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SCIENTIFIC PAPER

ON THE ENDOWMENT EFFECT IN 'APPLE-MARS' EXPERIMENTS

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Abstract: *In this article we take a close look at a specific type of behavioural experiment that Antonides conducted to study the endowment effect. We argue that if such experiments ignore to test for the presence of persons in the sample who are indifferent between alternatives, the identification procedure for establishing an endowment effect is fallible.*

1. Introduction

With this article we seek to provide an interesting contribution to this Festschrift for professor Antonides. It deals with one of his favourite subjects: the endowment effect. This topic has received much attention in recent years because of a Nobel prize in 2002 awarded to Kahneman and Smith for their contribution to behavourial and experimental economics.[1]
In brief, the endowment effect concerns the phenomenon that consumers value an article more as soon they possess it (Thaler, 1992).
Antonides conducted various experiments to study the endowment effect (Cramer and Antonides, 2011; Antonides and Cramer, 2013). Understanding the endowment effect may particularly increase our understanding of consumer behaviour. For instance, in the thesis of one of Antonides' Ph.D. students (Cramer, 2009), a goal is to obtain more insight into the presence of reference effects when consumers make food choices using the idea of the endowment effect. But Antonides was not only interested in such insights. With these experiments, he -- and in this he is not alone -- aimed also to demonstrate that standard (read: 'neoclassical') economic theory is inadequate in explaining consumer behaviour by arguing that standard theory cannot explain the results of the experiments.
In this article we take a close look at a specific type of experiment Antonides conducted to study the endowment effect. We refer to this as the standard apple-Mars experiment. In this experiment the so-called exchange fraction plays an important role and it is typically found to be less than 1/2. The literature (see below) claims that this value indicates an endowment effect and that neoclassical theory cannot explain this inequality because it would predict an exchange fraction equal to 1/2. Our aim is to examine the accuracy of these two statements. Among other things, we will show that the neoclassical prediction of the exchange fraction critically depends on how one handles consumer indifference. In particular, we will argue that, in the case in which indifference among alternatives cannot a priori be ruled out, a Marshallian application of neoclassical theory is very well able to support the less-than-1/2 exchange fraction found in the apple-Mars experiments.[2]
The organisation of the article is as follows. Section 2 describes the standard apple-Mars experiment. Section 3 provides an analysis of the experiment in the case of consumers who behave according to neoclassical theory; a short appendix contains a calculation. Section 4 defines the notion of endowment effect in the context of the standard apple-Mars experiment and reconsiders the question whether there is an endowment effect in the experiment. Section 5 discusses our results.

2. The standard apple-Mars experiment

The standard apple-Mars experiment (in the sense of Antonides) is an experiment in the real world with a group G of persons:

STANDARD APPLE-MARS EXPERIMENT. An experimenter randomly divides a large group G of persons into two subgroups G_a and G_m of nearly the same size.[3] To each person in the group G_a he gives an apple and to each person in G_m a Mars bar. Then they all get some time to examine their own article and those of their neighbours. Finally, the experimenter asks if anyone wants to trade the given article for the other type of article. He then implements the desired trades.

Concerning 'nearly the same size' we note that, given a group G, it is (in principle) possible to arrange that

$$|\# G_a - \# G_m| \leq 1, \qquad (1)$$

i.e., that the number of persons in these groups differ at most by 1 ($\#G_a$ denotes the number of persons in G_a, etc.).

1 Experimental economics is not so new as it may appear here. For instance, in the fifties Sauerman and Selten (1959) conducted experiments concerning oligopolistic situations.

2 Also other researchers have played down this assertion (e.g., Curran, 1999).

3 It is important that these groups are large as statistical considerations are used to analyse this experiment. We will not consider the question of what 'large' means here.

