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Personality Traits in Supply Chain Contracting

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Abstract

In this paper we study the correlation between a decision-making lab experiment on a simple supply chain setting and several personality traits of the decision makers which are measured using out-of-experiment surveys. We consider a scenario of a single manufacturer interacting with a single retailer who faces a newsvendor problem. The manufacturer determines the wholesale price, and the retailer determines the order quantity of the product with random consumer demand. We investigate the effects of self-esteem, regret tendency, (lack of) risk/loss aversion, and (lack of) inequity aversion on manufacturer's pricing decisions, and retailer's order quantity decisions. Despite the small sample sizes of the experiment our findings indicate that there is evidence for correlation between these personality traits and the contracting decisions of the subjects.

Keywords

Behavioral Operations, Supply Chain Management, Newsvendor Model, Personality Traits

1. Introduction

Aligning the objectives of the supply chain partners and helping them achieve optimal supply chain profit by eliminating inefficiencies such as double marginalization has been the objective of many researchers. Various alternative contract schemes have been proposed to allocate risk and profit between partners in order to coordinate the supply chain. In the last two decades with the rise of behavioral operations management, researchers have also focused on the practical performance of these contracts and how human decision makers behave in strategic contracting environments. And as such, these studies have revealed that in practice decision makers are not self-regarding, rational profit maximizers. Therefore, additional behavioral studies are needed first to understand the factors causing this gap between theory and practice as it results in significant suboptimalities, and second to alleviate and eventually eliminate this gap.

In this paper our objective is to study the relationship between supply chain contracting behavior and several different personality traits; namely self-esteem, regret tendency, and inequity aversion. We aim to investigate if these traits of the decision maker can provide us with a prediction of their behavior in a strategic supply chain environment. The ultimate goal, though beyond the scope of this paper, is to remedy the behavioral suboptimalities in supply chains by addressing the root causes directly. If a correlation between these personality traits and contract decisions can be shown, hopefully by training the decision makers or counselling them, these traits can be managed, and contract performance of the decision maker can be improved.

The study presented in this paper is derived from Akbay's (2016) doctoral dissertation with never-before-published analyses and figures. Akbay (2016), and thus the current paper, is the first, and to this date the only, authentic research to consider the behavioral effects of self-esteem and regret tendency, as well as inequity aversion on supply chain contracting decisions and to investigate the relationship between these traits and contacting behavior using an out-of-experiment survey.

1.1 Objectives

The objective of this paper is to investigate the correlation between
- the manufacturer's pricing decisions
- the retailer's stock quantity decisions
- the profit earned by the two firms

and their
- self-esteem,
- tendency to regret their actions afterwards,
- aversion to loss and risk, and
- (lack of) aversion to inequity.

2. Literature Review

In the last two decades there have been many studies investigating human behavior in supply chain context. Studies that consider single echelon manufacturer-retailer supply chain setting can be categorized into two groups: 1) studies considering linear (and deterministic) demand, 2) studies considering random demand. The first group focuses on strategic interaction by eliminating the uncertainty from the context. For instance, Loch and Wu (2008) use a simple linear demand setting and explore the impact of several social factors. They show that an emphasized relationship positively and status seeking negatively affects the efficiency of the contract.

The second group of behavioral operations studies focusing on contracting, which also includes the current paper, considers a setting with random consumer demand where unsold products lose their value at the end of the selling season. In other words these studies consider a newsvendor model where there is a second decision-maker, the manufacturer/supplier, that determines the price parameters of the model. Keser and Paleologo (2004) is the first of these studies. They consider a wholesale price contract setting in a repetitive game. The authors show that manufacturers' wholesale price decisions fall below the optimal resulting in a more fair sharing of the total supply chain profit between the manufacturer and the retailer. This indicates that fairness concerns affect contracting behavior. Katok and Wu (2009) also consider the wholesale price contract along with the buyback and revenue sharing contracts in a setting where subjects are matched with a computer placing newsvendor optimal order or generating random consumer demand. They show that although the buyback and revenue sharing contracts lead to higher profits compared to the wholesale price contract, contrary to theory they both fail to coordinate the supply chain. In a follow-up study, Wu (2013) considers a similar scenario with strategic interaction where subjects are matched with other subjects. However, the order quantity decisions of the retailer are restricted to eliminate bounded rationality factor from the experiment. The results show that reciprocity and fairness effect supply chain decisions.

