The Value of Feedback:
An Analysis of Reputation System

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Abstract

Markets prone to asymmetric information employ trust mechanisms to overcome inefficiencies arising from adverse selection and/or moral hazard. We explore a change in such a trust mechanism and its effect on the marketplace. Starting 2008, sellers on eBay can no-longer leave non-positive feedbacks for sellers to prevent retaliation. We show that this policy had two important impacts: first, the very worst sellers who used retaliation in the past exit the market disproportionately, resulting in an increase in sellers’ quality and reduction in adverse selection; second, the quality of transactions by surviving sellers increased, consistent with a reduction in moral hazard.

Keyword: eCommerce, Reputation, Feedback Ratings, Retaliation, Moral Hazard, Adverse Selection

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1 Introduction

Markets prone to asymmetric information problems may suffer due to adverse selection and/or moral hazard. The share of these markets in the total GDP is rising given the high growth rate of various e-commerce businesses. Examples of such markets include eBay, Amazon Marketplace, Alibaba, Tabao in retail; Airbnb and VRBO in room and house sharing; Uber and Lyft in transportation; and oDesk in the freelance and labor market. These marketplaces employ various trust mechanisms to minimize these inefficiencies. Designing these mechanisms requires a deep understanding of the participants’ incentives and valuation on the reputation system. Any small change to the rules and regulations may strongly influence participants’ actions.\footnote{In this paper, we study such a change in eBay’s reputation mechanism and investigate the changes it imposes on different participants.}

In this paper, we study such a change in eBay’s reputation mechanism and investigate the changes it imposes on different participants.

As many authors have noted, eBay is a market prone to adverse selection.\footnote{As noted by many authors, reputation mechanisms has helped eBay in its growth over time. See for example, Resnick et al. [2006], Brown and Morgan [2006], Lucking-Reiley et al. [2007], and Saeedi [2011], among others} When adverse selection hinders trade, reputation can be used as a possible mechanism in mitigating lemon problems.\footnote{Examples of such studies are Kollock [1999], and Yamagishi and Matsuda [2002]} At the center of eBay’s reputation system are the feedback ratings given by buyers and sellers. Sellers’ feedback ratings affect their ability to acquire reputation badges, such as ”Powerseller” status, which as shown in Saeedi [2011] can significantly increase sellers’ profit margins. Thus, an analysis of feedback behavior and its effect on market size is of utmost importance. We study the move from a two-sided feedback system to a system where sellers cannot leave negative or neutral feedback for buyers. This change is aimed at preventing retaliatory behavior of sellers, and increasing efficiency in the market.

We start with evidence of the existence of retaliation before the policy change.\footnote{Bolton et al. [2013], Dellarocas and Wood [2008], Masclet and Pénard [2008], Dellarocas [2002], Klein et al. [2006], and Resnick and Zeckhauser [2002] have noted the possibility that buyers are not completely truthful in their feedback left for sellers for fear of retaliation from sellers. In January 2008, eBay announced eBay sellers can only leave positive feedback for buyers, starting May 2008, to prevent retaliation and to have a more truthful reputation system.} We observe that in more than a third of transactions with a negative feedback rating for sellers, they retaliate with a negative rating for the buyer. This may be a consequence of a mutually
bad experience; however, when sellers leave feedback before buyers, they rarely leave negative feedback ratings. The percentage of negative feedback ratings from sellers increases by almost tenfold after the buyer has left feedback for the seller.

The change in the feedback system was implemented in order to reduce the cost of leaving negative feedback for buyers. However, we observed a reduction in the percentage of negative feedback ratings from buyers for sellers. In the paper, we consider various possible explanations for this observation, finding evidence for two. First, by losing the power of retaliation, sellers are forced to exert more effort, causing a reduction in moral hazard. We observe that almost all seller groups, when divided based on reputation or size, improved their outcome after the policy change, as measured by feedback rating as well as other measures of quality that did not get directly influenced by the policy; e.g., the number of disputes has fallen by 20% during this time period.

Alternatively, the very worst sellers on the market, who cannot sustain themselves without the power of retaliation, had to exit the market, causing a reduction in adverse selection. We observe that sellers’ size went down if sellers participated in a retaliation in the past, and after the policy change this reduction increased, resulting in further shrinking for these sellers. Furthermore, we show that the buyers’ exit rate has decreased as a result of this policy change, suggesting that buyers have better experiences in the marketplace.

Following this policy change, sellers of different segments, and in particular more experienced sellers, leave feedback ratings for buyers more often. On the other hand, buyers leave feedback ratings for sellers less often. In addition, we also observe that sellers leave feedback more promptly, on average within six days of ending the transaction, versus fifteen days before the policy change. Buyers only respond one day sooner than before the policy change, fourteen days versus fifteen days. These changes can be explained as follows: sellers can no longer leave negative feedback for buyers as a retaliation mechanism; therefore they do not have any incentives to wait for the buyer to leave feedback first. On the other hand,

Nosko and Tadelis [2014] argue that leaving negative feedback still has a negative cost associated with it, which comes from the possible harassment from the seller. In this paper, we only need this cost to be reduced, not necessarily down to zero, to get the same results.

This effect on the exit rate confirms the result in Cabral and Hortacsu [2010], in which sellers with negative feedback exit the market at a higher rate. The negative effect of retaliation on size does not change after controlling for the number of negative ratings received.
after receiving positive feedback from sellers, buyers have less incentive to leave any feedback for sellers.

In order to further analyze the interaction of feedback incentives by buyers and sellers, we construct a new model to capture the feedback interaction between buyers and sellers. We model seller and buyer behavior via a dynamic game of leaving feedback once the transaction has occurred. The seller and the buyer can move in different periods, and each can leave positive, negative, or no feedback for their opponents, depending on the quality of the transaction. We show that qualitative features of the model are consistent with the basic stylized facts of the data. Next, we test the model using the outcome of the transactions and the feedback received by sellers and buyers. We use data from both before and after the policy change for the test. We estimate the deep utility parameters of the users. The underlying assumption is that the main structure of the game doesn’t due to the policy change. This can be used to predict the effect of different scenarios, e.g. the effect adding incentives to leave feedback for buyers and sellers; the effect of automatic positive feedback if no feedback is left; and the effect of unanimous feedback from buyer and sellers.

**Related Literature:** Few papers have noted the existence of retaliation on eBay before us, i.e., Bolton et al. [2013], Dellarocas and Wood [2008], Masclet and Pénard [2008], Dellarocas [2002], Klein et al. [2006], and Resnick and Zeckhauser [2002]. The closest paper to our work is the working paper by Klein et al. [2014] who independently explore the effect of the same policy. They investigate possible forces behind the increase in the positive feedback ratings. To control for sellers’s quality, they consider the detailed sellers rating and they show that this rating goes up after implementation of the policy; they also show evidence of higher exit rates for low-quality sellers. Having access to more comprehensive internal eBay datasets, we can establish these findings more broadly. Furthermore, we explore the effect of this policy change on the quality of buyers’ experience on the marketplace by studying their exit rate. Additionally, we study the effect of the policy change on feedback adoption rate. Finally, we also study and estimate a dynamic model of feedback choice.

The rest of the paper is organized as follows: Section 2 gives an overview of the market structure on eBay and its feedback system. We also explain the policy change studied in this paper and the data used for this purpose. Section 3 shows evidence of retaliation existing
before the policy change. Section 4 explores the new policy in depth, and we describe
the insights provided by data after the policy change. Section 5 show that the findings in
previous section are robust. Section 6 describes the model in Appendix A. Finally, Section
7 concludes the discussion.

2 Background and Data

eBay is one of the oldest and largest online shopping websites. Buyers and sellers can use
the website to buy and sell a wide variety of items. eBay also has one of the first online
reputation mechanisms; the feedback system was the first tool introduced on the eBay website
as a signaling mechanism for participants in the marketplace. After each transaction on eBay,
sellers and buyers can leave feedback for the other party. This feedback can be negative,
neutral, or positive. Each seller’s feedback summary is available on his/her transaction page.
This addition has been counted as one of the main reasons eBay has overcome the asymmetry
information problem that exists among sellers and buyers.

The feedback system helps keep the very worst participants out of the market, since
sellers with very low feedback ratings are forced out of the market, because they cannot sell.\footnote{Cabral and Hortacsu [2010] show that the probability of a seller exiting eBay increases significantly after receiving their first negative feedback.} However, some low-quality sellers find ways to prevent getting negative feedback ratings. In a
two-way feedback system, a retaliatory approach may be used, where poor quality sellers wait
for buyers to leave their feedback first before leaving feedback. Subsequently, if the sellers
receive negative feedback, they retaliate with negative feedback, as noted by Dellarocas and
Wood [2008], Masclet and Pénard [2008], Dellarocas [2002], Resnick and Zeckhauser [2002],
and Klein et al. [2006]. The retaliation lowers the effectiveness and value of the reputation
system. To alleviate this problem, eBay introduced Detailed Seller Ratings in 2007. Detailed
Seller Ratings is a one-to-five rating that buyers can leave for sellers; however, it is anonymous
and sellers can only see the average rating they have received. This policy change has been
studied in depth by Bolton and Ockenfels [2008].

