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The Impact of An Interaction between Product Quality and Perceived Risk on Seller Profit

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Abstract

Purpose: This study examines the effect of full information disclosure on seller profit when there exists information asymmetry between sellers and buyers, focusing on the risk averseness of buyers. By investigating the interaction between product quality and perceived risk through online sales data, we attempt to figure out the incentive structure of full information disclosure specifically when buyers are risk-averse, so that we can suggest more feasible information disclosure strategy to sellers. **Research design, data and methodology:** Our empirical model analyzes the sales data of collectible goods from a major online seller using Poisson regression. In our model, we have specifically considered risk-averseness of buyers by estimating the interaction effect between the product quality and perceived risk on seller profit, aiming for a more precise empirical analysis on sellers' incentive structure of full disclosure. **Results:** Our empirical analysis strongly supports the effect of interaction between product quality and perceived risk, showing that the incentive for full disclosure is much stronger when product quality is higher, and vice versa. Therefore, sellers are strongly encouraged to voluntarily reveal product weaknesses when their product quality is higher than average, while it is more profitable to hide any product defects when quality claim is lower than average. **Conclusions:** This study supports the related literature by confirming economic incentives for full disclosure, and also supplements and strengthens previous studies by presenting that the effect of interaction between product quality and perceived risk strongly affects seller profit. Our unique finding supports both mandatory disclosure and voluntary disclosure arguments and presents practical implications to marketing managers by suggesting that seller's incentive for revealing weaknesses depends on the level of seller′s product quality.

Keywords : Information Asymmetry, Lemon Market, Online Auction, Quality Certification, Risk Aversion

JEL Classification Code: D81, D83, M31

1. Introduction[1]

1.1. Motivation

As product attributes get more complex and information asymmetry in markets becomes more serious, seller's information disclosure has become one of the main factors of marketing strategy. More specifically, when buyers cannot evaluate certain attributes before purchase (Nelson, 1970) or even after purchase (Darby & Karni, 1973), the information asymmetry between sellers and buyers plays a critical role in determining both sellers' and buyers' benefit, and many sellers actually decide to conceal negative information as much as possible in order to maximize profit under these circumstances. For example, when more than 500 new cars in the U.K. market were

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tested for their fuel figures, 95.5 percent showed lower miles per gallon (MPG) than officially claimed figures even under manufacturers' suggested driving conditions (http://www.whatcar.com/car-news/car-true-mpg-winners-losers/1200728). In this case, most car manufacturers were found to be concealing the fact that actual MPG figures were smaller than their claims, believing that customers would not be able to fully test MPG figures under proper conditions. Fraud in the olive oil market was also found to be a big issue, as a study found that 69 percent of imported olive oils labeled "extra virgin" did not actually meet the standard (Frankel et al., 2010). In this case, sellers were hiding the fact that the actual grades of their olive oils were lower than "extra virgin," since most customers could not accurately evaluate the grade. Similar examples of incomplete information disclosure under informational asymmetry can be readily observed in many other markets.

What we find interesting is that it is also not uncommon to witness sellers voluntarily disclosing unfavorable information about their products and services. Many online retailers, including Amazon.com, disclose information about weaknesses of the products they offer through various routes such as customer reviews on their own websites. Woot.com is especially famous for its preemptive revelation of the disadvantages of listed products, as they clearly state that they would prefer customers not to buy from them than to have customers regret their purchases (https://archive.is/b9cxI). Traditional firms also show willingness to communicate weaknesses about their products to customers. In 2012, Four Seasons Hotels renovated their websites and included customer reviews for each of their 80+ properties directly from Twitter, Facebook, and TripAdvisor, without censoring any of the unfavorable comments. Chipotle Mexican Grill's website not only explained positive aspects of their ingredients, but also clearly indicated drawbacks of the ingredients through a "Room for Improvement" section. Hans Brinker Hotel in Amsterdam, the Netherlands is famous for its strategy of honestly revealing its low quality to customers, and actively explaining negative aspects of their services such as rooms without a view and no hot water, through pictures and detailed descriptions. Nevertheless, a lot of travelers visiting Amsterdam still choose to stay at this hotel and leave positive reviews (https://archive.is/N9ZhL). As these examples show, some sellers do voluntarily share information about weaknesses of their products or services, thereby raising a question: When and how can sellers benefit from such disclosures? The question is both interesting and important, as sellers' decisions to hide any negative aspects of their products often lead to various market failures.