There are some studies investigating the effect of personal factors in newsvendor decisions but to the best of our knowledge there haven't been a study investigating the effect of personal factors in a supply chain contracting setting. Therefore, this study is an important contribution to fill in this unexplored area in the map of behavioral operations field.

There are studies conducted in experimental and behavioral economics field that explore the effect of personality traits in two-player games. Al-Ubaydli et al (2016) show that in a prisoner's dilemma setting, cognitive skills and openness (one of the Big-Five personality measures) of the players affect their cooperation and outcome. Curry et al. (2011) study the connection between psychopathic personality traits and cooperation in prisoner's dilemma and bargaining games, and show that some subscales such as the Machiavellian Egocentricity has negative effects on cooperation but mixed effects on bargaining. Paz et al. (2017) study the effect of self-esteem and fairness in the ultimatum game. They find that self-esteem or fairness didn't affect the decisions of the first mover but affected the decisions or emotions of the second mover. Specifically subjects with higher fairness scores rejected unfair offers more. Men rejected more offers than women. Self-esteem didn't affect the rejection of the offers, however it affected the amount of stress and anger the second player feels in the face of an unfair offers.

In terms of newsvendor decisions, Moritz et al. (2013) have shown that cognitive reflection significantly improves newsvendor performance. Akbay (2016) has shown that self-esteem and regret tendency affect ordering decisions. Subjects with high self-esteem and lower regret tendency place higher orders and under high profit margin setting earn higher profit values In an exploratory study Akbay (2022) has investigated the effect of Hexaco-100 personality

traits in a newsvendor experiment and has shown that fairness and sincerity affects ordering decisions positively while emotional stability decreases demand chasing behavior.

Considering these findings, we believe effect of personality traits in an interactive contracting experiment is an important contribution to the literature.

3. Theoretical Solution and Experimental Procedure

3.1 Theoretical Solution

In this paper, we consider a simple supply chain setting with two firms. Hence the theoretical solution is a simple Stackelberg Game. For a detailed explanation of the theoretical solution see Akbay (2016).

3.2 Experimental Design and Procedure

The parameters of the experiment are as follows:
- Manufacturer's production cost: $3
- Retailer's selling price: $12.
- Demand distribution: Uniform between 51 and 150
- Experiment duration 40 period
- Subject decisions are restricted to be integers

44 subjects participated in the study. The participants are recruited from the student body of a research university. Participants were motivated with monetary reward proportional to their earnings in the experiment. Average reward is $22. The roles and pairs are randomly assigned by the software and stayed same throughout the experiment. The experiment is conducted using HP Mums software. Experiments are conducted in the laboratory and each session lasted about 2 hours.

Surveys are collected online and matched with the experiment data. For self-esteem we use Rosenberg's (1965)self-esteem scale of 10 questions. For regret tendency we use Schwartz et. al's (2002) regret scale. For risk and loss aversion we use Gachter et al.'s (2022) lottery choice questions. For inequity aversion questions we use a scale that is similar to the risk and loss aversion questions but based on the ultimatum game.

4. Experiment Results

Here, we present the results of the personality traits analyses. For the analysis of the experiment data see Akbay (2016).