We can summarise the result of a standard apple-Mars experiment in a table, further to be called the experimental observation table:

TABLE 1: Structure of an experimental observation table

Group	Fraction that does not trade	Fraction that trades	Size
G_a	x_{a0}	x_{a1}	$\#G_a$
G_m	x_{m0}	x_{m1}	$\#G_m$

Here x_{a0} (x_{m0}) is the fraction of persons in G_a (G_m) that does not trade, and x_{a1} (x_{m1}) is the fraction of persons in G_a (G_m) that trades. Hence, it holds

$$x_{a0} + x_{a1} = x_{m0} + x_{m1} = 1. \qquad (2)$$

We use the symbol E for such a table. As in the real world, the persons may behave as they like as long as they choose either trade or no-trade and so restriction (2) applies. Given an experimental observation table E, the fraction of persons f_E in G that trades thus equals

$$f_E = \frac{x_{a1}\#G_a + x_{m1}\#G_m}{\#G_a + \#G_m}.$$

So in the case: $\#G_a = \#G_m$, we have $f_E = (x_{a1} + x_{m1})/2$. A concrete example of an experimental observation table can be found in Cramer (2009, p. 25):

TABLE 2: Example of an experimental observation table

Group	Fraction that does not trade	Fraction that trades	Size
G_a	147/270	123/270	270
G_m	217/284	67/284	284

For this table we find

$$f_E = \frac{190}{554} \approx 0.34.$$

So f_E is less than 1/2.
The literature (see, e.g., Thaler, 1992; Laibson and List, 2015) states that in such experiments the neoclassical theory predicts $f_E = 1/2$. For instance, in Laibson and List (2015, p. 387) we read

Give half of your students a mug and half of your students a (big) chocolate bar, randomizing this endowment by switching every other seat in the classroom. Let the students examine their own and their neighbors' endowments, and then ask the class who wants to trade with you for the good that they didn't receive. Fewer than a quarter of the students will take up this offer, but the traditional economic theory predicts that half of them should (Kahneman, Knetsch, and Thaler, 1990; Tversky and Kahneman, 1991).

It is not immediately clear, also after considering the references cited here, where the 'half' comes from, i.e., why neoclassical theory would lead to $f_E = 1/2$. In the next section we show that this alleged prediction of neoclassical theory is implicitly based on one or two disputable assumptions.

3. Neoclassical treatment

In this section we give a neoclassical treatment of the standard apple-Mars experiment. So consider such an experiment and suppose that all persons behave according to the postulates of neoclassical theory. Then with regard to the preferences of each person P in group G, there are precisely three possibilities: P prefers a Mars to an apple, P prefers an apple to a Mars, and P is indifferent between an apple and a Mars. Let the fraction of persons with the same preference be denoted by, respectively,

$$n_m, n_a, n_0.$$

As the groups G, G_a and G_m are large and the subgroups G_a and G_m are constructed randomly out of G, we may assume that the fractions n_m, n_a and n_0 are the same in the subgroups G_a and G_m.
Although the apple-Mars experiment would look somewhat peculiar in the neoclassical research programme, let us now discuss how neoclassical theory would connect preferences to the decision of whether or not to trade a just received article. Therefore consider the following statements:

- If P prefers an apple, then P only trades if P received a Mars.
- If P prefers a Mars, then P only trades if P obtained an apple.
- If P is indifferent between an apple and a Mars, then P does not trade.

Statements A and B are straightforward enough implications from neoclassical theory and need no comment. Only the third statement appears to be susceptible to some debate. Note first that neoclassical theory does not discuss how persons deal with choice situations in which they are indifferent. For example, which article would a person P choose when he is indifferent between two equally expensive articles lying in the shop window? Little more can be said than that P would make his choice with probability 1/2. The choice situation in the apple-Mars experiment is even more subtle: what would P do if he is indifferent between two articles of which one is in his possession and the other is waiting in the hands of the experimenter? In the frictionless world of neoclassical theory, where any transaction cost is absent, we again have to conclude that P would make his choice with probability 1/2. However, to the practitioner of neoclassical theory, who follows Alfred Marshall's adage that theory is not the truth but an engine to discover the truth (see, e.g., Landreth and Colander, 2001, Ch. 10) and who knows that the real world is full of little transaction costs arising from mental or physical effort, it is obvious that *P* will refuse to trade his article.