Nevertheless, the motivation for the sellers with low-quality products to fully disclose unfavorable information has rarely been studied in the literature. Therefore, this study attempts to investigate whether, when, and how sellers' disclosure of unfavorable information may benefit themselves. In examining the effect of seller's information disclosure, we have focused on how perceived risk of buyers affects market outcomes. Ever since Bauer (1960) first identified the concept of risk as a major influence on customer choice, various researchers have produced some general understanding about perceived risk of purchase (Dowling, 1986; Markin, Jr., 1974; Ross, 1975; Stone & Winter, 1985; Taylor, 1974). The literature has generally considered perceived risk of purchase to be the function of two factors: the probability and the size of loss from purchase (Dowling, 1986; Markin, Jr., 1974; Peter & Ryan, 1976; Peter & Tarpey, Sr., 1975; Ross, 1975; Srinivasan & Ratchford, 1991; Taylor, 1974). Perceived risk has a pseudo-vertical characteristic since customers usually try to decrease the probability rather than the size of loss when attempting to reduce the risk before purchase (Cox, 1967; Markin, Jr., 1974; Peter & Ryan, 1976; Ross, 1975). In other words, if buyers are risk-averse, they will carefully consider any misleading information from sellers, and would prefer any products which provide more trustworthy information, and are thus less likely to be risky.

From this understanding, we estimate and analyze an empirical model to understand how the disclosure of unfavorable information affects market outcomes, focusing on risk-averse buyers' reaction. Our model basically adopts the empirical models of Huh (2021) that has examined the effect of sharing unfavorable information in online markets. However, we believe their assumption of uniformly distributed risk sensitivity is somewhat limited to explain real market outcomes, and thus clearly consider buyers' risk-averseness in our empirical model. Surprisingly, the updated assumption of risk-averse customers has actually presented a meaningful result with a more realistic interpretation about the effect of sellers' full disclosure. More specifically, due to the interaction effect between perceived risk and product quality, the incentive for revealing any weaknesses becomes much larger as the quality of product gets higher. Therefore, we can conclude that hiding any negative aspects hurts seller profit when the actual quality is higher than average, while fraudulent claim seems to be more effective when the actual quality is lower than average. More detailed analysis will be presented in the following chapters.

1.2. Related Literature

There has been a series of literature in economics and marketing that investigates the lack of full information

disclosure in markets. First, the inclination of low-quality sellers to hide quality information has been regarded as one of the main reasons why we do not observe full disclosure. The literature supporting mandatory disclosure has argued that full disclosure does not happen because low-quality sellers try to withhold quality information under various circumstances, such as high disclosure cost (Verrecchia, 1983; Viscusi, 1978), highly competitive environment (Board, 2009; Cheong & Kim, 2004; Guo & Zhao, 2009; Hotz & Xiao, 2013; Stivers, 2004), irrational customers (Fishman & Hagerty, 2003; Harbaugh et al., 2011; Hirshleifer et al., 2004; Schwartz, 2008), and others (Bar-Isaac et al., 2012; Gavazza & Lizzeri, 2007; Grubb, 2011; Matthews & Postlewaite, 1985; Milgrom & Roberts, 1986). The literature has also generally agreed that there exist incentives for high-quality types to reveal their types, but not for low-quality types (Akerlof, 1976; Milgrom, 1981; Milgrom & Weber, 1982; Spence, 1973). Our study attempts to counter-argue these studies by empirically examining possible incentives for sellers to fully disclose any unfavorable information.

Although there have not been a lot of studies which investigate how unfavorable information benefits sellers, a few recent studies have investigated possible economic incentives for sellers to voluntarily reveal negative information. For example, Berger et al. (2010) have investigated how negative publicity can help sellers. This study has shown that negative reviews by the *New York Times* may increase awareness of less-known books, resulting in boosted sales. Tadelis and Zettelmeyer (2015) have investigated the situation where separate markets exist for products with different quality levels, and discovered that negative information can perform the role of a matching mechanism and increase sales of low-quality products. While these papers have focused on rather special cases, such as the product with low awareness or the customers who look for low-quality products, Huh (2021) has provided more universal explanations on how full disclosure helps sellers through examining online sales data of some collectible goods. Our study thus attempts to support and strengthen this finding through adopting a more realistic assumption and provide more feasible strategic suggestions on how sellers can benefit from the disclosure of weaknesses of their products.