4.1 Effects of Self-Esteem

Considering the literature, we form the following hypotheses for the effects of self-esteem:

Hypothesis 1a: *High SE retailers place larger orders.*
Hypothesis 1b: *High SE retailers are able to place orders away from the demand mean.*
Hypothesis 1c: *High SE retailers reject more contracts.*
Hypothesis 1d: *High SE retailers earn higher profit.*
Hypothesis 1e*: High SE manufacturers offer higher prices and earn more profit.*

Figure 1 plots various performance measures against the self-esteem score of the retailers. Additionally Results of the regression analyses are presented in Table 1. We expect subjects with higher SE scores to order larger quantities, however in a contracting setting the price they are offered at every period can be different. Therefore, a better measure would be to consider the ratio of the order decision to the optimal order quantity. We don't find any support for this hypothesis. *Hypothesis 1a* is not supported by the data. Secondly, we expect subjects with higher self-esteem scores to make order decisions that are not stuck in the neighborhood of the demand mean. We find some support for this hypothesis in Figure 1 and Table 1, but the effect is not significant. So, *Hypothesis 1b* is weakly supported. For rejection numbers we don't have support in the data for the hypothesis. Finally for *Hypothesis 1d,* we find directional support, but the effect is not significant.

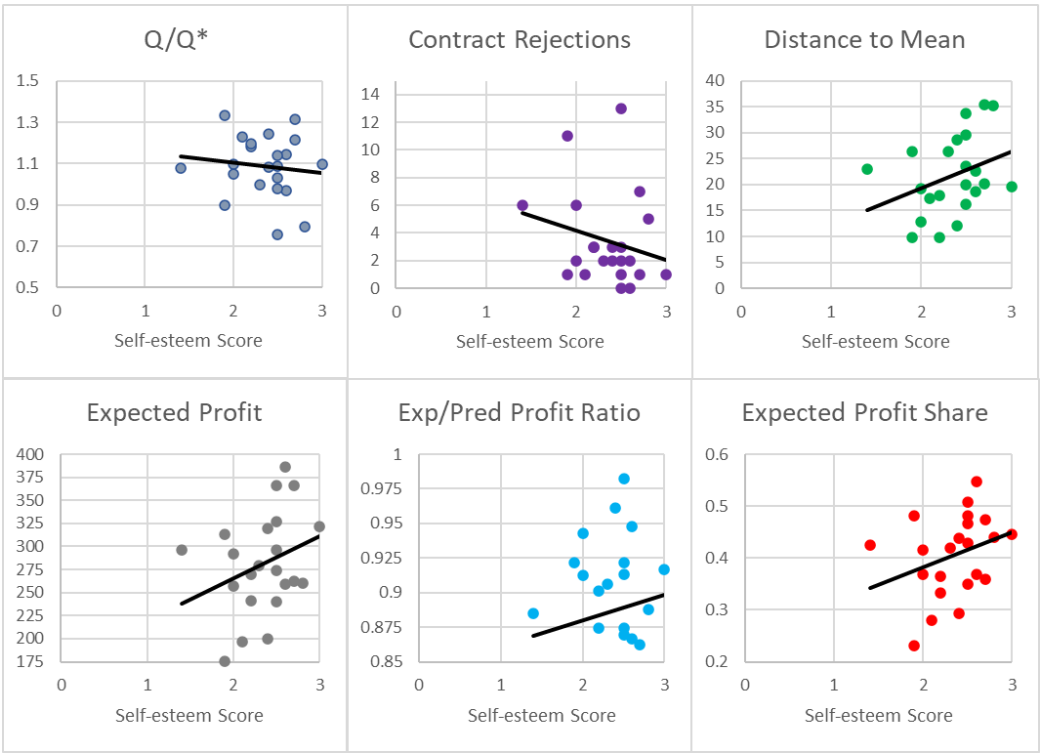

Figure 1. Scatter plot of various performance measures for retailer vs self-esteem scores.

Table 1. Self-esteem regression results for retailer's performance metrics.

