Truck, barter and exchange versus the endowment effect: virtual field experiments in an online game environment.

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20. January 2008

Truck, barter and exchange versus the endowment effect: virtual field experiments in an online game environment.

By

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Abstract

We examine the feasibility of using a massively multiplayer online role-playing game (MMORPG) to test economic theories. As a test vehicle we use the well-known hypothesis about the relationship between market experience and the endowment effect. Our results confirm earlier field experiments that individuals with more trading experience are less likely to exhibit status quo behaviour in trade. However, we also find evidence that highly experienced individuals are more likely to swap the item rather than keep it – i.e. there appears to be a propensity to 'truck, barter and exchange'. A further experiments suggests that this feature is robust and is unlikely to be due to subject misperception or experimenter demand effects. We conclude that virtual economies may be a useful venue for field experiments.

Keywords: Endowment effect, virtual field experiment, Runescape, MMORPG.

1. Introduction

It has been regularly observed that the minimum compensation which individuals are willing to accept (WTA) in return for giving up a good is greater than the amount which they would be willing to pay (WTP) to acquire it in the first place (Kaheneman, Knetch, and Thaler 1991). This "endowment effect" has been recorded by researchers many times in laboratory experiments (Kaheneman et al, 1991; Shogren et al, 1993, Bateman et al 1997). Field experiments on the phenomenon are notably rarer, but in a remarkable series of trials using memorabilia markets, John List (2004) has put forward evidence that suggests the endowment effect is eroded by repeated exposure to real markets.

In this experiment we provide some further evidence on the instability of the endowment effect in markets using data from a popular online role playing game (RPG), Runescape. In doing so, we have three main aims. First, games such as Runescape, Second Life or World of Warcraft have claims to be real economies (Castronova, 2002). In them, individuals labour to produce goods which are then exchanged with the products of other peoples' time within well-developed trading institutions.[1] As with real-world societies, experience acquired through the investment of time and energy changes productivity, while the freedom given to players to define their own strategies means that institutions and associations emerge and disappear spontaneously. Thus, one aim of the research is to extend understanding of behaviour in these online economies. Secondly, virtual game environments have the potential to be venues for economics experiments. One particular feature of RPGs is that, like the sports card and pin markets, virtual markets have a natural variation between experienced and inexperienced individuals. Furthermore, the level of experience in this virtual market is typically reflected in player scores that make it easier to categorise experienced and inexperienced market players. Our second aim is therefore methodological: to explore the feasibility of using multiplayer gaming environments

[1] That these goods are valuable is documented by the well-developed markets for exchanging products from inside the game for real-world money.

for (virtual) field tests of economic theories.[2] Finally, there is value in seeing whether List's results are obtainable in other arenas or whether they are confined to the particular US memorabilia markets he studies.

The main results of our experiments are as follows: first we find evidence of a large endowment effect for inexperienced players. In other words, online players act like subjects in many other experiments on the subject. Secondly, in keeping with other field studies we find that the higher the level of experience the lower the endowment effect. However, our third main result is that highly experienced players over-trade, in the sense the average person is more likely to swap their endowment for the alternative than to stick to the status quo. This is where our headline quote from Adam Smith comes in: for experienced players the propensity to truck barter and exchange[3] appears to overwhelm any endowment effect.

The outline of this paper is arranged as follows. Section 2 provides background material on our virtual laboratory and describes the experimental designs; section 3 presents and analyses the empirical evidence and section 4 concludes with some speculation on the implications of our results for the interpretation of field experiments on the endowment effect.

2. Methodology and Experiment Design

About Runescape

Runescape is a Java programme based MMORPG (massively multiplayer online role-playing game). It has over ten million active accounts, where more than one million are paid-to-play accounts (P2P) and the rest are free-to-play accounts (also known as F2P, this type of account have limited features). Server capacity means that at any one

[2] The term 'virtual reality experiments' has been used (e.g. Harrison et al, 20067, Bateman et al, 2006) to denote experiments where individuals are immersed in a tailor-made virtual reality to better understand environment problems. This is obviously quite different to the kind of work described here.

[3] "This division of labour, from which so many advantages are derived, is not originally the effect of any human wisdom, which foresees and intends that general opulence to which it gives occasion. It is the necessary, though very slow and gradual consequence of a certain propensity in human nature which has in view no such extensive utility; the propensity to truck, barter, and exchange one thing for another." Adam Smith, 1776, Book 1, Chapter 2.

time, up to 280,000 can play the game, which is designed to be accessible from any location with an Internet connection. It runs on an ordinary web browser such as Internet Explorer.

The game takes place in the fantasy realm of Runescape (also referred to as Gielinor) which is divided into 18 different kingdoms or regions. Players are shown on the screen as playable avatars. Compared to some other MMORPGs, the game gives more freedom to players in term of setting their own objectives, and deciding which of the available skills and activities to pursue. Because of this freedom, players can be an expert in all skills; the only obstacle is the time and money needed to achieve this goal. There is no linear path that must be followed in Runescape, players can engage in fight with or against others or with monsters. They are free to choose to complete quests - set tasks designed to teach players to trade and develop new and old skills – or to follow a certain story line or to just spend all there time playing with others in cooperative mini-games.