As this study empirically investigates the effect of information signaling in an online environment, it is also closely related with some recent studies such as Jin and Kato (2006), Lewis (2011), and Li et al. (2009).

While Li et al. (2009) and Lewis (2011) have contributed to the literature through investigating various types of risk intermediaries, they have not looked at the effect of quality claim, which is actually the main factor of our study. Although Jin and Kato (2006) have estimated the variable representing the product quality as we do, the focus and results are different from ours as they have shown that overstating quality may work positively for low-quality sellers, only supporting mandatory disclosure policy.

2. Empirical Model

2.1. Risk-Averse Buyers

As is explained, this study attempts to achieve a more precise understanding of the incentive structure of sellers' information disclosure by considering more realistic market environments. More specifically, while Huh (2021) has assumed that buyers are uniformly distributed according to their risk sensitivities, our study considers that buyers are generally risk-averse and thus there exist more risk-sensitive buyers than risk-insensitive buyers, based on the following reasons. First, many studies that have observed the risk propensities of customers have shown that there exist more risk-averse customers than risk-loving customers. For example, Binswanger (1980) has observed the risk propensities of Indian customers through an experimental gambling method and found that the number of customers has increased as the risk propensity moves from risk-taking to risk-averse. It has also observed that the customers' risk aversion has increased as the payoff size of their gambling gets larger. Second, to replicate Binswanger (1980)'s observation and confirm our assumption, we have run several sessions of monetary gambles, which is one of the most widely used methods in the literature to estimate people's risk propensity (Binswanger, 1980; Holt & Laury, 2002), with 718 undergraduate students at a public university. We have measured our subjects' risk propensities from 1 (extreme risk aversion) to 6 (extreme risk preference), and observed that the number of risk-averse people is generally larger than the number of risk-taking people. In Table 1, we can see that the numbers actually decrease as risk-sensitivity diminishes, which is consistent with the findings from Binswanger (1980). Therefore, we have gained supports for the assumption of this study that the number of risk-sensitive buyers is larger than risk-insensitive buyers, from both previous literature and our own observations.

Table 1: Observed Distribution of Risk Propensities

	Extremely Risk-Averse	Fairly Risk-Averse	Moderately Risk-Averse	Moderately Risk-Taking	Fairly Risk-Taking	Extremely Risk-Taking
Number of Subjects	512	105	45	18	12	26
%	71.3	14.6	6.3	2.5	1.7	3.6

Note: Percentage numbers are calculated based on 718 subjects.

To apply this assumption to our empirical model, we consider a factor of interaction between the level of product quality and the level of perceived risk, and the rationale goes as follows. If more customers are risk-averse, lower-risk products will be more popular than higher-risk products. Therefore, the absolute change in demand caused by the unit change in product quality will be higher for low-risk products than high-risk products, as more buyers are interested in the products with low-risk. We thus hypothesize the interaction effect between the quality and perceived risk, because the effect of product quality on demand will be affected by the perceived risk of the product.

This interaction effect suggests important implications about the incentive for full information disclosure. Figure 1 shows that the impact on demand caused by the unit change in quality level is lower for the product with high risk than for the product with low risk, due to the suggested interaction. We can also see from this graph that the same amount of reduced product risk increases the demand for high-quality product more ($\Delta Demand^H$) than the demand for low-quality product ($\Delta Demand^L$), because of the interaction effect.

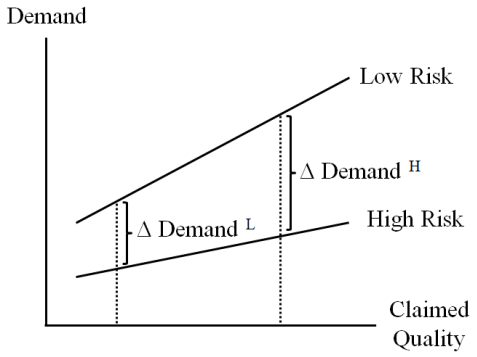

Figure 1: Interaction between Claimed Product Quality and Perceived Risk

Therefore, the effect of perceived risk on demand is stronger for high-quality products than low-quality products. Judging from these, we can expect that the seller's incentive for disclosure of weaknesses is affected by the level of product quality. We will look into this prediction more in detail with the empirical analysis below.