In any case, to further evaluate statement C, the analysis in the rest of this section will allow for both possibilities by assuming a probability $\gamma \in \{1/2,1\}$ that an indifferent person in the experiment does not trade. Then the (expected) fraction of persons in group G_a that trades is equal to $n_m + (1-\gamma)n_0$ and this fraction in G_m is equal to $n_a + (1-\gamma)n_0$. This leads to the following *neoclassical observation table:*

TABLE 3: Neoclassical observation table

Group	Fraction that does not trade	Fraction that trades	Size
G_a	$n_a + \gamma n_0$	$n_m + (1-\gamma)n_0$	$\#G_a$
G_m	$n_m + \gamma n_0$	$n_a + (1-\gamma)n_0$	$\#G_m$

A neoclassical observation table thus is completely determined by the numbers γ, $\#G_a$, $\#G_m$, n_a, n_m, and n_0. We see that, unlike in an experimental observation table, besides restriction (2) also other restrictions apply. For example, in the case $\gamma = 1$, it must hold (using the notations of Table 1) that $x_{a0} \geq x_{m1}$ (and equivalent with this, $x_{m0} \geq x_{a1}$).

Now it is a simple textbook exercise to calculate the fraction of persons that trades:

$$f_\gamma^{neo} = \frac{1+n_0(1-2\gamma)}{2} + \frac{(\#G_a - \#G_m)(n_m - n_a)}{2\#G}$$

(see Appendix). Formula (3) is valid if *G* is large and also the subgroups G_a and G_m are large. However, the assumption that G_a and G_m are almost of the same size is not used for this result. If we make this assumption also, as required in the apple-Mars experiment, then, noting that

$$\left|\frac{(\#G_a - \#G_m)(n_m - n_a)}{2\#G}\right| \leq \frac{1}{2}\frac{|\#G_a - \#G_m|}{\#G}$$

(even $\leq \frac{1}{2\#G}$ if (1) holds), formula (3) implies $f_\gamma^{neo} \approx \frac{1+n_0(1-2\gamma)}{2}$. Hence, if the groups are almost equally large, the fraction of persons that trades is equal to

$$f_\gamma^{neo} \approx \begin{cases} \frac{1-n_0}{2} & \text{if} \quad \gamma = 1 \\ \frac{1}{2} & \text{if} \quad \gamma = \frac{1}{2} \end{cases} \qquad (4)$$

(a strict equality holds when $\#G_a = \#G_m$). Of course, without the assumption, $f_\gamma^{neo} > 1/2$ is possible.

Therefore, the claim that neoclassical theory predicts that in the experiments half of the persons will trade implicitly assumes that either

(1) no one in the experiment is indifferent between the two articles (i.e., $n_0 = 0$) or

(2) any person who is indifferent between the two articles makes his choice with probability 1/2 (i.e., $\gamma = 1/2$).

The first assumption is an empirical hypothesis that could be tested (or organised for). If the experiment is indeed about apples and Mars bars, the outcome may well be that a large group *G* contains persons who care the same about the two (i.e., $n_0 > 0$). If there are indifferent persons, then following in the footsteps of the practitioner of neoclassical theory, and thus accepting statement C above (i.e., $\gamma = 1$), the neoclassical prediction for the standard apple-Mars experiment is

$$f^{neo} < 1/2,$$

so less than half of the persons will trade.

4. Endowment effect

We are now able to give a precise (neoclassical) definition of the endowment effect in the context of a standard apple-Mars experiment. For this we accept statement C formulated in the previous section that indifferent persons do not trade.

Suppose an experimental observation table *E* and let f_E be its associated exchange fraction. Having formula (4), we speak of an *endowment effect* if

$$f_E < \frac{1-n_0}{2}.$$

From a logical point of view, it is also possible that

$$f_E > \frac{1-n_0}{2},$$

in which case we speak of a *trade effect*.

To decide whether there is an endowment effect, we need not compare f_E with 1/2 but with $(1-n_0)/2$. The identification of an endowment effect thus critically requires information on n_0. If this is provided, we can conclude that an endowment (or exchange) effect obtains if f_E 'substantially' differs from $(1-n_0)/2$.