In games such as Runescape, it takes a long time to build up experience. This knowledge is reflected in a number of published scores, chief amongst which is the *combat level* of a character – a basic measure of their ability to deal with monsters and other aggressive players. Combat levels of experience are also highly correlated with other scores such as that for quests. Some skills acquired through quests are directly relevant to combat (and therefore feed into the combat level score) and some are very important for the survival of players – such as providing food, armour and weapons to the character. In fact, there are 23 skills players can choose to learn and train with. Seven are combat skills (e.g. attack, defence, magic) and the remaining 16 are non combat related (e.g. mining, smithing, crafting, fishing and cooking). From these 16 non combat skills 8 can be used by F2Ps and P2Ps alike; however, the 8 remaining skills are available to paying member only. Items to enhance skills, such as particular magic spells or armour can be acquired through killing specific monsters, through production (which takes time) or through trade. Items can also be banked for future use or exchange.

The game has its own currency called the gold coin or also known as “gp”. Players can earn “gps” buy killing monsters and NPCs (non player characters). When

monsters or NPCs die they also drop items of all kind; players can then keep or sell these items to shops or other players.

In fact there are many ways players can earn money in the game. The simplest way is to kill NPCs, monsters or even other players. However, this risks dying and the associated cost of losing precious items in the process. Another way is to develop the "money making skills" that allow players to obtain items or goods that can then be sold to others. For instance a player might mine gods or grow crops or add value to existing goods through smithing or cooking. The player to player trading market is very close to a real world market and shares the same basic microeconomic fundamentals of demand and supply. For instance, the shock of a macro (script that allows reproducing actions in the game without the intervention of the player) illegally introduced into the game to automate the harvesting flax led to a sharp decrease of prices for flax. [4]

In fact macros are also banned from the game, as is trading goods for real money outside the game. Yet, real world trading with third party websites is not uncommon and provides another risky way for players to gain income for their characters. Jagex, the owners of Runescape, actively police the internet and claim to have seized billions of gps from accounts design for selling gold coins and banned thousands of players' accounts for trading with these websites[5], but nevertheless the trade continues.

Within the game there are four different communication systems which can be used to initiate trade. The first system and the most use is the public chat box, located on the bottom of the game's window. Players can communicate with each other and read comments from others, even if they are not directed to them. This form of communication is used often to advertise items that are being sold or for requesting help from others. The second chat system is the personal chat box (also know as pm). This system allows communication in private with another player without others being able to see the conversation. Recently the operators added a third chat system, this time designed for use by members of clans and guilds, associations of members. This system allows more than one player to communicate with others in private

[4] Source: www.zybez.com.
[5] Runescape.com, knowledge and base section :www.runescape.com

without the use of the public chat. Finally, there is the public forum, designed to post announcements or comments about the game, where only members are able to post. Players often use the forum to buy or sale items.

Trading is particularly simple within this game. There are two pop-up trading windows: the first one shows the item(s) that are being traded; and the second window is to confirm the trade. This system provides players a total control in trading – both players can have a look of the object(s) that is or are being exchanged – both players need to agree by clicking the accept icon in the last window in order for a trade to succeed. During trading either player can call off the deal at anytime before confirming the deal. This fuels trading activities among players for items. For some goods there are specific shops, but trading can also take place either through random encounters with other players or in response to forum messages or in a number of specific and well-advertised locations in the virtual world where individuals who wish to trade congregate.

2b. Experimental Design.

The design of these experiments is similar to other field trials of the endowment effect. Subjects were approached within the virtual world and invited to take part in an experiment. If they accepted the invitation they were endowed with one of the goods at random. Subjects were then asked to complete a short question and answer session (details below) and then asked if they wished to swap their endowment for a newly introduced alternative.

The goods were selected for the experiment on the grounds that they were well-known and potentially useful to a wide-range of players, as well as being of approximately equal value. Pre-tests with a small number of Runescape members confirmed this.

We wished to have a range of trading experience amongst subjects, so we recruited participants from two subject pools. There are no fixed rules to determine what an experienced player is, but in the Runescape gaming community it is generally believed that a player is considered as a high level only if he or she reaches 70-75

combat skills[6] or above – anyone lower than that is seen as a "noob" or "new comer". Hence, we labelled subjects with a combat level of 75 or above as highly experienced market players and if below this limit then, they are low experienced players. (Later on we will also divide the lower experienced player into two sub groups - call them medium low level (level 74 to 30) and very low level (29 and below).

Higher level players are often difficult to reach as they prefer to disable their public chat – so as to avoid to be disturbed by lower levels asking stupid questions or begging for items. The Runite Legion is a clan based community of several hundred members many of whom have high combat levels; they all have extensive experience of the game. To obtain a sample of higher level players we recruited members from this community using the chat system for clans. For low level players, who have just started playing, recruitment was straightforward because when a new player starts the game proper after undergoing training,[8] they all pop up at the same place. We therefore waited at this place and approached novice players at random as and when they appeared.