2.2. Data

As Huh (2021) has done in their study, we also investigate some collectible goods sold online, because these product categories show clear information asymmetry, have different levels of perceived risk among products due to third-party certification, and the quality of the products can be easily compared through their respective universal grading standards. From numerous kinds of collectible goods actively traded, we have chosen collectible baseball cards for our analysis, and have collected the sales data of 456 cards from eBay. Among them, 225 cards were professionally graded while 231 cards were not professionally graded.

2.3. Variables

Following previous studies on Internet auctions and pursuing our research object, we have carefully selected the variables appropriate for our study. Since our main interest is to figure out how demand is affected by information disclosure and other factors, the number of unique bidders is chosen as a dependent variable. We use the number of bidders as a proxy to estimate the size of demand for each product since each bid in an eBay auction is regarded as a legal contract to purchase the product (When you bid on a product at eBay, you see a message that says, "By clicking Confirm bid, you commit to buy this product from the seller if you are the winning bidder."). Next, the variables that we believe to influence the number of bidders in this empirical application are selected as potential candidates for independent variables and classified into four groups: perceived risk, claimed quality, price of the product, and others.

We have chosen the first variable for perceived risk as the dummy indicating whether the product grade is certified or not. If the product is graded and certified, the perceived risk is assumed to be low. Moreover, since the

product's physical condition is critical in determining quality level, product pictures can also reduce perceived risk, and thus how many card sides are shown in high-resolution pictures is also chosen as an independent variable. The variables measuring seller-side risk are the feedback score, a dummy variable for hundred-percent positive feedback, and a dummy variable for "Top Rated" seller. eBay defines the feedback score by subtracting the number of negative feedback from the number of positive feedback, and entitles "Top Rated" to those sellers who meet a few requirements, such as keeping an eBay account for at least ninety days, a positive feedback of at least ninety-eight percent, and at least hundred transactions and $1,000 in sales over recent twelve-month period. The claimed quality is represented by the standard grade the seller announces, which ranges from 1 (Poor) to 10 (Gem Mint). In terms of the price, we observe starting price and shipping price, but not final price, as a seller cannot directly control it. Finally, other variables include the auction length, delivery time, return period, and the dummies measuring whether the auction finishes during prime time or weekend (Melnik & Alm, 2002).

2.4. Specification

The dependent variable - the number of unique bidders - has mostly been regarded as being exogenous in auction literature. More specifically, those literature has analyzed traditional auction markets where the number of bidders is fixed and also commonly shared to all participants (Athey & Haile, 2002; Bapna et al., 2004). However, the literature on online auction has considered the number of bidders to be random and some have considered the arrival of buyers (i.e., the number of bidders) to follow a Poisson process (Ackerberg et al., 2006; Bajari & Hortacsu, 2003; Etzion et al., 2006; Hong & Nekipelov, 2012). As we obtained our sales data from an online auction, we follow the perspectives of these online auction studies and run count data analysis for our investigation.

Before our count data analysis, we have first checked over-dispersion to determine whether Poisson or negative binomial distribution conforms to our data. The likelihood ratio test for over-dispersion shows a very low chi-squared value. Since over-dispersion parameter alpha is not significant (p = 0.49), we can see that negative binomial and Poisson distributions are not different and that over-dispersion is not serious in our case. In terms of zero-inflation, we cannot confirm that there exists any separate process causing zero bidders in our auction data, and the Vuong statistics (obtained from *ZIPCV* and *ZINBCV* of STATA 13.1) do not support the zero inflation either. Based on these results, we continue with a Poisson regression to analyze our data.