To completely overcome the retaliation problem and to improve effectiveness of the rep-
utation system, in May 2008, eBay implemented a new policy to remove the ability of sellers to leave negative or neutral feedback for buyers. This changed the feedback system to practically a one-sided system where only the sellers get rated in transactions; buyers can only get positive feedback or no feedback.⁸ In this paper, we study the effects of this policy on sellers’ and buyers’ behaviors and on the overall marketplace. We further use this policy to shed lights on the incentives of sellers and buyers regarding the reputation system.

eBay has various markets, e.g., Collectibles, Stamps, Electronics, Motors, and Toys. Each of these markets potentially has a distinct pool of participants; therefore, each represents a different level of participation in the trust mechanism, and also in adoption of different sales formats.⁹ To ascertain whether the discovered effects of the policy change are universal and able to expand to other markets, we consider three categories: Electronics, Stamps, and Collectibles. Electronics is a category with a high growth in sales volume on eBay in recent years, and has gone through many changes. On the other hand, Stamps and Collectibles are two categories that have existed on eBay for a long time. These two categories have many sellers and buyers that interact with one another repeatedly.

### 2.1 Data

The introduction of the new policy was announced in January 2008, and it was implemented starting May 2008. We analyzed all transactions in Electronics from July 2007 until July 2009. For each transaction, we have the following information: the date and type of feedback from sellers and buyers (if any), the date and the rating of Detailed Seller Ratings (if any), and disputes from buyers.¹⁰ Note that our data does not have any truncation bias; we have the outcome of transaction as well as the feedback ratings even if the feedback is left after the end of this time period for a transaction that happened in our timeframe. Furthermore, we collected information on the past transactions of buyers and sellers, which enabled us to investigate buyers and sellers with different levels of experience, as well as their exit rate.

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⁸Note that the other participants cannot determine if a buyer has not received a feedback rating or has had few transactions, since the list of past transactions of participants are not public.

⁹For a complete discussion refer to Shen and Sundaresan [2011].

¹⁰If a buyer is not satisfied with a transaction and if s/he cannot resolve the issue directly by contacting the seller, s/he can escalate the case to eBay; this is called a dispute.
Table 1: Sellers’ Feedback, Electronics

<table>
<thead>
<tr>
<th>Feedback Left by Sellers</th>
<th>Positive</th>
<th>Negative or Neutral</th>
<th>No Feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Seller Moves First</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>98.83%</td>
<td>1.17%</td>
<td>–</td>
</tr>
<tr>
<td>Positive</td>
<td>99.95%</td>
<td>0.05%</td>
<td>–</td>
</tr>
<tr>
<td>Negative or Neutral</td>
<td>91.94%</td>
<td>8.06%</td>
<td>–</td>
</tr>
<tr>
<td>No Feedback</td>
<td>96.7%</td>
<td>3.3%</td>
<td></td>
</tr>
<tr>
<td><strong>B. Buyer Moves First</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>88.47%</td>
<td>0.04%</td>
<td>10.49%</td>
</tr>
<tr>
<td>Negative or Neutral</td>
<td>5%</td>
<td>37%</td>
<td>58%</td>
</tr>
</tbody>
</table>

Notes: In this table the percentage of time that sellers leave positive, negative or neutral, or no feedback is shown. The data is divided into two segments. The first segment is when the seller is moving first, before the buyer leaves feedback. In this segment, we also divide the data conditionally on the buyer’s response after the seller’s feedback. The second segment is when the buyer has left feedback before the seller. The seller’s response is reported conditionally on the buyer’s action.

Throughout the main body of the paper, we discuss the result related to Electronics category, and in the Appendix, we show the results for Stamps and Collectible categories. While the magnitude of the effects varies from one category to another the qualitative results remain the same.

3 Existence of Retaliation

We first show that before the change in policy, buyers and sellers were engaged in retaliatory strategies: after leaving negative feedback for sellers, buyers were much more likely to receive negative feedback from them. As shown in Table 1, after negative feedback is received from a buyer, a seller will respond with negative feedback in 37% of the transactions. This number is 0.04% if a buyer leaves positive feedback for a seller. Moreover, if the seller is the first party to leave feedback, they will leave negative feedback only in 0.3% of transactions. Buyers, as well as sellers, care about their feedback percentage for a few reasons. First, they might sell items on eBay as well, and eBay does not separate feedback ratings users received as a seller or as a buyer in the main listing page. Second, if a buyer has very low feedback percentage, sellers are potentially unable to sell to them. Third, in case of a dispute, eBay will not be in favor of a user who has a very high percentage of negative feedback ratings.
Another evidence of sellers’ strategic behavior as the result of negative feedback is illustrated in Figure 1. This figure represents the proportion of positive feedback among all feedback left from sellers for buyers. The x-axis shows the number of days between the dates that buyers and sellers leave each other feedback; positive numbers correspond to transactions in which the seller has left feedback first, and negative numbers are those in which the buyer has responded first. The 0.5 on the x-axis corresponds to the transactions in which sellers leave feedback first and then the buyer leave feedback on the same day; -0.5 is defined accordingly. When the sellers move first, they rarely leave any negative feedback for the buyers; however, when they moved after the buyer, the share of negative feedback increases by about tenfold. This timing shows that the sellers would not show their disappointment in the quality of transaction until buyers leave them a feedback. Moreover, note that there is a drop toward the left end of Figure 1; this is consistent with Klein et al. [2006]’s finding that sellers tend to leave negative feedback more often toward the end of the time window in which they can leave feedback.
Figure 2 demonstrates additional evidence for the existence of retaliation. In this figure, the share of positive feedback for buyers is shown as conditional on buyers’ feedback ratings: positive, negative, and neutral. When the seller is leaving feedback first, most of the feedback ratings are positive even if the buyer leaves negative or neutral feedback for the seller afterwards. However, if the buyer has left feedback first, the sellers’ feedback is strongly correlated with the buyers’ feedback rating. These figures show that the data in Table 1 is not only a result of correlated satisfaction with the outcome of transaction among buyers and sellers. There are many transactions in which sellers leave positive feedback for buyers, but then the buyer leaves negative or neutral feedback for the seller. The probability that sellers will leave negative feedback after the buyer leaves feedback for them increases sharply only if the buyers’ feedback is negative or neutral. We will explore this further in Appendix A.
4 Effects of the Policy Change

In this section, we show the response of sellers and buyers to this policy. The most striking finding in this section is that after implementation of the policy, buyers consistently leave fewer negative feedback ratings for sellers. As will be shown in Section 5, this finding is robust regardless of which party leaves feedback first, and also to various indicators of sellers’ and buyers’ decomposition. We argue that the reduction in the power of the sellers to manipulate feedback ratings has forced them to increase their efforts in providing better service and higher quality items, resulting in a reduction in Moral Hazard. Moreover, we show that sellers who used retaliation the most in the past exited the marketplace at a high rate, which is consistent with a reduction in Adverse Selection. These two effects result in a market with higher quality sellers and items. This improvement in average quality can also be demonstrated in other measures of sellers’ performance, as is shown in this section. We further discuss how the change in the policy has affected the feedback adoption rate, and also the timing of leaving feedback.

4.1 The Effect on Feedback Ratings

The removal of retaliation has affected buyers’ actions in terms of leaving feedback. Before the policy change, the instances of negative feedback ratings from buyers to sellers were very low, about 2%. Retaliation from sellers was considered to be the main cause of this low percentage of negative feedback ratings. Hence, removing the ability of sellers to leave non-positive feedback should lead to higher share of negative feedback ratings from buyers, as argued by Bolton et al. [2013], Dellarocas and Wood [2008], Masclet and Pénard [2008], Dellarocas [2002], and Resnick and Zeckhauser [2002]. Contrary to this assumption, we observe that the percentage of negative or neutral feedback from buyers has fallen to 1%, a 50% reduction compared to before the change. In this section, we explore possible reasons for this reduction of negative or neutral feedback ratings. This finding is consistent across multiple dimensions: across time and different sellers’ and buyers’ groups as is shown in Section 5.
4.2 Change in Sellers’ Quality

After the policy change, sellers are unable to leave negative feedback; therefore, sellers lose the retaliation tool which helps them to stay in the market despite being of low-quality. After the policy change, low-quality sellers can no longer sustain themselves in the market. This forces these sellers to either to exert more effort, or to exit the market. In this section, we show evidence of an increase in sellers’ overall quality.

Sellers are performing better as measured with other quality metrics which are not directly affected by the policy. Other variables that indicate sellers’ performance in the market are the number of disputes, Detailed Seller Ratings, and chargebacks. Buyers can dispute a transaction directly with eBay when they are not satisfied with the situation and cannot resolve the issue by contacting the seller. Detailed Seller Ratings work the same way as feedback, but it is anonymous and sellers can only observe average ratings, not individual ones. This rating is not directly affected by the policy change, but it could be affected indirectly by a change in sellers’ performance. Buyers can rate sellers in four different categories, and in each they give sellers a rating from one to five. Buyers can get chargebacks from their credit card company, bank, or PayPal account if they argue that the item was not as described, or was never shipped to them. Table 2 shows the frequency of each of these actions. As shown in Table 2, seller performance has improved in all of these categories, and the market is less prone to moral hazard.