In the question and answer section (see Appendix 1b) we collected the following information. Firstly, combat level (combat skills), total level (the total level of all skills, including combat), quest points amount. Then, we asked the player how many times he or she traded per day. Because of privacy rules governing the game that ban people from sharing any private information, we decided to not ask for any personal information other than age and gender. Moreover, in order to respect the rules on privacy, we decided to use range values and explicitly warned the player that they were not obliged to answer the two personal questions (in fact all did so). The next question was to know how much the subject knew about the item and how much it was worth. Finally, the subject would be asked how long he had played the game. Once these questions were completed the alternative object was introduced and the player was invited to swap.

[6] Essentially, to be effective in combat a player must typically acquire protective armour, weapons, food and various spells. These specific goods are usually unobtainable unless the player trades goods previously produced, found or won as a result of earlier combat.

[8] All players must pass through a training module, where they must complete certain tests of understanding in order to proceed to the game proper.

Experiment 1.

As noted above we conducted two experiments. In the first we used moderately expensive goods and sampled both experienced and inexperienced players.

In experiment 1 the goods were as follows:

> Good A was 150 mind runes (players from any level can use this item), a magic artefact that allows the user to cast basic elemental attack spells including teleporting.
>
> Good B was 150 iron arrows (players from any level can use this item). Arrows are use for ranging skills - this allows players to attack enemies at distance.

These goods are common and well-known and trade within the game for around gp 3,000. To put this in perspective, a novice player begins the game with 32 gp and might take 20-30 hours of work to acquire sufficient funds to afford one of these bundles of goods. A higher level player might typically take only 1-3 hours to achieve the same income.

3. Experimental Results.

Table 1 shows a summary statistical description for both groups, high and low combat levels. In total in the first experiment we collected 90 observations from players, 47 high combat levels and 43 low levels.

The pattern of ages and gender revealed by this data is perhaps not expected. Subjects are typically male and in their late teens (i.e. similar ages to the university students typically used in laboratory experiments). Most subjects were from the USA or the UK, with 8 coming from European countries in which the main language is not English. Columns 1 and 2 in table 1 reveal that high combat level players seem older than the lower levels, they spend twice more time playing the game and there seem to be more female within the high level sample. Estimates from high level players are closer to the real price range value for both treatments (2250-3750gp each bundle), showing perhaps a better understanding of the market price.

Table 1. Characteristics of participants, experiment A

	Experiment A	
	High level players Mean (std dev.)	Low level players Mean (std dev.)
Combat level	89.66 (10.48)	34.79 (27.3)
Fraction female	0.17	0.07
Item estimations	3061.70 (435.04)	2275.86 (1852)
Years of playing	1.88 (0.99)	0.68 (1.00)
Trading habits	0.66 (0.48)	0.28 (0.45)
Age Range	1.79 (0.55)	1.28 (0.45)
Fraction endowed with B	0.49	0.58
Fraction USA based	0.69	0.40
Fraction UK based	0.19	0.44
Fraction, non-English speaking countries.	0.04	0.11
N	47	43

Notes:
1. Item estimations *denote how much the subject thinks the bundle traded worth.*
2. Trading habits *denotes 1 if subject trade 5 times or more per day, 0 otherwise.*
3. Age range *denotes categorical variable, 1 if subject is between 13 to 16 years old, 2 if he is 17 to 21 years old and 3 if he is 22 years old or more.*

The trading habits are higher for the high combat levels than low combat levels. Twenty-three subjects (but only one high level player) reported that they never or rarely traded objects. Nearly all of these players were concentrated amongst the novices. The remainder reported trading at least once a day on average, but as table 1 indicates around half of the sample trade more than 5 items on average *per day*. It is worth noting that in List (2004) the most intense private trading category was 11 or more items *per month*. In other words, as measured by the volume of trades, most subjects here are trading at intensities several times higher than those encountered in the sports memorabilia markets.

Finally the table shows that the treatments were fairly distributed across all samples, 49 percent of high levels and 58 percent of low combat levels were endowed with good B.

The top row of the table 2 shows the summary trading statistics for the entire pooled data. It shows that 54.5 percent players decided to trade their item, 47.9 percent for Good A for B and 61.9 percent for Good B for A. Given that all participants were randomly given treatment A or B, the equivalence of WTA and WTP would imply that approximately half the goods were being allocated and should be traded (Knetsch (1980); Kahneman et al, 1991 and List, 2003). Using the Fisher's exact test, we accept the hypothesis of no endowment effect (p=0.250).

Table 2: Summary trading Statistics for all players

Variable	Percent Traded	P- values for Fisher's Exact test
Experiment A		
Total combat levels sample (n = 90)	54.5	
Good A for Good B	47.9	P=0.250
Good B for Good A	61.9	
High combat levels (n = 47)	78.7	
Good A for Good B	78.3	P<0.001
Good B for Good A	79.2	
Low combat levels (n = 43)	27.9	
Good A for Good B	20	P<0.001
Good B for Good A	38.9	
Medium low levels (n = 24)	45.8	0.223
Very low levels (n = 19)	5.3	P<0.01

However, when we disaggregate by combat level the pattern of trading is very different, a picture illustrated by Figure 1. It points to the fact, also shown in Table 2, that higher levels of combat are associated with a much higher level of trading that typically exceed 50%. It can also be seen that this conclusion is robust to changes in the combat level of 75 as the divide between high and low experience players. Along with the rows in Table 2, it supports the notion that highly experienced players tend to over-trade (meaning that they are more likely than not to trade). When we conduct a one-sided Fisher's exact test that the proportion of high combat level players who

prefer A to B is independent of the endowment, this is firmly rejected with a p value below 0.001.