3. Empirical Analysis

3.1. Estimation

We now explicitly check the suggested interaction effect to examine what impacts it has on seller's incentives for information disclosure. While the basic structure of our empirical analysis follows the empirical model of Huh (2021), we modify the primary assumption and consider that there are more risk-averse buyers. Based on this, our model introduces an interaction between the dummy showing whether the card is professionally graded and the card grade announced by the seller. Now we can assume that the number of unique bidders for item j sold by seller i follows a Poisson distribution where the mean of the distribution is demonstrated by the parameter λ_{ij}:

$$\text{Prob}\ (Q_{ij} = q) = \frac{e^{-\lambda_{ij}}\lambda_{ij}^{q}}{q!},$$

$$\text{where } q = 0, 1, 2, \ldots, \text{and } \ln(\lambda_{ij}) = \beta \cdot X_{ij}.$$

Here, we apply the following specification for independent variables:

$$\begin{aligned}\beta \cdot X_{ij} = {} & \beta_0 + \beta_1 \cdot \text{Dummy for Professional Grading}_{ij} \\ & + \beta_2 \cdot \text{Number of Card Sides Shown with High Resolution Pictures}_{ij} \\ & + \beta_3 \cdot \text{Feedback Score}_{ij} + \beta_4 \cdot \text{Dummy for Positive Feedback Only}_{ij} \\ & + \beta_5 \cdot \text{Dummy for "Top Rated" Seller}_{ij} + \beta_6 \cdot \text{Claimed Card Grade}_{ij} \\ & + \beta_7 \cdot \text{Auction Starting Price}_{ij} + \beta_8 \cdot \text{Shipping Price}_{ij} \\ & + \beta_9 \cdot \text{Dummy for Professional Grading}_{ij} \times \text{Claimed Card Grade}_{ij}\end{aligned}$$

The final variable here represents the interaction effect of our interest, and Table 2 shows the result of this estimation. While main variables (whether the card is certified, card grade, and starting price) are significant under this modified model, we can analyze the key consideration of the model's specification by observing the changes caused by the interaction effect. Table 2 presents that the interaction effect is strongly significant (with p < 0.01), meaning that the effect on demand caused by the change in product quality is much bigger when the product is certified and has low risk. Therefore, the modified

assumption applied in our empirical model seems to be much more feasible and true to the real market situation.

Table 2: Estimation Results

Perceived Risk		
Dummy = 1 if professionally graded	-1.8781	***
	(0.5173)	
Number of card sides clearly shown	0.0812	*
	(0.0422)	
Feedback score	0.00000161	**
	(0.000000741)	
Dummy = 1 if only positive feedback	0.0404	
	(0.0576)	
Dummy = 1 if "top rated" seller	0.0324	
	(0.0605)	
Claimed Quality		
Claimed card grade	0.1304	***
	(0.0403)	
Price		
Auction starting price ($)	-0.0542	***
	(0.0030)	
Shipping price ($)	-0.0072	
	(0.0167)	
Interaction		
Dummy = 1 if professionally graded * Claimed card grade	0.2341	***
	(0.0601)	
Observations	451	
Chi-squared	497.16	***
d.f.	9	

*** p<0.01
** p<0.05
* p<0.1.

3.2. Interpretation of Results

We now explore more about the findings from our empirical model that the incentive for full information disclosure differs with the product quality, focusing on the effect of interaction. More specifically, since the estimated coefficient for the interaction effect is 0.234, the factor of $e^{(0.234)} \approx 1.264$ should be counted when the card is professionally graded and has lower risk.

Based on this calculation, we can now analyze the comprehensive effects of these variables to figure out either overstating quality or disclosing low quality helps sellers. In order to do this, we have estimated demand for three different strategies of sellers: i) overstating quality, ii) revealing true quality with no certification, and iii) revealing true quality with certification. For the first strategy, we assume that sellers dishonestly overstate the quality of their baseball cards by a half grade. For the second strategy, we assume that sellers reveal the true quality of their baseball cards, without presenting any certification to support the quality claims. For the third strategy, we assume that sellers reveal true quality and support their claims using certification. We can now observe how the incentive for information disclosure works with respect to the quality levels. For this analysis, all other continuous variables and dummy variables are fixed at mean and zero values, respectively.