Response Var.	Explanatory Var.	Coeff.	Std. Error	P-value	R^2
Average Q/Q* Ratio	Intercept	1.20	0.22	**0.00**	0.01
	SE Score	-0.05	0.09	0.59	
Distance to Mean	Intercept	5.18	10.48	0.63	0.11
	Self-esteem Score	7.05	4.41	0.13	
# Contract Rejections	Intercept	8.36	4.83	**0.10**	0.05
	SE Score	-2.11	2.03	0.31	
Exp/Pred Profit Ratio	Intercept	0.84	0.09	**0.00**	0.01
	Self-esteem Score	0.02	0.04	0.62	
Expected Profit	Intercept	174.57	76.01	**0.03**	0.09
	Self-esteem Score	45.64	31.98	0.17	
Expected Profit Share	Intercept	0.25	0.11	**0.03**	0.10
	Self-esteem Score	0.07	0.05	0.16	

Similar to the retailers, we expect the manufacturers with higher self-esteem scores to earn more profit. For manufacturers of the wholesale price contract the price they offer is directly determines their predicted profit, which is the profit determined assuming that the retailer places the newsvendor optimal order. Thus, higher prices will result in higher predicted profit for the manufacturer. Figure 2 displays directional support for this expectation. Table 2 shows the results of the regression analysis. Although the coefficients of self-esteem score are not significant, their sign confirms our expectations. Hence, we conclude that *Hypothesis 1e* is weakly supported by the data.

Figure 2. Scatter plot of various performance measures for manufacturer vs self-esteem scores.

Table 2: Self-esteem regression results for manufacturer's performance metrics.

Response Var.	Explanatory Var.	Coeff.	Std. Error	P-value	R^2
Predicted Profit	Intercept	368.75	24.13	**0.00**	0.04
	Self-esteem	9.54	10.66	0.38	
Expected Profit	Intercept	353.70	61.46	**0.00**	0.05
	Self-esteem	28.12	27.15	0.31	
Expected Profit Share	Intercept	0.51	0.07	**0.00**	0.08
	Self-esteem	0.04	0.03	0.21	

Thus, we conclude that there is weak or directional support for *Hypotheses 1b, 1c, 1d and 1e.*

4.2 Regret Tendency Analysis

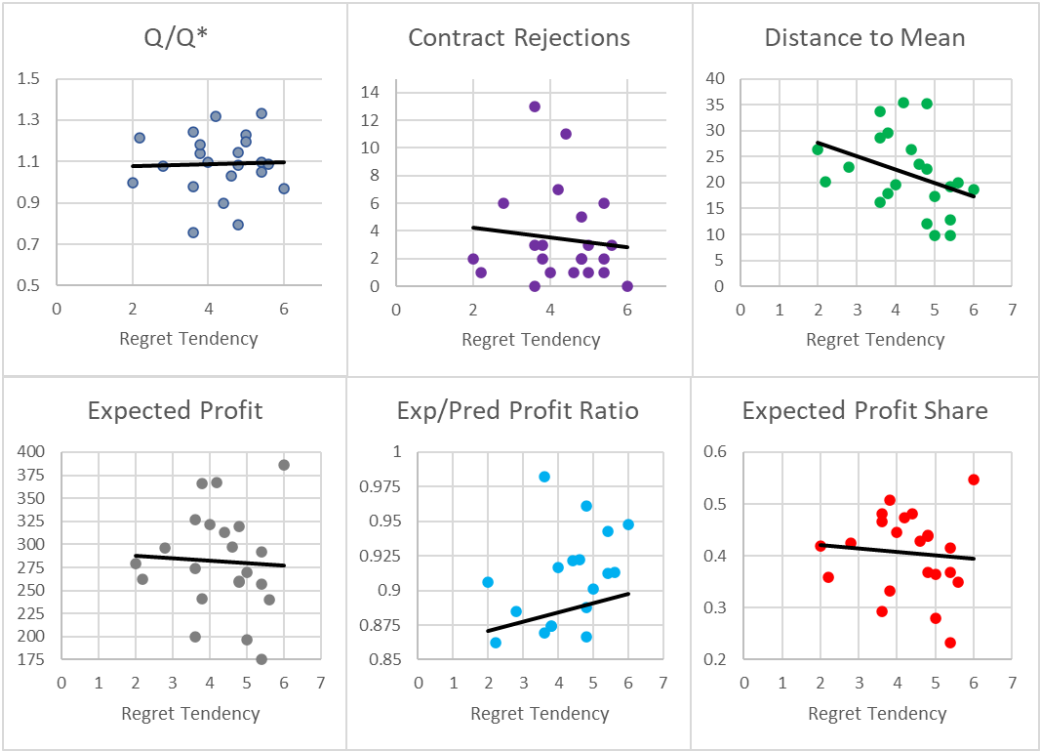

Figure 3. Scatter plot of various performance measures for retailer vs regret tendency scores. (Higher score means higher regret tendency)