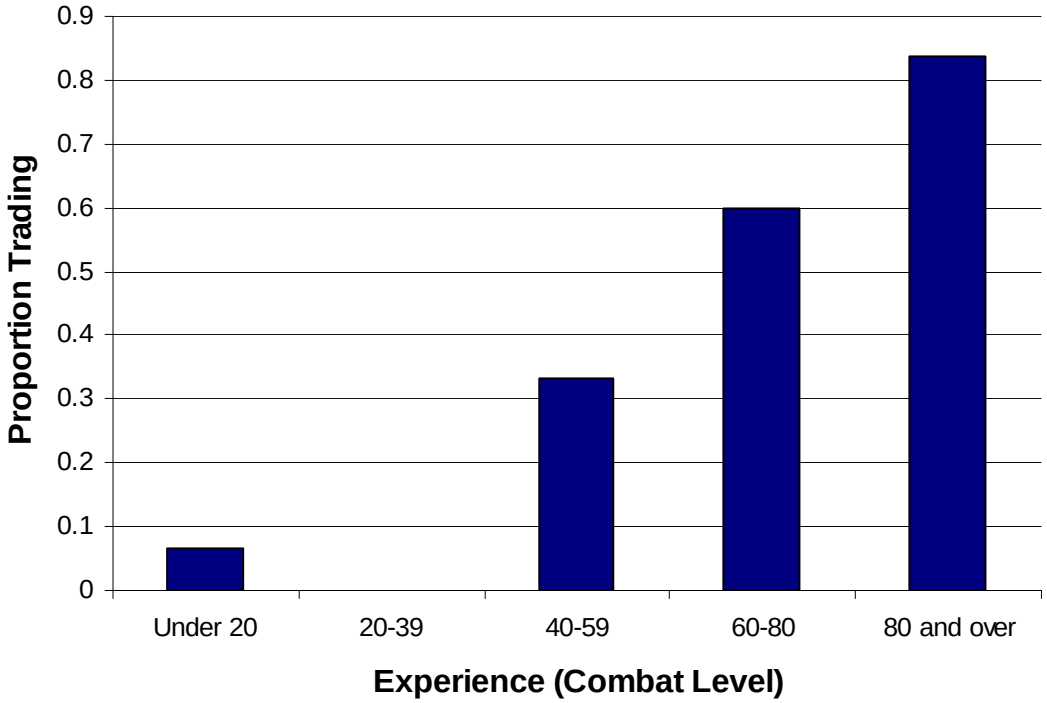

Figure 1. Trading and Combat Levels in Experiment A.

Conversely, when the low combat level group are tested we see that only 27.9 percent of players swap their endowment for the alternative. For this group, we reject the null that preference is not linked to endowment with p=0.007, suggesting that there is strong endowment effect within the low combat level sample (column 2, table 2). Figure 1 suggests that the endowment effect is most strongly associated with very low combat levels. We split the low level data into two and test again. The medium low combat levels (combat levels of 30 to 74) sub-sample shows a trading rate of 45.8 percent, compared to 5.3 percent of very low levels (combat level below 30). Not surprisingly therefore the null hypothesis of no link between preference and endowment is accepted for the 24 medium low level players but strongly rejected ($p<0.01$) for the 19 very low combat level players.

4. Experiment B.

Our results so far are consistent with previous evidence on the endowment effect in that market experience tends to reduce its incidence. However for players with higher combat levels we also found robust evidence of over-trading, which appears unique in the context of tests of the endowment effect.[9]

One class of explanations of the endowment effect is based on the notion that individuals mis-forecast their own preferences (Loewenstein and Adler, 1995). Specifically, the attachment to a new good is underestimated and this makes subjects more inclined to hang on to their endowments. To explain our results using this type of model, highly experienced players would have to *underestimate* the value of the endowment relevant to the alternative good. This is by no means an unfamiliar notion in everyday life. In English, 'the grass is greener on the other side'[10] is a well-known saying summing up the pull of objects that are not possessed. Meanwhile, in Shakespeare's 'Much Ado about Nothing' Friar Francis laments

> "That what we have we prize not to the worth.
> Whiles we enjoy it, but being lack'd and lost.
> Why, then we rack[11] the value, then we find the virtue that possession would not show us" (Act 4, Scene 1).