Sellers’ improved performance can also be demonstrated by combining all above measures of buyers’ dissatisfaction into one factor, which we will call ‘complaint.’ We consider a transaction to have a complaint if any of the following happens: negative feedback, low DSR, or dispute. Figure 3 shows the probability that a transaction does not have any complaints.
received. As shown, the probability of not receiving any complaints increased after the feedback policy change. In this figure, and the ones in the next sections, we designate the transition period. Transition period is the time between the announcement of this policy in January and the time the policy has been implemented in May. Note that sellers could not leave a negative feedback rating after May which also affected the transactions that taken place in the past couple of months, March and April. During the transaction period sellers and buyers being aware of the change taking place in near future may act differently, we do not focus on this transition period, but we note it on the relevant graphs.

4.3 Sellers’ Size

To investigate dynamics of low-quality sellers, we study the change in sellers’ size in Table 3.\(^{(11)}\) In this table, we consider two different periods, each including a six-month time frame, one before and one after the policy change. The dependent variable for each data point in the regression is the size of a seller, defined as the number of completed transactions in each

\(^{(11)}\)Note that on eBay a lot of sellers may stop being active; however, they might occasionally sell a few personal items. Therefore, we consider the change in size rather defining exit as a dummy variable.
Table 3: Sellers’ Size, Electronics

<table>
<thead>
<tr>
<th></th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Future Size</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>2.29***</td>
<td>2.23***</td>
<td>2.01***</td>
<td>2.05***</td>
</tr>
<tr>
<td></td>
<td>(0.37)</td>
<td>(0.37)</td>
<td>(0.39)</td>
<td>(0.39)</td>
</tr>
<tr>
<td>Lagged Size</td>
<td>1.04***</td>
<td>1.04***</td>
<td>0.95***</td>
<td>0.95***</td>
</tr>
<tr>
<td></td>
<td>(0.1E-3)</td>
<td>(0.8E-3)</td>
<td>(0.9E-4)</td>
<td>(0.9E-4)</td>
</tr>
<tr>
<td>Lagged # Retaliation</td>
<td>-21.53***</td>
<td>-12.65***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.22)</td>
<td>(0.29)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lagged # Retaliation * Policy</td>
<td>-47.44***</td>
<td>-69.73***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.41)</td>
<td>(0.57)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lagged # Negative</td>
<td>-3.5***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.13)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lagged # Negative * Policy</td>
<td>8.13***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.14)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lagged % Retaliation</td>
<td>-2.3</td>
<td>-1.29</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(14.33)</td>
<td>(15.76)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lagged % Retaliation * Policy</td>
<td>-11.90</td>
<td>-9.24</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(21.56)</td>
<td>(23.30)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lagged % Negative</td>
<td>-1.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(6.50)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lagged % Negative * Policy</td>
<td>-2.59</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(8.61)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>R^2</strong></td>
<td>0.78</td>
<td>0.79</td>
<td>0.76</td>
<td>0.76</td>
</tr>
<tr>
<td><strong>Observations</strong></td>
<td>378,249</td>
<td>378,249</td>
<td>378,249</td>
<td>378,249</td>
</tr>
</tbody>
</table>

*Notes:* This table shows the result of regressing the size of the sellers, i.e., the number of items they sell, as a function of their lagged size, lagged percentage and number of retaliations they have made, and lagged percentage and number of negative feedback ratings they have received in the previous period. Each period is six months, one before and one after the policy change. ‘Policy’ is a dummy variable equal to one if the period is after the policy change. ‘Negative’ is the number of negative or neutral feedback ratings, and ‘Retaliation’ is the number of transactions with a retaliation from the seller. Retaliation is defined as a transaction in which seller leaves a negative feedback rating after receiving a negative feedback rating from a buyer. *** Indicates results that are statistically significant at the one percent level.
period of time. ‘Policy’ is a dummy variable which is equal to one if the period is after
the policy change and zero otherwise. To predict the size of a seller, we use various lagged
variables of them: their size, number of retaliations, and quantity of negative feedback they
received. We assume that retaliation has happened if the seller has left a negative feedback
rating after receiving a negative feedback rating. This table shows that the size of sellers who
used retaliation has gone down, and this decrease is larger after the policy change, leading
to shrinkage of the size of retaliatory sellers. The first column of Table 3 shows a decline
equivalent to 21 fewer items sold in six month for each retaliation that happened in the
previous six months before the policy change, and this decline increases to 69 fewer items
after the policy change. On average, sellers in our data sold 30 items in six months.

As suggested by Cabral and Hortacsu [2010], the quantity of negative feedback received
could have a negative effect on the size of sellers, and not necessarily retaliation. Hence,
we control for the number of transactions in which sellers receive negative feedback as well
as retaliation. As shown in regressions II and IV, the negative effect of retaliation on the
size of sellers next period persists even after controlling for the number of negative feedback
ratings. We have done the above for various definition of period and the results are robust
across all.

In summary, the above results are consistent with there being two main reasons for the
decline in negative or neutral feedback ratings despite elimination of retaliation. First, the
very worst sellers in the market either shrink in size or exit the market – a reduction of
adverse selection. Second, all seller groups increase their effort to offer a better service on
eBay – a reduction of moral hazard.

4.4 Effect on Buyers’ Exit Rates

Buyers’ exit rate, the probability of no new purchase in the following six months from the date
of transaction in Electronics, has gone down in response to the new policy, on average a 2-3
percent drop. This effect comes from a few different sources. To dissect this effect, we divide
transactions into different groups. First, as defined before, we consider transactions with
and without a complaint. A complaint is defined as either negative or neutral feedback, low
Detailed Seller Ratings, or Dispute from buyers. We further refine the groups as a function
Table 4: Buyers’ Exit Rates, Electronics

<table>
<thead>
<tr>
<th></th>
<th>Experienced Buyers</th>
<th>New Buyers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before</td>
<td>After</td>
</tr>
<tr>
<td>No Comp’t, + Fdbk</td>
<td>21.5%</td>
<td>20.9%</td>
</tr>
<tr>
<td>No Comp’t, No Fdbk</td>
<td>26.7%</td>
<td>26.3%</td>
</tr>
<tr>
<td>Comp’t, + Fdbk</td>
<td>22.8%</td>
<td>21.1%</td>
</tr>
<tr>
<td>Comp’t, - Fdbk</td>
<td>25.8%</td>
<td>21.4%</td>
</tr>
<tr>
<td>Comp’t, No Fdbk</td>
<td>22.8%</td>
<td>23.4%</td>
</tr>
</tbody>
</table>

Notes: This table shows the probability that a buyer does not buy any item in the following 6 months of a purchase in each category. Buyers are divided into two groups, with buyers who spent more than $450 in purchases in the previous year considered ‘experienced,’ and those who spent less than $450 as ‘new buyers.’ A transaction is considered to have a complaint if: negative or neutral feedback from buyer, low Detailed Seller Ratings, or a Dispute from Buyer exist.

of the feedback received from buyers, or lack thereof. This will give us five different groups before and after the policy change.\textsuperscript{12} Considering each group separately, and comparing buyers’ exit rate before and after the policy change, buyers’ exit rates go down in almost all groups.\textsuperscript{13} The decline in exit rate for each group is between 2 and 16 percent.

Buyers’ exit rates are the highest for novice or experienced buyers who do not leave any feedback ratings or dispute a transaction, consistent with results in Nosko and Tadelis [2014]. One drawback of the policy is that the share of transactions without feedback from buyers will go down, as discussed in the next section. This will increase the share of transactions which go into this subgroup: novice buyers without any complaints to eBay or any feedback for sellers. This change might be because sellers are not as persistent in trying to get a feedback rating from buyers as they used to be before the policy change. This leads to a reduction in buyers’ exit rate of only 2-3 percent compared to the exit rate of each group that is mostly larger.
Figure 4: Adoption Rate for Feedback, Electronics

Note: This figure shows the proportion of transactions with feedback left by sellers and buyers over time. X axis: Time period. The policy change happened in May 2008. Y axis: Proportion of transactions with feedback from sellers and buyers.

4.5 Feedback Adoption

In addition to addressing the retaliation problem, the policy change had other interesting and noteworthy effects on buyers and sellers’ behavior. There are two main observations related to probability of leaving feedback rating, known as feedback adoption rate, from sellers and buyers. First, sellers leave feedback for buyers more often, as shown in Figure 4. Specifically, data in the Electronics category shows that following the May 2008 policy change, the likelihood of sellers leaving feedback increased from 70% to 78%. Second, buyers are leaving feedback less often, down from 68% to 62%.