Considering the literature, we form the following hypotheses for the effects of regret tendency:

Hypothesis 2a: *High RT retailers place smaller orders.*
Hypothesis 2b: *High RT retailers are more affected by the mean-anchor heuristic.*
Hypothesis 2c: *High RT retailers reject fewer contracts.*
Hypothesis 2d: *High RT retailers earn lower profit.*
Hypothesis 2e*: High RT manufacturers offer lower prices and earn lower profit.*

Figure 3 displays the scatter plot of several relevant performance measures of the retailer decisions against the regret tendency score. Table 3 presents the regression analysis results of these performance measures against the regret tendency of the participants. In this scale a higher score means the subject has a higher tendency to regret their actions afterwards. For retailers with higher regret tendency, we expect them to act more mellow and make less risky decisions. From Figure 3 and Table 3 we don't see support for *Hypothesis 2a.* The average distance of the orders to the demand mean decreases with regret tendency and this effect is significant at 10% significance level. Hence, there is support for *Hypothesis 2b.* From the figure and table we see there is directional support for *Hypothesis 2c*, meaning that subjects with higher regret tendency avoid rejecting contracts. In terms of our expectation regarding the relationship between regret tendency and profit, we see there is partial weak support for *Hypothesis 2d.*

Table 3. Regret tendency regression results for retailer's performance metrics.

Response Var.	Explanatory Var.	Coeff.	Std. Error	P-value	R^2
Average Q/Q* Ratio	Intercept	1.07	0.14	**0.00**	0.00
	RT Score	0.00	0.03	0.89	
Distance to Mean	Intercept	32.94	6.56	**0.00**	0.13
	Regret Tendency	-2.60	1.48	**0.09**	
# Contract Rejections	Intercept	4.95	3.12	**0.13**	0.01

	RT Score	-0.36	0.70	0.62	
Exp/Pred Profit Ratio	Intercept	0.86	0.06	**0.00**	0.01
	Regret Tendency	0.01	0.01	0.60	
Expected Profit	Intercept	292.67	50.49	**0.00**	0.00
	Regret Tendency	-2.52	11.39	0.83	
Expected Profit Share	Intercept	0.43	0.07	**0.00**	0.01
	Regret Tendency	-0.01	0.02	0.69	

For the manufacturers, as their regret tendency increases, we expect them to offer smaller prices to avoid their contract being rejected and earn less profit. From Figure 4 and Table 4, we see these expectations are supported by the data, though not significantly. Hence, we conclude that there is weak support for *Hypothesis 2e.*

Table 4. Regret tendency regression results for manufacturer's performance metrics.

Response Var.	Explanatory Var.	Coeff.	Std. Error	P-value	R^2
Predicted Profit	Intercept	415.02	21.14	**0.00**	0.07
	Regret Tendency	-5.51	4.41	0.23	
Expected Profit	Intercept	475.98	54.47	**0.00**	0.06
	Regret Tendency	-13.19	11.36	0.26	
Expected Profit Share	Intercept	0.67	0.06	**0.00**	0.08
	Regret Tendency	-0.02	0.01	0.22	

Figure 4. Scatter plot of various performance measures for manufacturer vs regret tendency scores. . (Higher score means higher regret tendency)

Thus, we conclude that there is support for *Hypothesis 2b,* and there is weak/directional support for *Hypotheses 2c, 2d and 2e.*

4.3 Risk/Loss Aversion Analysis

Considering the literature, we form the following hypotheses for the effects of risk/loss aversion:

Hypothesis 3a: *High RLA retailers place smaller orders.*
Hypothesis 3b: *High RLA retailers are more affected by the mean-anchor heuristic.*
Hypothesis 3c: *High RLA retailers reject fewer contracts.*
Hypothesis 3d: *High RLA retailers earn lower profit.*
Hypothesis 3e*: High RLA manufacturers offer lower prices and earn lower profit.*

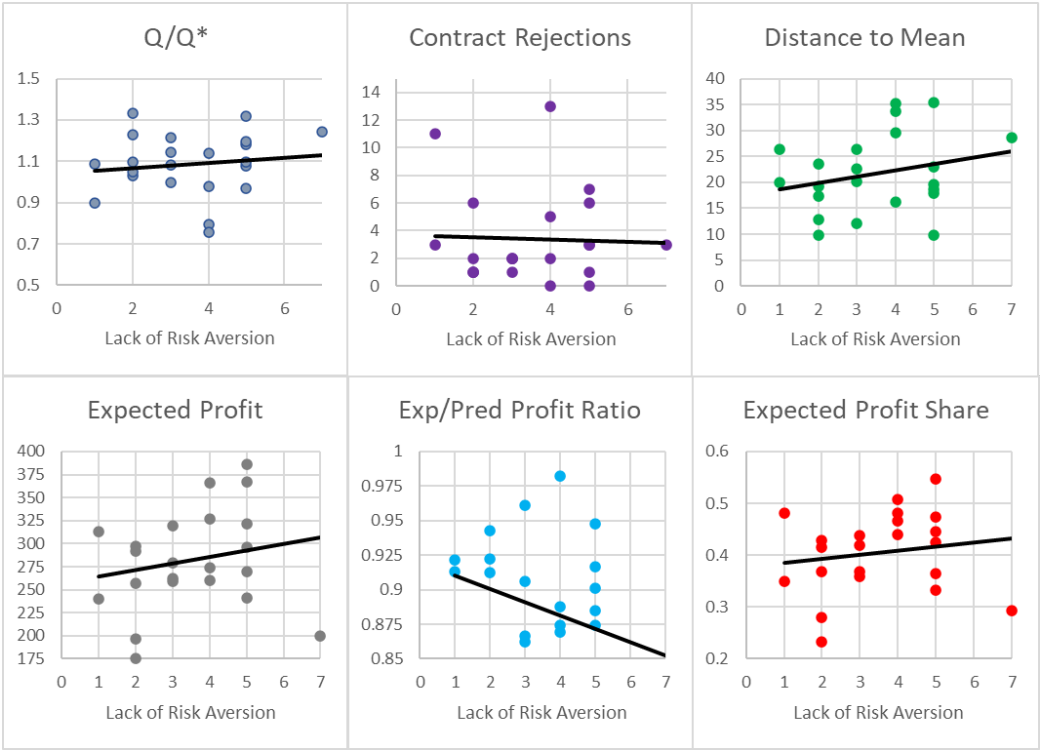

Figure 5. Scatter plot of various performance measures for retailer vs risk/loss aversion scores. (Higher score means lower risk/loss aversion.)

Figure 5 displays the scatter plots of retailer performance measures against the risk/loss aversion scores. Table 5 present the regression results of these measures. From these, we conclude that there is no support for *Hypotheses 3a,* and *3b.* However, there is directional support for *Hypotheses 3c, 3d and 3e.*

Table 5. Risk/loss aversion regression results for retailer's performance metrics

Response Var.	Explanatory Var.	Coeff.	Std. Error	P-value	R^2
Average Q/Q* Ratio	Intercept	1.04	0.08	**0.00**	0.02
	RLA Score	0.01	0.02	0.56	
Distance to Mean	Intercept	17.43	4.02	**0.00**	0.06
	Lack of Risk Aversion	1.23	1.05	0.26	
# Contract Rejections	Intercept	3.71	1.85	**0.06**	0.00
	RLA Score	-0.09	0.48	0.86	
Exp/Pred Profit Ratio	Intercept	0.92	0.03	**0.00**	0.06
	Lack of Risk Aversion	-0.01	0.01	0.26	
Expected Profit	Intercept	256.89	29.14	**0.00**	0.04
	Lack of Risk Aversion	7.12	7.63	0.36	
Expected Profit Share	Intercept	0.38	0.04	**0.00**	0.03
	Lack of Risk Aversion	0.01	0.01	0.48	