In keeping with Friar Francis, we call this possible relative underestimation of the value of the currently-held object, the 'prize not to the worth' effect. We have no direct evidence on it from experiment A, but we do know that experienced players are more likely to value accurately their endowment: for inexperienced players average values were 770gp below the typical market price – a deviation of over 25%, but for experienced players with a combat level of at least 70, average values were within 1% of the typical market price. Given the random nature of the endowment it does

[9] Amongst intense private traders, List (2005) finds 56% swap their endowment for the alternative, but this is not significantly different from 50% given the sample size. It is however suggestive that overtrading is not confined to our dataset.

[10] Sunstein, 1993 (p. 224), writes that 'The popular notion that "the grass is always greener" suggests that preferences may be strongest for things to which people do not have entitlements, but there is apparently no empirical support for this intuitively plausible view.' This experiment seems to provide such empirical support.

[11] In this context, 'rack' means raise or magnify.

suggest that there was no systematic overvaluation of the alternative among experienced players.

We also have information about whether subjects were familiar with their endowed good. We can say that across the two treatments there were no differences in reported familiarity (Fisher's exact test, $p = 0.284$). There were differences in trading patterns conditional on familiarity: subjects who said they were familiar with their endowed good were more likely to swap it compared to subjects who were not familiar (31 out of 46 in the first category, 18 out of 44 in the second category, $p = 0.019$ for a Fisher's exact test of no difference),[12] though to a large degree this reflects the fact that more experienced subjects were more likely to be familiar with their endowment. Indeed the familiarity variable is not significant once behaviour is conditioned on combat level via a logit model.

An alternative hypothesis is that there are two competing drives amongst players: one is that typically found in experiments on the endowment effect, which we can denote as 'caution' (Bateman et al, 1997). The second is Adam Smith's propensity to 'truck, barter and exchange'. By this we mean players gain some utility from exchange itself. Models explaining caution in trading have been put forward by a number of authors, including Huck et al, 2005 and Carmichael and MaCleod, 2006. A common theme of these works is that understating willingness to pay (or overstating minimum compensation required) can raise the expected payoff for individuals in some forms of bilateral bargaining. Such behaviour is not incentive compatible in simple exchange games such as the one used in this experiment, but the idea is that cautious trading may become a default heuristic used in all trading situations. The key point is that undertrading is not simply consistent with these theories – it is implied, so overtrading cannot be explained by changes in parameter values. Rather it represents a fundamental reject of the tenets of the models. Viewed in this light overtrading appears difficult to understand. Moreover in some contexts it appears perverse, since with myopic agents it might imply cycles of exchange.

[12] It is worth noting that subjects were asked about their familiarity and valuation of their endowed good first, before it was revealed to them that they had an opportunity to trade the good for another.

The question is therefore why the truck barter and exchange motive might be given more weight in some settings. The purpose of this paper is not to elaborate a detailed theory of why this might be the case, but it is possibly worth revisiting Smith in order to provide the sketch of a story.

In Smith's original argument, the propensity is necessary to exploit the gains from the division of labour:

> "But without the disposition to truck, barter, and exchange, every man must have procured to himself every necessary and conveniency of life which he wanted. All must have had the same duties to perform, and the same work to do, and there could have been no such difference of employment as could alone give occasion to any great difference of talents." Ch. 2 page.

Theories that produce expected gains from cautious trading do so in the context of exchange. But in an economy where agents both produce and consume, being over-attached to the endowment may mean a person undervalues the gains from specialisation. Figure 2 illustrates the outline of this argument with a familiar diagram of a production possibility frontier and indifference curve in a 2 good economy. In autarchy, the individual produces and consumes at N where the indifference curve UU' is tangential to the production frontier. Suppose that the line PP represents trading opportunities then the utility maximizing individual should specialise, by producing more of good two and selling it to finance consumption of the other.

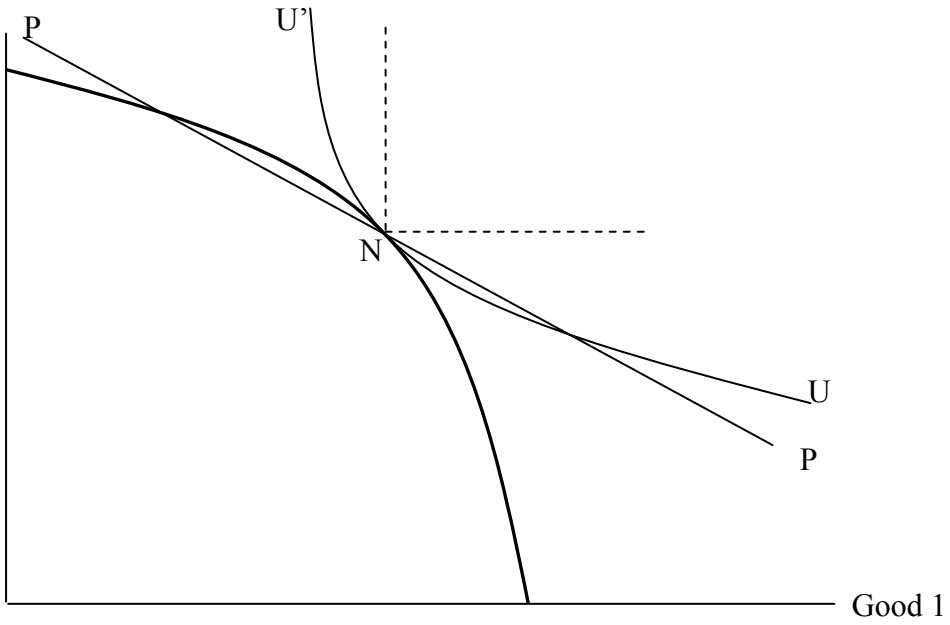

Figure 2. Trading and Production.