For illustration, let us return to the experimental observation Table 1 with exchange fraction $f_E = 0{,}34$. To establish whether this value contradicts neoclassical predictions, we have to know n_0. Since $\frac{1-0.32}{2} = 0.34$, the practitioner of neoclassical theory has a problem if n_0 substantially differs from 0.32. If n_0 is known and some test shows that it is substantially lower than 0.32, then we may conclude that there is an endowment effect. And if n_0 is substantially higher than 0.32, then there is a trade effect. Unfortunately, the conducted apple-Mars experiment does not provide information on the value of n_0 (see Cramer, 2009). Indeed, as far as we know, similar experiments on the endowment effect ignore to test for the presence of persons who are indifferent between alternatives. Some casual experiments by the second author suggest that in an apple-Mars experiment is substantially less than 0.32. So for the standard apple-Mars-trade experiment in Table 1, we cannot rule out the finding of an endowment effect.

5. Concluding remarks

We conclude that as long as experiments like the standard apple-Mars experiment ignore to test for the presence of persons who are indifferent between alternatives, the identification procedure for establishing an endowment effect is fallible. Because if there are some indifferent persons in the sample, a Marshallian application of neoclassical theory also predicts a less-than-1/2 exchange fraction. Identifying an endowment effect then critically depends on the precise fraction of indifferent persons.

To be sure, by pointing at the role of indifferent persons in the sample we do not just want to add some analytical precision to generally accepted findings. Rather, we want to emphasize that in designing this type of experiments the researcher implicitly increases the probability that the sample will indeed contain some indifferent persons.

For illustration, suppose an experiment where subjects have to choose between a one-euro coin and a two-euro coin. Although we did not conduct such an experiment, it is safe to say that everyone will prefer the two-euro coin and so all those who received a one-euro coin will trade it for a two-euro coin. The neoclassical prediction that 50% of the subjects will trade holds (it is unlikely that the transaction cost arising from a bit mental or physical effort will exceed one euro), and there is no endowment effect. What would happen if the experiment is about the choice between a one-cent coin and a two-cent coin or between two mugs with slightly different colours? These cases probably increase the scope for finding an endowment effect, but at the same time increase the likelihood that the sample contains indifferent persons and so the neoclassical prediction of a less-than-1/2 exchange fraction applies.

Appendix: Derivation of formula (3)

Consider Table 3. In the main text we considered $\gamma = 1$ or $\gamma = 1/2$. But nothing hinders us here to allow for $\gamma \in [\frac{1}{2}, 1]$.

In total, $(n_m + (1-\gamma)n_0)\#G_a + (n_a + (1-\gamma)n_0)\#G_m$ persons want to trade. So for the fraction of persons who trade we have

$$f^{neo} = \frac{(n_m + (1-\gamma)n_0)\#G_a + (n_a + (1-\gamma)n_0)\#G_m}{\#G}.$$

With s :=#Ga – #Gm and #G = #Ga + #Gm, it follows that #Ga = (#G + s)/2 and #Gm = (#G – s)/2. With na + nm + n0 = 1, we obtain

$$f^{neo}_\gamma = \frac{(n_m + (1-\gamma)n_0)\frac{\#G+s}{2} + (n_a + (1-\gamma)n_0)\frac{\#G-s}{2}}{\#G}$$

$$= \frac{\#G(n_m + n_a) + s(n_m - n_a) + 2(1-\gamma)n_0\#G}{2\#G}$$

$$= \frac{\#G(1 - n_0) + s(n_m - n_a) + 2(1-\gamma)n_0\#G}{2\#G}$$

$$= \frac{\#G(1 + n_0(1-2\gamma)) + s(n_m - n_a)}{2\#G}.$$

Thus

$$f^{neo}_\gamma = \frac{1 + n_0(1-2\gamma)}{2} + \frac{(\#G_a - \#G_m)(n_m - n_a)}{2\#G}.$$

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