the difference between all bests and worst counts for each attribute is divided by the number of respondents. Marley & Louviere (2005) noted the resulting BWS scores can then be interpreted as the average of the number of times an item is selected as best or worst which gives an interval scale. Thus, to estimate the relative importance of the risk management strategies at the aggregate level, the difference between all best and worst counts was divided by the number of respondents to give BWS at the aggregate level for each strategy. Following Ochieng and

Hobbs (2016) and Atta and Micheels (2019), the best-worst score for each strategy were transformed into standard scores using the formula below:

$$Standard\ score = \frac{count(Best) - count(Worst)}{4n} \quad (1)$$

where n is the number of survey respondents and 4 is the frequency with which each source of risk appears in the design.

The standardization was necessary to allow for easier interpretation and comparison between different groups of respondents (Goodman et al.; 2005). According Ochieng & Hobbs (2016), the standard scores provide little information on the relative importance of the attributes; therefore, ratio scores need to be generated to allow for comparison of the relative importance of attributes (risk management strategies in this case). Following procedures outlined by Loose & Lockshin (2013), the ratio scores were generated with the formula below;

$$\text{Weighting Factor}_{\text{important weight}} = \frac{100}{\sum_{1}^{n} \sqrt{(\frac{B}{W})}} \quad (2)$$

Where, B = best scores and W = worst scores.

BWS results of the relative importance of the risk management strategies

Table 3 presents the results of the aggregate ranking of all the sixteen risk management strategies based on the standard scores. Producers consider *producing at a lower cost* and *keeping financial reserve* as their top two most important risk management strategies. Financial risk mostly arises from a combination of reduced borrowing capacity and reduced financial reserves (which can be interchangeable if cash flow is reduced). This risk may be greatest when firms experience increased borrowing combined with reduced cash reserves. Keeping financial reserve (which could be cash or a stock portfolio) provides an additional source of liquidity which would alleviate the need to depend on external sources to finance farm operations. *Implementing pest and diseases control programs* was the third most important risk management strategy followed by *reducing debt level, buying crop insurance, diversification, getting market information* and *forward contracting.* Respondents ranked other strategies such as *having farm reservoir/irrigation, working off-farm, off farm investment* as least important strategies.

Following the standard score ranking, we estimated a standardized square root interval or ratio scale from the best-worst scores. This allowed for comparison and understanding of the relative importance of the risk management strategies since the standard score ranking only provides information on the basic ranking of the strategies. The results of the ranking of the relative importance of the risk management strategies based on the ratio scale is presented in table 3 column 11. The probability ratio scale, which measures the relative importance of the attributes did not reveal any significant changes in the ranking of the risk management strategies. *Producing at low cost* was still ranked the most important risk management strategy followed by *keeping financial reserve, implementing pests and diseases control programs, reducing debt level, buying crop insurance, diversification, getting market information* and *forward contracting* in order of most important. The results also indicate a big interval between the 2nd and 3rd most important strategies emphasizing the relative importance of the top two risk management strategies to respondents compared with the others.

The best-worst results reveal that respondents consider strategies that help reduce the effect of production and price risks on the farm business as more important. Most of the highly ranked strategies are those that help minimize the effect of production and price risk on the farm. For example, keeping the cost of operating farm business low, implementing pest and diseases control programs by buying crop insurance could generally increase output and farm income or reduce the financial loss resulting from natural disasters such as drought. Seeking market information on output prices would enable farmers to have greater strengths in negotiating, make production decisions and reduce uncertainty of price variation. Moreover, keeping financial reserve means that farmers do not need to depend on such external sources to finance farm operations. Our results are consistent with other studies that found diversification, farm equity, crop insurance, keeping cost of production low, prevention of pest and diseases, use of market information and contracting as important risk strategies to producers (Nguyen et al., 2005; Melyukhina, 2011a; Bard et al., 2003; Antón & Kimura, 2009; Anton et al., 2011).

As mentioned in the previous section, the BWS provides results on the aggregate ranking of the risk management strategies but does not reveal heterogeneity among respondents. We next estimated the standard deviation of the individual best worst scores over all respondents as a means of further exploring heterogeneity in their choices. As indicated by Mueller & Rungie

(2009), the standard deviation of the individual B–W score over all respondents measures the variations in the importance of the attribute over the sample. The standard deviation of all the risk management strategies as shown in table 3 column 7 reveal the presence of heterogeneity in respondents' ranking of the relative importance of the risk strategies. The standard deviation of all sixteen risk management strategies were above one providing hints of heterogeneity in the responses of producers (Mueller & Rungie, 2009).