Figure 6 displays profit performance measures for the manufacturers against the risk/loss aversion scores. Table 6 presents the regression results of these measures. From these we conclude that there is weak support for *Hypothesis 3e.*

Figure 6. Scatter plot of various performance measures for manufacturer vs risk/loss aversion scores. (Higher score means lower risk/loss aversion.)

Table 6. Risk/loss aversion regression results for manufacturer's performance metrics

Response Var.	Explanatory Var.	Coeff.	Std. Error	P-value	R^2
Predicted Profit	Intercept	386.82	15.25	**0.00**	0.00
	Lack of Risk Aversion	0.90	4.45	0.84	
Expected Profit	Intercept	404.51	39.06	**0.00**	0.00
	Lack of Risk Aversion	3.44	11.38	0.77	
Expected Profit Share	Intercept	0.58	0.04	**0.00**	0.01
	Lack of Risk Aversion	0.00	0.01	0.69	

4.4 Inequity Aversion Analysis

Considering the literature, we form the following hypotheses for the effects of regret tendency:

Hypothesis 4a: *High IA retailers reject more contracts.*
Hypothesis 4b: *High IA retailers earn more profit.*
Hypothesis 4c: *High IA manufacturers offer smaller prices and earn lower profit.*

From Figure 7 and Table 7 we observe there is weak support for *Hypothesis 4a.* However, we see results opposite our expectations for the profit comparisons. Retailers with less inequity aversion earn higher profit. Hence, *Hypothesis 4b* is rejected by the data.

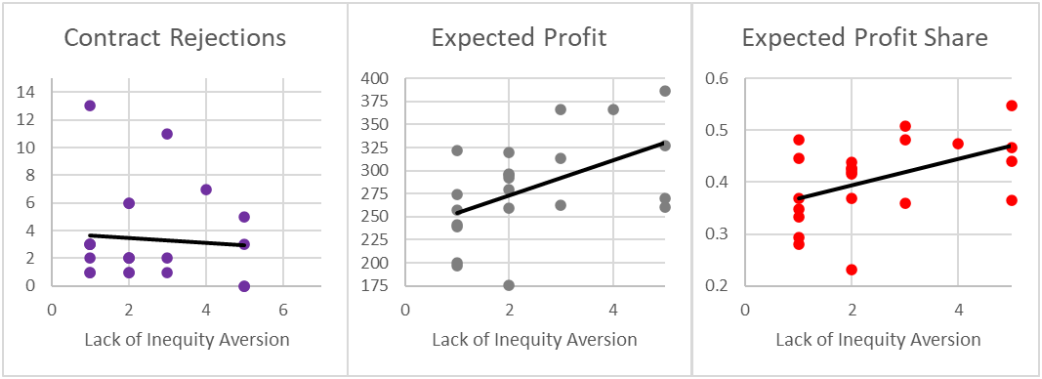

Figure 7: Scatter plot of various performance measures for retailer vs inequity aversion scores. (A higher score means lower inequity aversion.)

Table 7: Inequity aversion regression results for retailer's performance metrics

Response Var.	Explanatory Var.	Coeff.	Std. Error	P-value	R^2
# Contract Rejections	Intercept	3.85	1.46	**0.02**	0.01
	Inequity Aversion	-0.18	0.51	0.73	
Expected Profit	Intercept	235.58	20.32	**0.00**	0.26
	Lack of Inequity Aversion	18.84	7.14	**0.02**	
Expected Profit Share	Intercept	0.34	0.03	**0.00**	0.22
	Lack of Inequity Aversion	0.03	0.01	**0.03**	

Our expectation for *Hypothesis 4c* also fails as Figure 8 and Table 8 show that with higher inequity aversion manufacturers offer higher prices.