The change in the feedback adoption rate is not driven by a change in composition of sellers and buyers in the market. To show this, we group sellers and buyers based on their activity as well as sellers’ reputation status. To control for buyers and sellers’ activity level we divide them into four different groups based on the volume of their transactions in the twelve months leading to the particular transaction, with Group I being the most active and

\[12\] Groups are: 1. without complaint, with positive feedback, 2. without complaint, without feedback, 3. with complaint, with positive feedback, 4. with complaint, with negative or neutral feedback, 5. with complaint, without a feedback. For each group we consider buyers less more than $450 purchases, separately.

\[13\] The exception is for more experienced buyers who disputed a transaction but left no feedback. This is a very small sample each month and the difference is not statistically significant.

16
Figure 5: Adoption Rate for Feedback, Electronics

Note: This figure shows the proportion of transaction with feedback left by buyers over time conditional on buyer’s activity, I-IV, from most active to least active.
Y axis: Proportion of transactions with feedback from different buyer segments.

Group IV being the least active. As depicted in Figure 5, more active buyers leave feedback for sellers more often and the least active buyers which tend to be new buyers leave feedback for sellers less often. Even though different groups have different levels of leaving feedback for sellers, all show the same pattern after the change in policy: they all leave feedback less often after the policy change. The probability of leaving feedback for buyers by sellers is not a function of buyers’ activity level; therefore, we do not present that graph here.

Next we examine the effect of sellers’ size on feedback adoption. Figure 6(a) shows the feedback adoption rates for different seller groups. The most active sellers, Group I, changed their actions dramatically after the change in policy, leaving feedback about 30% more often after the policy change. eBay lets their most active sellers leave automatic feedback ratings for buyers either after clearing payment or after positive feedback was received from the

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14 The definition of the four groups for sellers are as follows:
Group I: more than 125K,
Group II: more than 250 and less than 125K,
Group III: less than 250 and more than 12,
Group IV: less than 12 sales in the prior 12 months leading to the particular transaction.
The thresholds for groups I-IV buyers are $10,000, $2,500, $450, and $0 total purchase in the past 12 months, respectively.
Figure 6: Feedback Adoption Rate, Different Seller Segments, Electronics

*Note:* This figure shows the proportion of transaction with a feedback for different sellers groups. Sellers are divided into four groups as a function of their size, I-IV, from the least active to most active. Figure a. shows the feedback ratings left by sellers and Figure b. shows the feedback ratings left for sellers from buyers.

Y axis: Proportion of transactions with feedback from different buyer segments.
Figure 7: Feedback Adoption Rate, Electronics

Note: This figure shows the proportion of transaction with a feedback rating for different sellers groups. Sellers are divided into two groups, powersellers and non-powersellers. Figure a. shows the feedback ratings left by sellers and Figure b. shows the feedback ratings left for sellers from buyers. X axis: Time period. The policy change happened in May 2008. Y axis: Proportion of transactions with feedback, Powersellers vs. non-Powersellers.
The pattern in Figure 6(a) suggests that a large portion of these sellers change their setting to automatically leave positive feedback to the buyer right after payment clears, while before the policy change, they left positive feedback only after receiving the same. The effect on the least active sellers is the reverse: they left feedback less often right after the change in policy, but after a few months their adoption rate increases. It might be as a result of change in composition of these sellers as argued before: low-quality sellers exiting the market and replaced with new high-quality sellers. The pattern of the change in buyers’ feedback adoption rate does not vary across different seller groups, as shown in Figure 6(b). High-volume buyers tend to leave feedback more often compared to novice buyers on eBay. Despite this difference, all groups leave feedback for sellers less often.

Figure 7 demonstrates the change in feedback adoption rate for Powersellers versus non-Powersellers. Most of I and II sellers are Powersellers, and most of the III and IV sellers are not Powersellers. Powersellers leave feedback ratings more often both before and after the policy change. However, both groups show similar trends, with the feedback adoption rate from buyers not differing substantially across seller groups.

4.6 Timing of Feedback

Before the policy change, many sellers would wait for the buyer to move first in order to have the option to retaliate. After the policy change, they do not have this incentive to wait for the buyers to leave feedback first. Therefore, sellers in many cases leave feedback for buyers right after the payment has been received. This has implications for the timing of the feedback as well. Since the policy change, sellers leave feedback before buyers in more cases. This finding is displayed in Table 5. In 51% of current transactions, sellers leave feedback before buyers, up from 29% before the policy change. This data also includes transactions in which the seller is the only party who leaves feedback.

Additionally, as shown in Figure 8, both buyers and sellers leave feedback sooner as a
Figure 8: Timing of Feedback Compared to End of Transaction, Electronics

*Note:* This figure shows the average number of days after a transaction that feedback is received by sellers or buyers. Only transactions with feedback are considered for this average number.

X axis: The time period. The policy change happened in May 2008.

Y axis: The number of days participants in the market wait before leaving feedback.

result of the policy change. The number of days a seller will wait to leave feedback for a buyer has significantly decreased. The average number of days a seller would wait to leave feedback for buyer was thirteen days before the policy change, and it since went down to seven days. The effect on the buyer is similar, though less substantial; the wait time has gone down by about two days.

Note that in Figure 8, the average number of days buyers will wait to leave feedback is higher than the average number for sellers. This may seem to contradict the number in Table 5, but it can be explained. The first reason is the greater variance in the number of days buyers will wait to leave feedback for sellers. Second, sellers who are waiting for the buyer to leave feedback first tend to leave feedback in response immediately after they have received feedback, often in the same day. Third, Table 5 also includes the transactions for which the buyer never leaves feedback, but in Figure 8 both parties must leave feedback to be considered.
5 Robustness Analysis

In this section, we analyze competing theories that could explain the change in percentage of positive feedback ratings. We first show that change in timing of leaving feedback, which is discussed in the previous section, cannot be the source of change in observed increase in percentage of positive feedbacks. We consider various decomposition of sellers and buyers and show that the results in Section 4.1 are robust across these different groups and it cannot be explained by change in composition of participants.

5.1 Timing

We first consider whether a change in timing of leaving feedback might be the cause of observed reduction of negative feedback ratings. We consider two different time windows: first, the number of days between the end of a transaction and the day the feedback was left by the buyer; second, the number of days between the dates feedback was left by sellers and buyers. Figure 9 shows a consistent decline in percentage of negative or neutral feedback ratings received from buyers throughout the time span they may leave feedback to sellers. This graph shows the average share of negative or neutral feedback ratings among all feedback left for sellers as a function of number of days between end of transaction and when buyers leave feedback for sellers. It illustrates that the buyers are leaving less negative or neutral feedback throughout time, and the change is not a result of a possible change in timing.

As is mentioned in Section 4.6, since the policy change, many sellers leave feedback sooner and are usually first party to act. To explore the possible effects of this change in timing, we consider Figure 10. This figure shows the proportion of positive feedback among all feedback left for sellers as a function of the number of days between the time sellers and buyers leave feedback for the other party. Buyers are consistently leaving a higher share of positive feedback after the policy change than before the policy change; therefore, the change in timing cannot explain the decline in negative feedback to sellers.\footnote{Note that the drop at the right ends of Figure 10 shows that buyers who leave feedback in the last minute tend to leave more negative feedback, which is consistent with Figure 9.}

Note that Figure 10 also shows that buyers leave more positive feedback for sellers if
Figure 9: Share of Non-Positive Feedback from Buyers, Electronics

Note: This figure shows the proportion of non-positive feedback received for sellers as a function of number of days after the end of transaction for before and after the no-negative policy. 
X axis: The number of days buyers have waited from end of transaction to leave feedback. 
Y axis: Ratio of Non-Positive feedback over the total feedback left at the same day by buyers for sellers.

Figure 10: Share of Positive Feedback from Buyers, Electronics

Note: This figure shows the proportion of positive feedback ratings among all feedback ratings left by buyers as a function of the number of days between buyers’ and sellers’ feedback ratings, before and after implementing the no-negative policy. 
X axis: The number of days the buyer has left feedback after the seller. 
Y axis: Percentage of positive feedback over the total feedback left at the same day by buyers for sellers.
Figure 11: Share of Positive feedback for Sellers, Different Buyer Groups

**Note:** This figure shows the proportion of positive feedback ratings left by buyers over the number of days between buyer’s and seller’s feedback ratings, before and after implementing no-negative policy. Figures I-IV divided buyers into four groups, from most active to least active. These graphs show that the change in buyers’ actions overall are not due to a specific buyer group.

X axis: The number of days the buyer has left feedback after the seller.
Y axis: Percentage of positive feedback over the total feedback left on the same day by buyers for sellers.

they are the party who moved first or if they moved after receiving a positive feedback from sellers. The fact that sellers can only leave positive feedback for buyers after the policy change can affect buyers overall utility from transaction which may potentially lead them to leave more positive feedback ratings. However, this story cannot explain the fact that buyers leaved more positive feedback ratings for sellers even when they were the party who moved first, the negative values for $x$ in Figure 10. Additionally, the fact that buyers actions change independent of sellers’ action according to the figure can also show that reduction in buyers’ retaliation cannot fully explain the decrease in negative feedback ratings from them.