Table 3: Summary Statistics of Best-Worst Scaling

Risk Management Strategies	(1) Total Best	(2) Total Worst	(3) Aggregate B-W Score	(4) B/W Score (Standardized)	(5) Ranking Based on Standardized Score	(6) Mean of Individual B/W Score	(7) StDev of Individual B-W Score	(8) StDev/Mean	(9) Sqrt B/W	(10) Standardized Sqrt interval Scale (relative importance)	(11) Ranking Based on Standardized Scale
Producing at low cost	1315	169	1146	0.478	1	1.910	1.672	0.875	2.789	100.00	1
Keeping financial reserve	1099	184	915	0.381	2	1.525	1.606	1.053	2.444	87.61	2
Implementing pest and disease control programs	894	278	616	0.257	3	1.027	1.742	1.696	1.793	64.29	3
Reducing debt level	925	373	552	0.230	4	0.920	1.966	2.137	1.575	56.45	4
Buying crop insurance	827	353	474	0.198	5	0.790	2.072	2.623	1.531	54.87	5
Diversification	647	406	241	0.100	6	0.402	1.796	4.468	1.262	45.26	6
Getting market information	637	513	124	0.052	7	0.207	1.8	8.696	1.114	39.95	7
Forward contracting	566	554	12	0.005	8	0.020	1.82	91.000	1.011	36.24	8
Spreading sales	497	528	-31	-0.012	9	-0.052	1.622	-31.192	0.970	34.78	9
Use of futures markets	447	510	-63	-0.026	10	-0.105	1.608	-15.314	0.936	33.56	10
Participating in government support programs	468	537	-69	-0.029	11	-0.122	1.753	-14.369	0.934	33.47	11
Replacing labour with machinery	306	653	-347	-0.145	12	-0.578	1.658	-2.869	0.685	24.54	12
Having seed reserves	322	814	-492	-0.205	13	-0.820	1.868	-2.278	0.629	22.55	13
Off-farm investment	212	1011	-799	-0.333	14	-1.332	1.635	-1.227	0.458	16.42	15
Working off farm	308	1182	-874	-0.364	15	-1.457	2.223	-1.526	0.510	18.30	14
Having farm reservoir/irrigation	130	1535	-1405	-0.585	16	-2.342	1.762	-0.752	0.291	10.43	16

In addition, to determine the extent of heterogeneity of responses, we estimated the ratio of individual standard deviation and individual mean. Column 8 of table 3 displays the ratio for all the risk management strategies. While greater absolute ratios indicate greater heterogeneity in responses, ratios that are zero or close to zero suggest absolute agreement or greater uniformity in the extent to which producers considers a particular risk management strategy as important or not (Atta and Micheels, 2019).

Producers seem to differ on their agreement on the relative importance of the risk management strategies. Apart from *producing at low cost, keeping financial reserve* where producers seem to show relatively higher agreement on their relative importance, there is heterogeneity on the relative importance with regards to the other risk management strategies. For example, risk management strategies such as *spreading sales, forward contracting, use of future markets, getting market information* among others all have standard deviation over mean ratio well above one. Respondents ranked *forward contracting* among the most important risk management strategies, but the ratio of the standard deviation relative to the mean shows a greater heterogeneity in the agreement of producers. Mueller & Rungie (2009) noted that specific attention needs to be paid to such risk that show a high amount of heterogeneity and reasonable importance as only a subset of producers considers it to be important. If developing new policies to support farmers in managing risk, policy makers should target risk management strategies where there is higher agreement among producers with regards to their relative importance in coping with risk. This is because, such risk strategies are more likely to have higher adoption rate because most producers agree to its importance in managing risk they face.

Conclusions

Farm entrepreneurs face many risks and uncertainties which if not properly managed, may lead to increased losses to farmers in their production activities. Producers are confronted with volatile input and output price variations,

unpredictable weather conditions and essential changes in technology inherent in their farming business which could cause fluctuations in farm profitability. As indicated earlier, producers attempt to minimize the effects of these risks and uncertainties and stabilize farm income or smooth consumption ability or avoid bankruptcy may adopt various risk management strategies to mitigate these risks. However, producers may respond to risk differently based on the level of risk and other factors such as the farm manager's ability to manage risk. Therefore, different farm managers may adopt different combination of risk management strategies necessary to the specific nature of the risk involved or the characteristics of the farm.

Other authors have studied risk and risk management activities among farm operators, however; few have used the best worst approach to understand farmers perception of risks or risk management strategies (see Thompson et al. 2019). Our study examined producers' perception on the various risk management strategies using a more homogeneous sample population. As suggested by Martin & Shadbolt (2000), assuming a relationship between the type and risk and the subsequent strategy that should be adopted may not be necessary be effective. Since management strategies adopted by farmers are influenced by several factors, focusing on a particular or class of strategies ignores the "whole farm context in which farmers manage risk" (Martin & Shadbolt, 2000 p. 68) and could create imperfect picture of the risk environment facing farmers and obscure understanding of how they may react to changing risk situations. This implies that farmers' perception of the importance of the various risk management strategies may not necessarily be same which makes it necessary to understand why these importance ratings may differ.

The BWS results from this study suggest that Saskatchewan grain and oilseed farmers perceive various combination of production, marketing and financial risk management strategies important in managing risk in their farm business. Particularly, strategies such as *producing at cost, keeping financial reserve, implementing pests and diseases control programs, reducing debt level, buying crop insurance,*

diversification, seeking market information and forward contracting were among strategies perceive by respondents as important in managing farm risk.

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