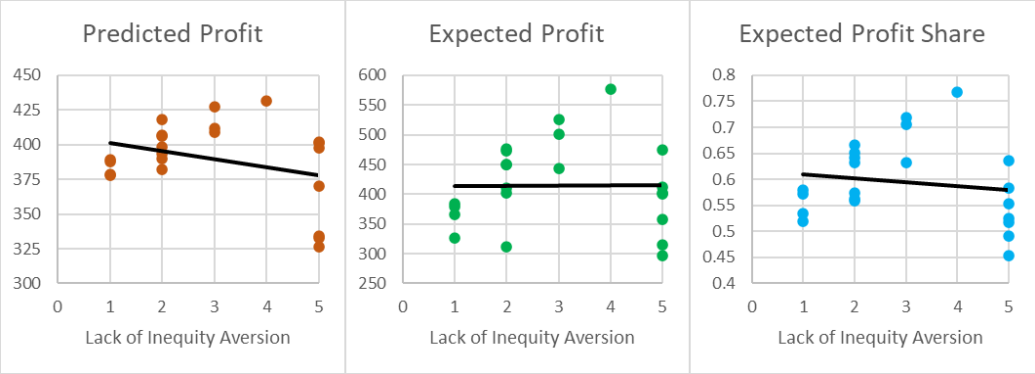

Figure 8. Scatter plot of various performance measures for manufacturer vs inequity aversion scores. (A higher score means lower inequity aversion.)

Table 8. Inequity aversion regression results for manufacturer's performance metrics

Dependent Variable	Independent Variable	Coeff.	Std. Error	P-value	R
Predicted Profit	Intercept	407.22	12.84	**0.00**	0.11
	Lack of Inequity Aversion	-5.86	3.81	0.14	
Expected Profit	Intercept	414.61	34.81	**0.00**	0.00
	Lack of Inequity Aversion	0.23	10.33	0.98	
Expected Profit Share	Intercept	0.62	0.04	**0.00**	0.02
	Lack of Inequity Aversion	-0.01	0.01	0.49	

5. Conclusion

In this study we examine the correlation between self-esteem, regret tendency, lack of risk/loss aversion, lack of inequity aversion and supply chain contracting decisions. Our findings show that there is some weak directional support for the hypotheses about the effect of self-esteem, regret tendency and lack of risk/loss aversion. Some of our hypotheses are rejected by the data. Here, we must note that the study is conducted with a limited number of subjects; there were 22 manufacturer-retailer pairs in this study. This sample size is quite small for comparisons we attempted to do in this paper. As a matter of fact the sample sizes in a similar study about newsvendor behavior conducted by Akbay(2016) is much larger and they were able to obtain significant results in their analyses. Hence a further study with a larger sample size seems necessary in order to come up with more definite conclusions. Nevertheless we believe with this study we made an important contribution to the behavioral operations study.

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Biographies

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Murat Kaya is currently working as an assistant professor at the Industrial Engineering Program of Sabancı University, Istanbul, Turkey. He received his BSc degree in industrial engineering from the Middle East Technical University (METU), Ankara, Turkey and his M.S. and Ph.D. degrees in Management Science and Engineering (MS&E) from Stanford University. During his Ph.D. study, Dr. Kaya has worked for several projects at Hewlett Packard Research Laboratories in Palo Alto, USA. Dr. Kaya's research is concerned with strategic decision analysis in supply chains. Having worked with traditional supply chains in apparel, FMCG, automotive and pharma industries, Dr. Kaya's recent interest is directed towards applied decision & optimization problems in energy supply chains. His research has been supported by an EC Marie Curie International Reintegration Grant (IRG). At Sabancı University, Dr. Kaya has been the academic director of the Energy Technologies and Management (ETM) graduate program since 2018. He served as the Vice Dean of the Faculty of Engineering and Natural Sciences (FENS) between 2019-2020. Dr. Kaya is also affiliated with Sabancı University Istanbul International Center for Energy and Climate (IICEC). He is a recipient of numerous teaching awards of the University.