### 5.2 Change in Buyers’ Composition

In this section, we show that changes in composition of buyers were not the cause of the increase in share of positive feedback ratings left for sellers. To examine it, we divide buyers into four groups based on the value of items they purchased on eBay in past, with Group I
being the most active and Group IV being the least active; the thresholds for groups I-IV are $10,000, $2,500, $450, and $0 total purchase in the 12 months prior to the transaction, respectively. As shown in Figure 11, all buyer groups leave more positive feedback for sellers; therefore, change in buyer composition cannot explain the change in the proportion of positive feedback ratings and this change can be observed within each group. We can also follow buyers over time, but given that buyers become experienced over time, we may expect their action to change; therefore, the above cross section study is more fitted to our study than a panel study.

Another interesting observation from Figure 11 is that before the policy change, Group I and II buyers leave positive feedback for sellers more often compared to Group III and IV buyers. Assuming the percentage of positive feedback is positively correlated with having good experiences on eBay, this observation suggests that more experienced buyers are better equipped in ways to distinguishing high-quality sellers from low-quality ones, and on average they have better experience on the marketplace. After the policy change, the percentage of positive feedback ratings from group IV buyers has increased dramatically, suggesting that these buyers encounter the largest positive change in sellers’ quality. New buyers on eBay tend to be deal seekers and they may not understand the value of reputation on eBay and may end up buying from low-quality sellers on eBay. As it is argued in Section 4.4, sellers with lowest quality levels and who participated in retaliation before the policy change had to exit the market. These leads to average higher quality sellers and especially a big shift up from the bottom of the quality distribution; therefore, the quality of sellers that new buyers on eBay interact with has significantly improved. Consequently, an improvement in the quality of sellers they face in their first few purchases can improve their perception of the sellers’ quality on eBay, and decrease their exit rate significantly, as shown in Section 4.4.\(^{16}\)

\(^{16}\)Nosko and Tadelis [2014] run an experiment on eBay in which they improve the average quality of sellers the new buyers interact with and they find a consistent reduction in exit rates for these buyers.
5.3 Change in Sellers’ Composition

In this section, we show that changes in sellers’ composition did not lead to the increase in positive feedback ratings for sellers. Additionally, we show that this change in feedback ratings can be observed for almost all subgroups that we consider here, which suggests that after the policy change all different type of sellers have improved their quality. We decompose sellers based on on their reputation status and also their size and experience on eBay.

Reputable and larger sellers on eBay receive a reputation badge, the “Powerseller” badge. These sellers tend to perform better than smaller sellers.\textsuperscript{17} We consider sellers with and without the badge, and we consider changes in the percentage of positive feedback before and after the policy change. Figure 12(a) shows the percentage of positive feedback for Powersellers in the market as a function of number of days buyers left feedback after they have received feedback from the seller. Comparing Figures 12(a) and Figure 12(b) demonstrates that Powersellers tend to receive fewer negative or neutral feedback ratings, but the pattern does not differ from no powersellers’ feedback, nor did the policy change affect the relative difference. Powersellers still get a higher proportion of positive feedback after the policy change. We can also explore the share of positive feedback ratings the two group receive over time, as depicted in Figure 13; both groups of sellers perform better on average after the policy change. This observation confirms the main finding in Section 4.2, all seller groups improve their quality.

To further explore differences in the composition of sellers, we divide sellers into different groups based on their volume: Groups I-IV, with I being the group with sellers with the most transactions in 2008, and Group IV being the sellers with the least transactions.\textsuperscript{18} First, we consider the analogue of Figure 10 for different groups of sellers in Figure 14. Similar to the Powerseller case, the trend does not change: all groups of sellers receive fewer negative feedback ratings after the policy change, confirming the finding in Section 4.2. However, the

\textsuperscript{17}Saeedi [2011] explores the effect of this reputation badge in detail. To become a Powerseller, sellers must sell at least 100 items or $1,000 per month, for the past three months; have a 98\% or higher feedback rating; and have low dispute rates.

\textsuperscript{18}The definition of the four groups are as follows:
Group I: more than 125K,
Group II: more than 250 and less than 125K,
Group III: less than 250 and more than 12,
Group IV: less than 12 sales in the past year.
Figure 12: Share of Positive feedback for Powersellers and non-Powersellers, Electronics

Note: This figure shows the proportion of positive feedback ratings left by buyers over the number of days between buyer’s and seller’s feedback ratings, before and after implementing the no-negative policy. Figure a includes only Powersellers, and Figure b includes only non-Powersellers.

X axis: The number of days the buyer has left feedback after the seller.

Y axis: Percentage of positive feedback over the total feedback left at the same day by buyers for sellers.
Figure 13: Share of Positive feedback for Powersellers and non-Powersellers Over Time

Note: This figure shows the proportion of positive feedback ratings left by buyers over time for Powersellers and non-Powersellers.
Y axis: Proportion of transactions with positive feedback for Powersellers and non-Powersellers.

Figure 14: Share of Positive feedback for Sellers, Different Seller Groups

Note: This figure shows the proportion of positive feedback ratings left by buyers over the number of days between buyer’s and seller’s feedback ratings, before and after implementing the no-negative policy. Figure I-IV divided sellers into four groups, from most to least active. It shows that the change in buyers’ actions is not due to a change in a specific seller group.
X axis: The number of days the buyer has left feedback after the seller.
Y axis: Percentage of positive feedback over the total feedback left at the same day by buyers for sellers.
Figure 15: Share of Positive feedback for Different Seller Groups

Note: This figure shows the proportion of positive feedback ratings left by buyers over time for different seller groups. Sellers are divided based on activity into four groups, I-IV, from most to the least active.

Y axis: Proportion of transactions with positive feedback for Different Seller Segments.

trend over time is different across different groups. Figure 15 shows that starting in May, groups I-III received more positive feedback; however, group IV, the smallest sellers, received more negative feedback for the first few months after the policy change, and after about six months they started recovering. This might be because of the exit of low-quality small sellers and entrance of new high-quality small sellers afterwards, confirming the finding in Section 4.3.

6 Overview of the Model

In the appendix, we have included the full model with its structural estimation. In this section, we present an overview of the model, its estimation method, and its possible applications. After the outcome of the transaction is realized, buyers and sellers can leave one another feedback sequentially. Sellers face a choice of leaving feedback before or after the buyers have a chance to leave feedback. Given the outcome of transactions, they receive different payoffs for leaving feedback, and the type of feedback they leave can be a function
of the feedback they receive. After the policy change, sellers can only leave positive feedback or no feedback at all. We identify these payoffs by matching various moments from the data and model: the probabilities of leaving and receiving different types of feedback before and after the policy change.

We use a nested fixed-point strategy, starting from an initial guess for buyers’ and sellers’ payoffs. We simulate the model using the average payoff values, generate the simulated moments, and compare them to the moments calculated from data. In the next step, we find the value of payoff for buyers and then sellers that match the moments. Using the new value for payoff we repeat the previous steps. We stop when we get convergence between the values of payoffs of two consecutive rounds.

The estimated parameters for average payoff for buyers and sellers are consistent with the findings in the data section. Particularly, it shows that sellers get a relatively high payoff from returning a negative feedback with a negative feedback in retaliation. Table 7 reports the values for buyers’ and sellers’ payoff. These represent the average payoff that buyers and sellers get in various cases. If the outcome of the transaction is positive and they have received positive or no feedback, buyers have more incentive to leave positive feedback. This incentive increases if the seller leaves positive feedback for the buyer. Additionally, buyers have very low incentive to leave negative feedback when the outcome is positive. Even getting negative feedback does not drive buyers to leave negative feedback most of the time, and in response they will leave no feedback. If the outcome of the transaction is negative or bad, in most cases buyers prefer not to leave feedback, as getting negative feedback in return is costly for them. Given the estimation of the model, we can run various counterfactuals to predict buyers’ and sellers’ reactions to various policy interventions.

7 Conclusion

Online platforms and applications increasingly rely on user-generated content. Such platforms are prone to adverse selection. Typically, some form of reputation mechanism is used to sustain the market and avoid deterioration. eBay is one of the earliest such e-commerce platform. With its adoption of a simple feedback mechanism, eBay has thrived and ex-
panded over the years. Yet we do not have a good understanding of the motivation behind
the participation of buyers and sellers in the reputation mechanisms on eBay. In this paper,
we sought to shed light on this matter by studying a change in the reputation mechanism:
no negative feedback from the sellers.

This policy implements a change to the symmetric two-sided feedback mechanism, re-
moving the ability to retaliate from the seller side. We showed that the policy change can
cause buyers and sellers to significantly change their behavior in leaving feedback. Surpris-
ingly, since this policy change, buyers leave positive feedback ratings for sellers more often.
We discussed two possible explanations for this: first, sellers losing their ability to retaliate
increase their effort to provide better service to buyers, resulting in a reduction of moral
hazard and better experiences for buyers. Second, the very worst sellers who could only
survive in the market using retaliation left the market at a high rate, resulting in a reduction
of adverse selection. The policy change has also affected the rate and timing of feedback
being left by sellers and buyers; sellers leave feedback more often, while buyers leave it less
often, and sellers leave their feedback sooner. This further shows that the participants in
the market take into account feedback ratings and they will actively react to the changes in
rules.