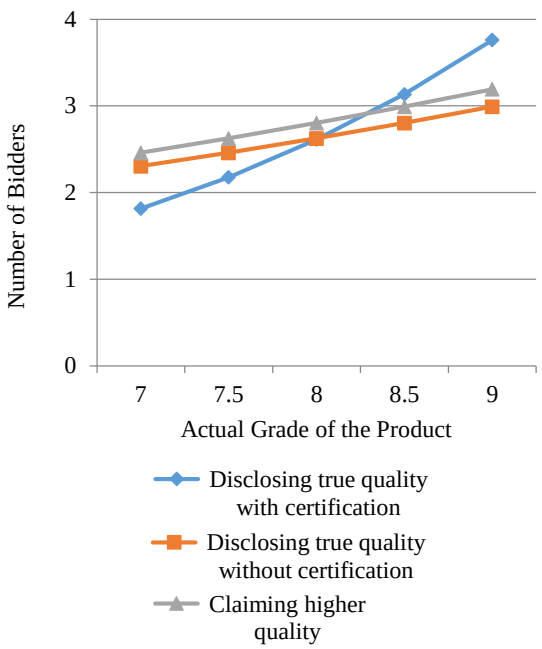

Figure 2: Plotted Demand with Interaction

Figure 2 shows the estimated demand of sellers' all three strategies by which we can examine and compare the incentives of information disclosure among these three options. First, we can consider a case where the seller's product has lower than average quality. For example, suppose a seller is selling a baseball card which has an actual grade of seven (Although the grading system for collectible baseball cards ranges from 1 to 10, the value of most cards in the market stand between 7 and 10. Moreover, according to the summary statistics, the average grade of the baseball cards in our data is 8.44, and the median value is 8.5. Therefore, a card with a value of 7 can be regarded as a lower than average quality product, while a card with a value 9 can be regarded as a higher than average quality product.). Now, the seller can select one of the three strategies above: he either overstates the quality and claim that the card has a grade of seven and a half, reveals true quality of seven with no certification, or reveals true quality of seven with certification. According to our empirical result, if a seller claims the actual value to be seven and a half, the number of bidders is expected to be 2.46. If this seller reveals the true quality of seven but does not show certification, the demand is expected to be 2.3, that is lower than the first strategy. Moreover, if this seller reveals the true quality of seven and show certification, the demand is estimated to decrease to 1.81, that is even lower than the second strategy. Therefore, the demand for the product revealing true quality will not be higher than the demand for the product which falsely claims higher quality, even with certification, when actual quality is lower than average.

Second, we can consider a case where the seller's product has higher than average quality. For example, suppose a seller is selling a baseball card which has an actual grade of nine. Again, the seller can select one of the three strategies above: he either overstates the quality and claim that the card has a grade of nine and a half, reveals true quality of nine with no certification, or reveals true quality of nine with certification. According to the empirical result, if a seller claims the actual value to be nine and a half, the number of bidders is expected to be 3.19. If this seller reveals the true quality of nine but does not show certification, the demand is expected to be 2.99, that is lower than the first strategy. However, if this seller reveals the true quality of nine and show certification, the demand is estimated to rise to 3.76, that is a lot higher than the first and second strategies. Therefore, the demand for the product revealing true quality and reducing risk will be higher than the demand for the product overstating quality, when actual quality is higher than average.

Therefore, the results from two cases with lower-than-average and higher-than-average qualities present that the economic incentive for honestly revealing true quality is bigger than the incentive for fraudulently overstating quality when the original quality level is high. These economic incentives are summarized in Table 3, where the information disclosure strategies achieving the highest demand are shown in bold characters.

Table 3: Estimated Demand with Information Disclosure

	Actual Quality of Baseball Card				
	7	7.5	8	8.5	9
Fraudulently increasing the grade by one half	**2.46**	**2.63**	**2.80**	2.99	3.19
Disclosing true quality					
Without certification	2.30	2.46	2.63	2.80	2.99

With certification	1.81	2.18	2.61	**3.13**	**3.76**

Notes: All other continuous variables and dummy variables are fixed at mean and zero values, respectively. The cases showing the highest demand for each quality level is presented in bold.

This asymmetric incentive structure for information disclosure is more noticeable if we compare Figure 2 with Figure 3 below. Figure 3 shows the demand without considering interaction estimated by Huh (2021), while Figure 2 shows the estimated demand with the interaction considered. What we can observe from these graphs can be summarized as follows. Under the assumption of uniform distribution of customers with respect to their risk propensity, the incentive of revealing true quality with certification can always be bigger than the incentive for dishonestly claiming high quality throughout all quality levels, although the gap is not substantial. However, under the assumption that there exist more risk-averse customers than risk-taking customers, the incentive for revealing true quality with certification is way bigger than the incentive for dishonestly claiming high quality when the product has higher-than-average quality, while dishonestly claiming high quality seems to be more appropriate when the product has lower-than-average quality. Overall, the result of our empirical analysis shows that while there exists an incentive for revealing true quality, this incentive becomes even more evident when the product quality is higher than average.