Suppose though that the individual trades as if she has the broken indifference curves – an extreme version of caution employed to illustrate the argument. Then there is no feedback from trade to guide her movement towards specialization and indeed no reason to specialize given the nature of her trading rule. The point is that 'learning to like what we have' is a poor strategy in a production context, where 'learning to specialize' is potentially valuable.

Similarly cautious trading may be counterproductive in an environment where retrading is possible at a later date. Suppose the consumer in figure 2 is considering selling some of her endowment of good 1. The terms of potential offers to trade are uncertain but PP provides a guide to the central tendency of the distribution. If this consumer anticipates the possibility of being able to buy back good 1 at a later date at more or less similar terms, then she may be willing to sell it now at a price below her marginal willingness to accept compensation. Any offers that put her in the region PU'N may produce the opportunity to trade in the future that puts her on a higher indifference curve than UU'.[13]

[13] To invoke another common saying, 'a bird in the hand is worth two in the bush' indicates that this may be a familiar trading strategy in which individuals grasp the opportunity in front of them rather than waiting for something that is potentially better but which might never happen.

To sum up, cautious trading may not be optimal in environments where traders are also producers or where retrading in the future is possible.

A third possibility is that the high levels of trading represent experimenter effects amongst high productivity subjects for whom the goods were of relatively low value. In other words some subjects might view trading as the point of the experiment and seek to conform. Since highly experienced subjects are also subjects with higher productivities, then this would explain the relationship between experience and overtrading. In other words, if the goods were of higher value, overtrading would disappear.

Finally we might wonder if the individuals attracted to trading environments, such as memorabilia markets, ebay, second-hand goods markets, collectors fairs and online role playing games may obtain utility from trade itself (for sociological evidence see Crewe and Gregson, 1998, Yee, 2007). In combination with an endowment effect eroded by market experience this might lead to the pattern of results observed in List, 2003 and in our first experiment.[14]

To make some headway in distinguishing between these explanations we ran experiment 2, in which the basic design is unchanged, but we make three adjustments to pursue further the issue of trading propensity. First, we use only experienced players, since it is amongst them that overtrading seems to occur. Secondly, we use considerably higher value goods, selected after brief trials with a larger set of possible prizes.

> Good A: A warrior ring, a decorative ring that adds four slash bonuses to any weapon when equipped.
>
> Good B: An Uncharged Black mask, a decorative mask that gives a 15% bonus in strength and attack during slaying tasks.

These rare items are valued between 400,000 to 500,000 gold coins – i.e. about 150 times the value of the items in experiment A. This places them in the top 10% of most

[14] List, 2003, tests to see if selection can explain the difference in behaviour between high and low trading intensity subjects and rejects the notion. The issue here though is whether the no-endowment effect propensity to swap is higher for individuals attracted to markets where trading can be a consumption good, compared to individuals who do not take part at all.

expensive items in the game, while their rarity limits their substitutability with money. They cannot usually be bought within the in-game shops and can only be obtained from trading with other players[15] or through quests. Even for highly experienced and productive players these products can only be obtained through many hours of endeavour. In other words, for nearly all experienced players 400,000 gold coins represent a significant proportion of their total wealth within the game.

We also extended the questionnaire to ask about the subject's perceived valuations of both goods (not just their endowment). Of course, questionnaire answers represent 'cheap talk' in that they are not incentivized, but responses may provide further insight into whether the 'prize not to the worth' story is plausible.

Table 3 provides the basic results for this variant. As can be seen, the null-hypothesis of no-endowment effect cannot be rejected. Indeed exactly half of the endowments are traded.

Table 3: Trading (Experiment B)

Variable	Percent Traded	P- values for Fisher's Exact test
All (n = 30)	50.0	
Good A for Good B	46.0	P=0.50
Good B for Good A	54.0	

However, as figure 3 shows, the pattern of trading is still markedly different between different levels of experience in the game. For players with a combat level below 70, 9 keep their endowment and 3 swap. For the 18 players with a combat level at 70 or above 12 swap and only 6 keep. This difference is statistically significant (Fisher's exact test, p = 0.030, one tailed test) and suggest that overtrading is not simply an artefact of using low value items. This result is robust to changes in the definition of

[15] There are two ways to find players selling these items. The first way is through the in-game forum, where players can post or read threads in the market section of the forum. Then they can meet in the game to trade items. The second method is to log-on to market worlds (servers). Since August 2007, Runescape has had specific servers for various in-game activities including trading. This had reduced the pressure to the unofficial trading worlds. However, players still prefer go to specific sites in these unofficial trading worlds to trade their rare items. For experiment 2, all the items selected were bought by logging-in to the unofficial trading world 2 and purchased from other players at a typical price of 500,000 gold coins per item. Funds for the purchase were generated by drawing down existing savings and through several weeks of intensive production and trade within the game by an experienced player with a high combat level.

experience. Moreover if a probit regression is run with combat level as the explanatory variable, then it is statistically significant at the 1% level. Of course we still do not know whether overtrading would disappear if we had used items in the top 1% of the value distribution or higher, but the results do not support a simple story of experimenter effects.