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Appendix

A Model

In this section, we develop a model to explain the sellers’ and buyers’ actions before and after the policy change. The model enables us to identify the participants’ payoff from leaving and receiving feedback. The model is dynamic, and sellers and buyers move in alternating time periods.

For simplicity, we assume that the outcome of the transaction is exogenous and the same for seller and buyer: $x \in \{0, 1\}$, where 0 represents a bad outcome for the transaction and 1 represents a good outcome. $\mu = Prob(x = 1)$ is known to buyers and sellers.

Sellers and buyers have a chance to leave feedback for the other party after transactions; the feedback can be positive or negative. Buyers choose among three different actions in response to the outcome of the transaction: $y \in \{-1, 0, 1\}$, where 0 represents leaving no feedback, 1 represents leaving positive feedback, and $-1$ represents leaving negative feedback for the seller. Similarly for sellers, they choose an action among three: $z \in \{-1, 0, 1\}$, where 0 represents leaving no feedback, 1 leaving positive feedback, and $-1$ leaving negative feedback for the buyer.

The buyer’s utility from leaving and receiving feedback is characterized by: $\alpha_{xyz}$ which is a function of the outcome of the transaction, $x$, buyer’s action, $y$, and seller’s action, $z$. Similarly, the seller’s utility from the feedback stage is characterized by: $\beta_{xyz}$, where $x$, $y$, and $z$ are as explained. $\alpha_{x0z}$ is the cost of leaving a feedback for buyer and the cost of leaving a feedback for seller is $\beta_{xy0}$. The effort level represents the time cost for the participants for leaving feedback, whether positive or negative. We normalize the utility the buyers and sellers get from leaving no feedback to zero. Therefore, the utility buyers get from each

\footnote{For simplicity, we have combined negative and neutral feedback into one category.}
action can be described as follows:

\[ u_b = \begin{cases} 
\alpha_{x,-1,z} - \alpha_{x0z}, & \text{Buyer plays } -1 \\
0, & \text{Buyer plays } 0 \\
\alpha_{xz1} - \alpha_{x0z}, & \text{Buyer plays } 1
\end{cases} \]

and for sellers’ utility function is:

\[ u_s = \begin{cases} 
\beta_{xy,-1} - \beta_{xy0}, & \text{Seller plays } -1 \\
0, & \text{Seller plays } 0 \\
\beta_{xy1} - \beta_{xy0}, & \text{Seller plays } 1
\end{cases} \]

We further assume that the sellers’ and buyers’ utility has a a permanent component: \( \bar{\alpha} \) and \( \bar{\beta} \), which are known to both players in the market. There are random components to buyers’ and sellers’ payoff, which are only known to them but not to their opponents: \( \eta_y \) and \( \gamma_z \), respectively:

\[ \alpha_{xyz} = \bar{\alpha}_{xyz} + \eta_y \quad y = -1, 0, 1 \]
\[ \beta_{xyz} = \bar{\beta}_{xyz} + \gamma_z \quad z = -1, 0, 1 \]

We assume that \( \eta_y \) and \( \gamma_z \) are iid random variables with extreme value distribution. The distribution is known to both parties but the realized values are only known to the player.

**A.1 Timing**

At \( t = 0 \) the outcome of the transaction is realized to both buyer and seller: \( x \in \{0, 1\} \). At \( t = 1 \), seller has a chance to move first and leave feedback for the buyer. At \( t = 2 \), buyer can observe the action of the seller and leave feedback. At \( t = 3 \), the seller has a final chance to leave feedback for the buyer, if the seller has not left feedback in the first period.

The above timing is to capture the sellers’ and buyers’ actions on eBay. There are many sellers on eBay that move very soon and leave feedback for buyers right after receiving it,
and there are some sellers that wait for the buyers to leave feedback before leaving feedback.

A.2 Buyers’ Problem

At the beginning of period 2, the buyer observes if the seller has left her feedback, and if the feedback is positive or negative. At this stage they have a chance to leave feedback for the other player. For simplicity, we assume that the buyers are myopic. When they decide to act during period 2, they take the action of the seller at period 1 as the final action and do not consider the possibility of the seller moving in the next period.

Assuming that the buyer is myopic, the optimal strategy of the buyer is simple. Given \( x \) and \( z \), they will choose the action that maximizes payoff, comparing these three values:

\[
\max\{\alpha x, -1, z, \alpha x 0, z, \alpha x 1, z\}
\]

and the buyer will choose the action \( y \) that maximizes \( \alpha xyz \).

A.3 Sellers’ Problem

After the transaction, outcome is realized: \( x \in \{0, 1\} \). The seller has the option of leaving feedback for the buyer either in the first period or in the third period. If the seller leaves feedback in period 1 he cannot change his feedback in the last period. But if he decides to wait he can leave feedback at the third period after the buyer has moved and has left him feedback.

If the seller has not left feedback in period 1, his optimal strategy in the third period is simple. The buyer has moved in period 2 and the seller should choose the action that maximizes his utility given \( x \) and \( y \), the buyer’s action. Therefore, he must choose \( z \) that maximizes:

\[
\max\{\beta x, y, 1, \beta xy, 0, \beta xy, 1\}
\]

The seller’s optimal strategy in the first period depends on his expectation about the buyer’s shock. Given the optimal strategy of the buyer and the seller in period two and period three, the seller’s expected utility in the period 1 is explained in the following theorem:
Lemma 1  Sellers expected utility from playing actions 0, 1, and −1 in the first period is:

\[ u_s = \begin{cases} 
\frac{\sum_y \exp(\hat{\alpha}_{xy0}) \max\{\beta_{x,y,-1}, \beta_{xy0}, \beta_{xy1}\}}{\sum_y \exp(\hat{\alpha}_{xy0})} - \beta_{xy0}, & \text{Seller plays } z = 0 \\
\frac{\sum_y \exp(\hat{\alpha}_{xyz}) \beta_{xyz}}{\sum_y \exp(\hat{\alpha}_{xyz})} - \beta_{xy0}, & \text{Seller plays } z \in \{-1, 1\}
\end{cases} \]

Proof. After the seller plays \( y \) in the first period, the buyer chooses an action that maximizes her utility:

\[ \max\{\alpha_{x_{-1,z}, \alpha_{x0z}, \alpha_{x1z}}\} \]

where \( \alpha_{xyz} = \bar{\alpha}_{xyz} + \eta_y \) where \( \eta_y \) is an iid random variable with extreme value distribution. The share of time that the action \( i \) is maximized is:

\[ \frac{\exp(\bar{\alpha}_{xyz})}{\sum_k \exp(\bar{\alpha}_{xz})} \]

And if the buyer plays \( i \), the seller’s return will depend on his strategy in the first period. If the seller has already moved and \( z \in \{-1, 1\} \) then the return in \( \beta_{xyz} \); otherwise, the seller has another chance to play; therefore, his return will be: \( \max\{\beta_{x,y,-1}, \beta_{xy0}, \beta_{xy1}\} \).

The seller in the first period will choose the action that gives him the maximum expected payoff.

A.4 After the Policy Change

We assume the game that the sellers and buyers play after the policy change is the same as before. The only difference is that after the policy change, the sellers no longer have the option of leaving negative feedback. The sellers have only two choices at periods 1 and 3, leaving positive feedback or leaving no feedback.

The options for buyers have not changed. The timing is also as previously described. We only let \( \mu - \text{Prob}(x = 1) \) to change. The probability of different outcomes used both before and after the policy change can help us identify this game.
A.5 Characterization of Equilibrium

In this section, we characterize the equilibrium further by making a few assumptions about the relationships between the parameters of sellers’ and buyers’ payoff from feedback. These assumptions will enable us to analytically show sellers’ and buyers’ reactions to the change in policy.

Assumption 1 Buyers’ average return from the feedback is supermodular.

\[ \bar{\alpha}_{xij} + \bar{\alpha}_{x'i'j'} \leq \bar{\alpha}_{x,\max\{i,i'\},\max\{j,j'\}} + \bar{\alpha}_{x,\min\{i,i'\},\min\{j,j'\}} \]

Assumption 2 Buyers’ and sellers’ return are increasing with their rivals’ action.

Assumption 1 implies the buyers’ payoff function has increasing differences on the returns. This assumption is analogue of concavity assumption in continuous cases. Assumption 2 implies that players benefit from positive feedback while they do not like negative feedback from their opponent.\(^{20}\)

Lemma 2 Given Assumption 1, the probability that the buyer plays 1 is increasing in the seller’s action in period 1.

Proof. Assume that \( j > j' \) are seller’s actions. We show that the probability that the buyer plays 1 is higher for \( z = j \).

\[ \frac{\exp(\bar{\alpha}_{x1j})}{\exp(\bar{\alpha}_{x,-1,j}) + \exp(\bar{\alpha}_{x0j}) + \exp(\bar{\alpha}_{x1j})} \geq \frac{\exp(\bar{\alpha}_{x1j'})}{\exp(\bar{\alpha}_{x,-1,j'}) + \exp(\bar{\alpha}_{x0j'}) + \exp(\bar{\alpha}_{x1j'})} \]

\[ \Rightarrow \exp(\bar{\alpha}_{x1j} + \bar{\alpha}_{x,-1,j'}) + \exp(\bar{\alpha}_{x1j} + \bar{\alpha}_{x0j'}) \geq \exp(\bar{\alpha}_{x1j'} + \bar{\alpha}_{x,-1,j}) + \exp(\bar{\alpha}_{x1j'} + \bar{\alpha}_{x0j}) \]

The above is true given Assumption 1. ■

The above theorem suggests that if the seller wants to leave positive feedback, if he leaves the positive feedback in the first period instead of waiting for the buyer to move first, then it will be beneficial for him.