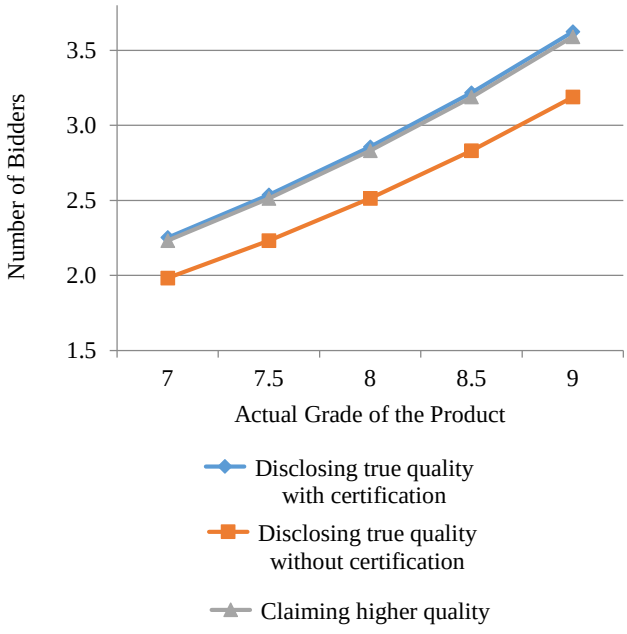

Figure 3: Plotted Demand without Interaction

3.3. Summary

A careful consideration of the interaction between whether the product is certified and the level of product quality has provided us with a more appropriate explanation about the incentive structure for full disclosure, and the effect from suggested interaction seems very clear if we compare Figure 2 with Figure 3. More specifically, in the model without the interaction considered, the effect of honest quality disclosure exists but is not significant, making it somewhat debatable to encourage sellers for voluntary information disclosure. However, the modified empirical analysis of our paper clearly shows how information disclosure works based on the product's quality level, and may strongly suggest honest disclosure of product's weaknesses when the quality is higher than average. We believe that this interesting result owes a lot to the observation that there are more risk-averse customers than risk-loving customers in the market, and our finding is also consistent with the findings of Dewally and Ederington (2006) where they have empirically found the similar interaction affecting the final price of the auction for comic books.

Therefore, our empirical result might support both voluntary disclosure and mandatory disclosure arguments in the literature. More specifically, our study has presented that honest disclosure is better than overstating quality when the product has high quality, verifying the evidence for voluntary disclosure, while it is the opposite when the product has low quality, suggesting the need for mandatory disclosure. More empirical studies on various other product categories are needed to fully understand this asymmetric incentive structure for full disclosure.

4. Discussion

Overall, this study has attempted to examine the effect of sellers' full disclosure, in particular by considering the existence of risk-averse buyers. We have basically measured the effects of full disclosure on demand through observing the sales data of collectible baseball cards, and shown that sellers may benefit from voluntarily disclosing unfavorable information. More importantly, relaxing the assumption of uniform distribution of customers' risk propensity and replacing it with a more practical assumption that the number of risk-averse customers is

larger than the number of risk-taking customers, we could have suggested more feasible marketing communications strategy under information asymmetry. More specifically, it has been verified that the incentive to honestly disclosing true quality is bigger than the incentive to dishonestly claiming high quality when the product has higher-than-average quality, due to the interaction between product quality and perceived risk. For this reason, marketing managers might be more likely to hide any weaknesses when selling low-quality products while they might voluntarily reveal those same weaknesses when selling high-quality products. Our result thus also provides explanations on why frauds in product descriptions or overstatements in advertising might be more often observed with low-quality products than with high-quality products, and also suggests that customers should be more careful about frauds or false claims when purchasing low-quality products.

As the incentive to reveal unfavorable information has rarely been analyzed in the literature, our study's contribution to the literature is evident as we provide various unique perspectives about the information asymmetry in markets. While the observation that disclosing low quality provides effective incentives to sellers generally supports voluntary disclosure, the finding that the incentive might only exist when the product quality is higher than certain level might support mandatory disclosure. The dimensions covered in this study may also provide meaningful public policy suggestions to solve fraud and market failure issues happening in many markets across various industries.

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