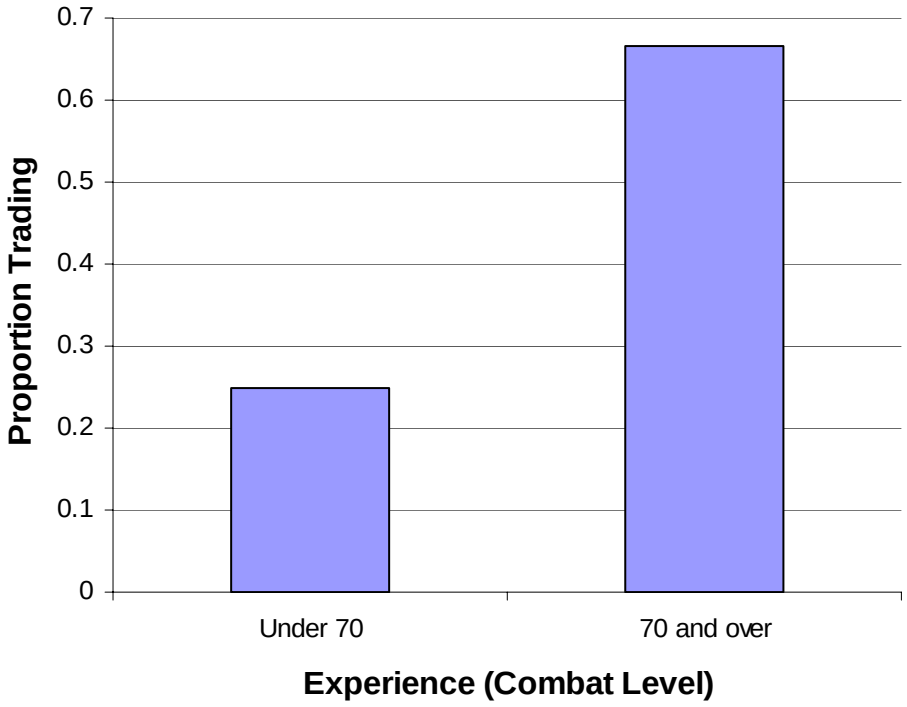

Figure 3. Trading in Experiment B

To examine the 'prize not to the worth' hypothesis, we test to see if knowledge of the objects plays a role in behaviour. 13 of our subjects claim to know both objects, while 9 profess ignorance of both. The remaining 8 obviously know one object, but there is no link between the pattern of claimed knowledge and the decision to swap. Similarly, there is no statistically significant link between the relative price placed on the two objects and the decision to sell. Now, we have six data points where subjects placed extremely high or extremely low valuations on one of the objects (but not both). Given the large number of zeros that need to be entered to give an accurate price, there is a possibility of error in these data points. When we add or subtract zeroes to bring the valuations into line with other estimates, the pattern of decisions is as shown

in Table 4.[16] While this data is more suggestive of the 'prize not to the worth' hypothesis the results are not statistically significant at standard levels of significance. Thus there is no good evidence for 'prize not to the worth'.

Table 4: Relative valuations and Trading

Relative valuation	Fraction Traded	P- values for Fisher's Exact test (one sided)
Alternative priced lower	4 from 11	P=0.225
Alternative priced equal or higher	11 from 19	

To cast further light on the 'truck barter and exchange' notion we use the data from both experiments to examine the relationship between favourite skill and propensity to swap. We code each person's favourite skill as either 'intermediate' or 'final'. For instance, combat is a final skill while woodcutting and farming are intermediate because individuals who specialise in these skills normally do so to sell the results of their production. The results are reported in Table 5, where we can see that individuals who favour intermediate production skills are more likely to swap their endowments. [17]

Table 5: Traders versus Fighters

Favourite skill	Fraction Traded	P- values for Fisher's Exact test
Intermediate	42 from 69	P=0.041
Final	22 from 51	

Finally we use the results from both experiments and check for other factors that might affect the propensity to trade. The results are reported in Table 6. In the first column of regression results we use OLS with combat level as the dependent variable to summarize the preliminary fact that several potential explanatory variables are

[16] When we use the uncleaned data the respective fractions are 5/12 and 10/18 – a similar pattern but still less significant.

[17] Some skills (e.g. cooking and farming on the one hand or slayer and combat on the other) are easy to classify, while others are more ambiguous (e.g. thieving), so we repeat the analysis, dividing the skills between fighter skills (a subset of final production skills) or non-fighter. We find a similar, statistically significant difference between categories.

closely correlated (and individually highly correlated with a propensity to trade). Older and more experienced players tend to have higher combat levels and having a trading skill as favourite is also correlated with higher a combat level. High traders are also more likely to have higher combat levels and players located in the USA tend to be older and more experienced and with higher combat levels.