\(^{20}\)We consider these assumptions to be reasonable assumptions. However, when it comes to estimation in the next chapter we do not impose these assumptions to the payoffs of buyers and sellers. But the estimated payoff values for sellers and buyers follow these assumptions.
Lemma 3  Given Assumption 1, the percentage of time the buyer plays $-1$ is decreasing in the seller’s action in period 1.

Proof. Assume that $j < j'$ are seller’s actions. We show that the probability that the buyer plays $-1$ is higher for $z = j$.

$$\frac{\exp(\bar{\alpha}_{x,-1,j})}{\exp(\bar{\alpha}_{x,-1,j}) + \exp(\bar{\alpha}_{x,0,j}) + \exp(\bar{\alpha}_{x,1,j})} \geq \frac{\exp(\bar{\alpha}_{x,-1,j'})}{\exp(\bar{\alpha}_{x,-1,j'}) + \exp(\bar{\alpha}_{x,0,j'}) + \exp(\bar{\alpha}_{x,1,j'})}$$

$$\Rightarrow \exp(\bar{\alpha}_{x,-1,j} + \bar{\alpha}_{x,0,j'}) + \exp(\bar{\alpha}_{x,-1,j} + \bar{\alpha}_{x,1,j'}) \geq \exp(\bar{\alpha}_{x,-1,j'} + \bar{\alpha}_{x,0,j}) + \exp(\bar{\alpha}_{x,-1,j'} + \bar{\alpha}_{x,1,j})$$

The above is true given Assumption 1. ■

The intuition behind Lemma 2 and 3 is that the buyers’ payoff from playing 1 increases in the sellers’ action, and their payoff from playing $-1$ decreases in their opponents’ actions. Therefore, they would prefer to play 1 more often and $-1$ less often in the equilibrium. These two lemmas lead to another result which stated in the Theorem 1:

Theorem 1  Given Assumptions 1 and 2, sellers will not leave negative feedback in the first period.

Proof. We argue that it is always weakly better for the seller to leave no feedback during the first period rather than leaving negative feedback. Given Lemma 2, the percentage of the time the buyer plays 1 is less if the seller plays $-1$ instead of 0. Moreover, Lemma 3 shows that buyers play $-1$ more often after the seller plays $-1$. Also note that by Assumption 2, sellers return in increasing in the buyers actions. Finally, the seller still has the option of leaving negative feedback in the third period. ■

The above is consistent with the evidence from the data section, as shown in Figures 1 and 2. Sellers have no incentives to leave negative feedback for buyers before buyers leave feedback. The next theorem is about the change in seller’s actions after the policy change.

Theorem 2  Given Assumptions 1 and 2, after the policy change, the sellers choose to leave positive feedback in the first period more often.

Proof. Theorem 1 shows that before the policy change sellers would not choose to leave negative feedback in the first period. The buyer’s optimal action in the second period,
given the seller’s action in the first period, has not changed, since the buyer does not take into account the future behavior of the seller. The seller’s expected utility from leaving no feedback before the policy change, the expression on the left of the below equation, is bigger than the expected utility of leaving no feedback after the policy change, the expression on the right of the equation:

$$\frac{\sum_y \exp(\bar{\alpha}_{xy0}) \max\{\beta_{xy, -1}, \beta_{xy0}, \beta_{xy1}\}}{\sum_y \exp(\bar{\alpha}_{0yz})} - \beta_{xy0} \geq \frac{\sum_y \exp(\bar{\alpha}_{xy0}) \max\{\beta_{xy0}, \beta_{xy1}\}}{\sum_y \exp(\bar{\alpha}_{xy0})} - \beta_{xy0}$$

This will decrease the expected utility to leave no feedback while the level of utility to leave positive feedback stays the same. This will lead to more positive feedback left by the sellers in the first period.

The above theorem is consistent with the data we observe in section 4, after the policy change sellers will act before the buyers more often. The intuition behind the proof is that after the policy change sellers’ incentives to wait and leave feedback in the third period after the buyer has moved will decrease, because their options to move in the third period does not give them as high a payoff as it used to.

## A.6 Identification Strategy

We identify the model using data from both before and after the policy change. We assume that the payoffs that sellers and buyers receive do not change by the change of the policy, so $\bar{\alpha}$ and $\bar{\beta}$ will stay the same over time. However, we assume that the share of the transactions with a positive outcome, $\mu = P(x = 1)$, can be different before and after the policy change.

To estimate the share of transactions with a positive outcome, we assume that if the transaction has an undesirable outcome for buyers they will report it through one of the mechanisms given by eBay, either through leaving negative feedback, leaving a low detailed sellers rating, or filing a dispute through eBay.\(^{21}\)

- Step 1. Start from an initial guess for $\alpha$ and $\beta$

- Step 2. Given $\alpha$ and $\beta$, find $\alpha'$ that is consistent with buyer’s choice

\(^{21}\)We are working on the possible mechanism to identify this probability directly from the outcome of the game.
• Step 3. Given \( \alpha' \) and \( \beta \), find \( \beta' \) that is consistent with seller’s choice

• Step 4. If the difference between the new parameters and starting parameters are bigger than \( \epsilon \) go to step 2 using the new parameters.

We use a fixed-point strategy. We start from an initial guess for the parameters and find the true parameter for buyers and sellers in different steps. We stop the process when the new parameters are close to the old parameters. Each of the steps is explained in details below:

Step 1. Different initial values are chosen in this step.

Step 2. Given \( \alpha, \beta, \mu, \) and \( \mu', \alpha' \) is estimated as follows:

We observe the probability that the buyer plays \( y \) after observing that the seller has played \( z \) in the first period, \( P(Y = y, Z_1 = z) \). Where \( Z_1 \) is the possible set of actions for the seller in period 1, and \( Y \) is the possible set of actions for the buyer. We do not observe \( x \) and \( P(Y = y, Z_1 = z) \) can be represented as:

\[
P(Y = y, Z_1 = z) = \sum_{x=\{0,1\}} \mu P(Z_1 = z|X = x) P(Y = y|Z_1 = z, X = x)
\]

where

\[
P(Y = y|Z_1 = z, X = x) = \frac{\exp(\tilde{\alpha}_{xyz})}{\sum_{y} \exp(\tilde{\alpha}_{xyz})}
\]

We set \( \mu \) to be the share of transactions with no complaints. Moreover, \( P(Z_1 = z|X = x) \) can be estimated using the initial guess for \( \alpha \) and \( \beta \) using the sellers’ problem in the first period. For each value of \( X = x, Y = y, \) and \( Z = z \), the above equation is valid for both before and after the policy change. This results in a two equations, two unknowns problem. Solving the equations will give us the new payoff function for buyers: \( \alpha' \). Step 3. Given \( \alpha' \) and \( \beta, \beta' \) is estimated using an optimization strategy:

\( \alpha' \) estimated in Step 2 gives us the optimal strategy of the buyers in \( T = 2 \): \( P(Y = y|X = x, Z = z) \). Having this values and starting from the \( \beta \) as an initial value, we simulate the sellers strategies at \( T = 1 \) and \( T = 3 \) using random draws for \( \gamma \). Doing so we can calculate

\textsuperscript{22}We do not have a proof for convergence or uniqueness of this procedure but in practice we were able to converge to a single solution using different starting values.
the simulated values for \( P_s(Z_1 = z) \) and \( P_s(Z_3 = z|Y = y) \). The next step is to get the distance between these values and the probabilities from the data.

\[
d(P_s(Z_1 = z), P_s(Z_1 = z)) + d(P_s(Z_3 = z|Y = y), P_s(Z_3 = z|Y = y))
\]

Where the function \( d \) takes the quadratic difference between each component of the two matrixes and it adds these numbers together. The last step is to use an optimization mechanism to minimize the distance function by changing the value of \( \beta \), the optimal value will give us \( \beta' \).

**Step 4.** We take the distance between starting values of \( \alpha \) and \( \beta \) and the new estimates \( \alpha' \) and \( \beta' \) and if this distance is higher than an \( \epsilon \) we try these steps again using the new estimates.

### A.7 Estimations and Results

In this section, we first show the moments we used for estimation as explained in the Section A.6. Afterwards, we report the estimated values for \( \bar{\alpha} \) and \( \bar{\beta} \). eBay sellers and buyers have sixty days to leave feedback for the other party and the timing is continuous in practice. In our model, we have assumed that there are three time periods. In the first period the seller is the only party that can leave feedback, in the second period the buyer can leave feedback, and in the third period, the seller can leave feedback if he has not left feedback in the first period. If both seller and the buyer have left feedback for the other party then if the buyer has left feedback first, then we assume the seller action in the first period to be 0, no feedback. If the seller has acted first then we assume that has happened in period 1. If only the buyer leaves feedback then we assume that the seller’s action was 0 in both periods. If the seller is the only party to leave feedback, then if he leaves feedback in the first thirty days after the end of the transaction we assume that he has moved in the first period and otherwise, we assume he has moved in the second period.