To find correlates with trading behaviour we use a logit model with the following underlying specification:

$$\text{Trade} = \beta_0 + \beta_1 \text{Item dummy} + \delta Y + u$$

where the dependent variable, Trade, equals 1 if subject chose to trade, and 0 otherwise; Item dummy takes the value 1 if the player is endowed with good A and zero otherwise and Y is a vector of within game characteristics including combat level and years of experience playing the game. The error term is u.

None of the player characteristics (gender, age, location) are remotely significant in this specification, so we drop them from the estimated equations. The close correlation between tradeskill, hightrader age etc. means that in finding predictors of trading behaviour there is an issue of multicollinearity. In fact as with player characteristics, favourite skill and level of trading[18] are not remotely significant in the presence of combat level and experience variables and are not reported in the Table. On the other hand, the equations estimated in Table 6 confirm the importance of both experience and combat level in affecting the propensity to trade. For instance, in the combined sample, an individual with one more year of experience and a combat level of 75 rather than 0 raises the propensity to swap by 0.77.

[18] It is probably not surprising that the level of trading is not significant given that the vast majority of our subjects were trading at a rate far more intense than the level of the memorabilia swappers in List's (2003) study. Forty-five percent of our subjects for instance, claimed to be trading at least 150 items per month.

Table 6: Estimation Results

Sample:	Combined	Experiment A	Experiment B	Combined
Dependent Variable:	Combat level	Trade	Trade	Trade
Model	OLS	Probit	Probit	Probit
Combat level	-	0.025*** (0.007)	0.028 (0.043)	0.021*** (0.0074)
Years of playing	12.36*** (2.47)	0.149 (0.155)	3.160*** (0.963)	0.427** (0.201)
Endowed with A dummy	-	-0.020 (0.303)	-0.604 (0.621)	-0.155 (0.257)
Experiment B dummy	13.56*** (4.61)	-	-	-0.100 (0.269)
USA	5.53 (4.16)	-	-	-
Age	10.21*** (3.93)	-	-	-
Tradeskill dummy	7.45 (4.22)**	-	-	-
HighTrader	9.93** (4.74)	-	-	-
Constant	19.51*** (6.24)	-1.732*** (0.460)	-4.48 (3.12)	-1.775*** (0.467)
Sample size:	120	90	30	120

1. the Trade dependent variable equals 1 if subject chose to trade; 0 otherwise
*2. the robust standard errors are in parentheses beneath coefficients. ** indicates significant at 5% level, *** indicates significant at 1% level, one tailed test.*

5. Conclusion

We conduct an experiment on the endowment effect in a virtual field – an online role-playing game. We show that this is feasible and much of the underlying pattern of results is consistent with previous work on the endowment effect. Individuals with

lower levels of trading experience exhibit a great reluctance to trade, but subjects who have traded in the market for longer show no endowment effect. In fact, the overall results of this study showed an unusual high level of trade - 54.5 percent for all sample groups. For higher levels of experience there was robust evidence of overtrading – in experiment A over 80% of subjects with combat levels above 80 chose to swap their endowment for the alternative. Players were more cautious in their behaviour when the goods were of significantly higher value, but there was still evidence that swap rates were above 50% for experienced players. Rather than day-to-day levels of trading (which were high for most players) it was years of experience playing the game and the player's combat level which were most closely correlated with swapping behaviour.

This evidence reopens the question of the effect of market experience on trading behaviour. The consensus to date is that private individuals with intense trading experience converge in their behaviour to professional traders who in turn show no evidence of the endowment effect or its converse. Since we have only private individuals, our evidence does not challenge that for professional traders, but it does raise questions about whether there is convergence between the two groups. Highly experienced individuals do not swap 50% of their endowed goods: they swap more.

Our follow up experiment enabled us to reject the notion of a 'prize not to the worth' tendency for experienced players. We also saw that raising the value of the goods by a factor of 150 did not eliminate overtrading, suggesting that experimenter demand effects were not an obvious explanation of our results. One hypothesis that could apply to both our results and previous field results on the endowment effect, is that trading can be a leisure activity and that certain kinds of markets may attract individuals who have a high propensity to truck, barter and exchange. High levels of buying and selling can be seen in many consumer activities, including collector's markets, 'car-boot' sales and, possibly, online auction sites. Under this reading, field experiments of the kind conducted by List (2003) or reported here would provide a poor guide to the stability of the endowment effect in other markets.

An alternative, and one in keeping with Adam Smith is that a propensity to truck, barter and exchange may be a beneficial heuristic in contexts where the individual is

both producer, trader and consumer. In this situation the cautious trading heuristics of inexperienced players may be gradually eradicated by the benefits obtained from specialisation and subsequent trade. This explanation is speculative, but it is compatible with our evidence.

Finally, whatever the conclusion drawn about the causes of overtrading amongst highly experienced subjects, this research has shown that virtual worlds may be useful platforms for testing economic theories and provide a further venue for economic experiments.

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