Table 6 shows the percentage values for \( P(Z_1 = z) \), probabilities that the sellers take different actions in period 1 before and after the policy change. Table 6, in addition, shows the percentage of the time buyers take each action conditional on the sellers’ actions in
Table 6

Sellers’ Actions in the First Period

<table>
<thead>
<tr>
<th></th>
<th>Before Policy Change</th>
<th>After Policy Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Negative</td>
<td>No feedback</td>
</tr>
<tr>
<td>Before</td>
<td>0.3%</td>
<td>74.3%</td>
</tr>
<tr>
<td>Change</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Buyers’ Actions in the Second Period

<table>
<thead>
<tr>
<th></th>
<th>Before Policy Change</th>
<th>After Policy Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Negative</td>
<td>No feedback</td>
</tr>
<tr>
<td>Z₁ = −1</td>
<td>10%</td>
<td>87%</td>
</tr>
<tr>
<td>Z₁ = 0</td>
<td>2%</td>
<td>32%</td>
</tr>
<tr>
<td>Z₁ = 1</td>
<td>1%</td>
<td>31%</td>
</tr>
<tr>
<td>After</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sellers’ Actions in the Third Period

<table>
<thead>
<tr>
<th></th>
<th>Before Policy Change</th>
<th>After Policy Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Negative</td>
<td>No feedback</td>
</tr>
<tr>
<td>Y = −1</td>
<td>37%</td>
<td>58%</td>
</tr>
<tr>
<td>Y = 0</td>
<td>0.3%</td>
<td>80.4%</td>
</tr>
<tr>
<td>Y = 1</td>
<td>0.04%</td>
<td>10.49%</td>
</tr>
<tr>
<td>After</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: y represents the buyers’ feedback (negative, no feedback, or positive), z similarly represents sellers’ feedback.
Table 7
Buyers’ Utility Values

\[
x = 1
\]

<table>
<thead>
<tr>
<th>( z = -1 )</th>
<th>( z = 0 )</th>
<th>( z = 1 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( y = -1 )</td>
<td>-2.15</td>
<td>-3.32</td>
</tr>
<tr>
<td>( y = 0 )</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>( y = 1 )</td>
<td>-3.24</td>
<td>0.52</td>
</tr>
</tbody>
</table>

\[
x = 0
\]

<table>
<thead>
<tr>
<th>( z = -1 )</th>
<th>( z = 0 )</th>
<th>( z = 1 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( y = -1 )</td>
<td>-2.15</td>
<td>0.11</td>
</tr>
<tr>
<td>( y = 0 )</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>( y = 1 )</td>
<td>-3.2</td>
<td>3.2</td>
</tr>
</tbody>
</table>

Sellers’ Utility Values

\[
x = 1
\]

<table>
<thead>
<tr>
<th>( z = -1 )</th>
<th>( z = 0 )</th>
<th>( z = 1 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( y = -1 )</td>
<td>-100</td>
<td>0</td>
</tr>
<tr>
<td>( y = 0 )</td>
<td>-100</td>
<td>0</td>
</tr>
<tr>
<td>( y = 1 )</td>
<td>-100</td>
<td>0</td>
</tr>
</tbody>
</table>

\[
x = 0
\]

<table>
<thead>
<tr>
<th>( z = -1 )</th>
<th>( z = 0 )</th>
<th>( z = 1 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( y = -1 )</td>
<td>9.42</td>
<td>0</td>
</tr>
<tr>
<td>( y = 0 )</td>
<td>-0.02</td>
<td>0</td>
</tr>
<tr>
<td>( y = 1 )</td>
<td>0.62</td>
<td>0</td>
</tr>
</tbody>
</table>

**Notes:** \( x \) represents the outcome of the transaction (positive or negative), \( y \) represents the buyers’ feedback (negative, no feedback, or positive), and \( z \) similarly represents sellers’ feedback.

period 1, before and after policy change. The last section of Table 6 shows the percentage of the time sellers take each action after the buyer has moved, before and after policy change. As mentioned before, in order to identify \( \bar{\alpha} \) and \( \bar{\beta} \), we made some normalization assumptions. First, we assume that \( \bar{\alpha}_{x_0z} = 0 \) and also \( \bar{\beta}_{x_0y} = 0 \). This is a normalization assumption and without this assumption the model is under-identified. Moreover, since after the policy change, sellers can no longer leave negative feedback, we only have one data point for the response of the buyers after negative feedback from sellers. To do the identification, we assume sellers do not leave negative feedback when \( x = 1 \): \( \beta_{1y, -1} \) is a big negative number.\(^{23}\)

\(^{23}\)In the identification procedure we set this number equal to -100 and it is enough to prevent the sellers from choosing \( z = -1 \) when \( x = 1 \).
Table 7 reports the values for $\bar{\alpha}$ and $\bar{\beta}$. These represent the average payoff buyers and sellers receive in various cases. If the outcome of the transaction is positive and they have received positive or no feedback, buyers have more incentive to leave positive feedback. This incentive goes higher if the seller has also left positive feedback for the buyer. Additionally, buyers have very low incentives to leave negative feedback when the outcome is positive. Even getting a negative feedback mostly does not drive buyers to leave a negative feedback most of the time, and in response they will leave no feedback. If the outcome of the transaction is negative or bad, in most cases buyers prefer not to leave a feedback possibly as getting a negative feedback is costly for them.

As mentioned, we normalize the sellers’ payoff from leaving a negative feedback when the outcome is positive to a high negative number to set the probability of leaving negative feedback to zero. Given the normalization, when the outcome is positive, sellers will prefer to leave positive feedback when they have received positive; otherwise, they slightly prefer to leave no feedback. When the outcome is negative, sellers strongly prefer to respond to negative feedback from the buyer with negative feedback, 9.42 compared to 0 and -49.33. This shows the effect of retaliation. Receiving positive feedback from buyers even when the outcome is negative changes the incentives of sellers so that they prefer to leave positive feedback more than leaving negative feedback, 1.87 compared to 0.62.

The estimated payoff can be used to predict the consequence of further policy change, e.g., making the feedback system one-sided and only giving buyers ability to leave feedback.

## B Data: Collectibles and Stamps

This section includes graphs related to the Collectibles and Stamps categories. The results are qualitatively the same as ones presented in the main body of the paper.
Figure 16: Proportion of Positive Feedback for Buyers, Collectibles and Stamps

Note: This figure shows the proportion of positive feedback ratings left by a seller over number of days between buyer’s and seller’s feedback ratings. Figure a. shows the data for collectables and Figure b. shows the data for stamps.

X axis: The number of days the seller has left feedback before the buyer.

Y axis: Proportion of positive feedback over the total feedback left at the same day.
Figure 17: Proportion of Positive Feedback for Sellers, Collectibles and Stamps

Note: This figure shows the proportion of positive feedback ratings left by buyers over number of days between buyer’s and seller’s feedback ratings, before and after implementing the no-negative policy. Figure a. shows the data for collectables and Figure b. shows the data for stamps.

X axis: The number of days the buyer has left feedback after the seller.
Y axis: Percentage of positive feedback over the total feedback left at the same day by buyers for sellers.
Figure 18: Proportion of non-Positive Feedback for Sellers vs. Timing of Feedback.

*Note:* This figure shows the proportion of positive feedback ratings left by buyers over number of days between buyer’s and seller’s feedback ratings, before and after implementing no-negative policy. Figure a. shows the data for collectables and Figure b. shows the data for stamps.

X axis: The number of days the buyer has left feedback after the end of the transaction.
Y axis: Proportion of non-positive feedback over the total feedback left at the same day by buyers.
Table 9: Timing of Feedback

<table>
<thead>
<tr>
<th></th>
<th>Before Policy Change</th>
<th>After Policy Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collectibles</td>
<td>38.00%</td>
<td>46.00%</td>
</tr>
<tr>
<td>Stamps</td>
<td>53.00%</td>
<td>59.00%</td>
</tr>
</tbody>
</table>

Figure 19: Adoption Rate for Feedback, Collectibles and Stamps

Note: This figure shows the proportion of transactions with feedback left by sellers and buyers over time. Figure a. shows the data for collectables and Figure b. shows the data for stamps. X axis: Time period. The policy Change happens in May 2008. Y axis: Proportion of transactions with feedback from the sellers and buyers.
Figure 20: Timing of the Feedback, Comparing to The End of Transaction, Collectibles and Stamps

Note: This figure shows the average number of days after a transaction that feedback is received by sellers or buyers. Only transactions with feedback are considered for this average number. Figure a. shows the data for collectables and Figure b. shows the data for stamps. X axis: The time period. The policy change happened in May 2008. Y axis: The number of days participants in the market wait before leaving feedback.