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# Experimenting with the Coase theorem

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## ABSTRACT

Kahneman, Knetsch, and Thaler's [(1990). Experimental tests of the endowment effect and the Coase theorem. *Journal of Political Economy*, 98, 1325–1348] experiment on the Coase theorem disrupted a string of experimental successes in the 1980s. The source of their refutation is the endowment effect which generates a reluctance to trade. We use Steven Medema's recent benchmark interpretation of the Coase theorem to subject their experiment to methodological scrutiny, generating four distinct explanations of their findings. We find that their explanation is the only one at odds with the theorem. While Kahneman, Knetsch, & Thaler argued that they undermined the Coase theorem, their result is constrained by the exclusion of the rationality assumption and the adoption of the invariance-efficiency criterion. There is no immaculate Coase theorem and therefore no single experimental test that can falsify it. Instead, different experiments test specific deviations from a benchmark theorem.

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## 1. Introduction

In a review essay celebrating the approaching 60 years since Coase published *The Problem of Social Cost*, Medema (2017) argues that the Coase theorem is not a typical theorem. Theorems cannot be tested, 'they are not empirical propositions' he argues, and may only be logically proved. The Coase theorem, however, is atypical in so far as it has often been empirically tested both in the field and in the laboratory. While the assumptions of a theorem may be too stringent to be replicated in the laboratory (and more so in the field), they may be relaxed to allow empirical testing.

Medema paves the way for the weakening of assumptions arguing that the Coase theorem should be seen as a benchmark from which deviations are introduced to allow empirical testing. The deviations can take the form of relaxing assumptions or varying the outcome criterion. As a benchmark, the Coase theorem is then quite similar to the First Fundamental Theorem of Welfare Economics in that it posits that some outcome will emerge when certain idealized conditions are met. There are, specifically, three advantages to the benchmark interpretation: 1- It serves as a heuristic generator of insights; 2- It allows the examination of the consequences of loosening the theorem's assumptions; and 3- It allows the analysis of the ways in which the real world departs from the benchmark. As a benchmark, it can no longer be objected that the Coase theorem is not testable in the laboratory or in the field. However, it also means that there is neither an immaculate Coase theorem nor a single test that can falsify it. All empirical tests of the theorem, accordingly, evaluate a specific deviation from the benchmark theorem.

In its most general and generic form the Coase theorem simply states that regardless of how property rights are allocated, efficiency and invariance will obtain when transaction costs are absent. Specifically, the theorem generates two results both of which are consistent with statements made in Coase (1960): The 'weak' (efficiency) version and the 'strong' (efficiency plus invariance)

version. The weak version, which has often been tested in the laboratory, rests on the efficiency result, namely, that when transaction costs are absent the allocation of resources will be efficient regardless of how the rights are initially assigned. This result can be found in all versions of the theorem (Medema & Zerbe, 2000, p. 838). The invariance result, complemented with the weak version, generates the strong version in which a unique efficient allocation obtains independently from the distribution of initial rights.

Coase (1960) does not list the assumptions behind his result in an axiomatic way, nor does he refer to a Coase theorem as such. Perhaps because of this much controversy has shrouded what came to be called the Coase theorem generating a sprawling literature in and outside economics with a broad range of claims and counter-claims – from those that confirm its efficiency and invariance results to those that contend it is false, tautological, incoherent, or ideological.<sup>1</sup>

We may then express some surprise as to why there has not been more methodological scrutiny of the Kahneman, Knetsch, and Thaler (1990) [KKT] experiment that rejected the Coase theorem. While some contested their finding (Plott & Zeiler, 2005, 2007), their result was rapidly absorbed in behavioral economics and may now be considered as part of the lore. We are, however, able to generate four distinct explanations of their experimental results, three of which, we claim, do not undermine the theorem. To help us motivate our four distinct explanations Medema's (2017) benchmark interpretation will prove handy.

Before the KKT experiment, the 1980s were characterized by a string of successful experimental tests.<sup>2</sup> Towards the end of the decade, however, KKT tested the Coase theorem running experiments between paired buyers and sellers that bargained over common consumer goods such as chocolate bars. In the experiment, bargaining was unstructured which means it was face-to-face and with no time limits (Davis & Whinston, 1965; Roth, 1995). The KKT experiment departs from the typical Coasean case study in using consumption goods and refraining from introducing externalities. KKT refute the theorem and posit a psychological bias, the endowment effect, which undermines it.

Their finding supports existing critiques of the Coase theorem. In law and economics, Medema (1999, p. 227) posits that the endowment effect disrupts 'the type of bargaining envisioned by the Coase theorem' and the normative prescriptions of the theorem can no longer be justified as their foundation is called into question. Korobkin (2003), similarly, concludes that 'the broad range of legal prescriptions based on Coase's insight requires reevaluation' and titles his (Korobkin, 2014) entry for *The Oxford Handbook of Behavioral Economics and the Law* 'Wrestling with the Endowment Effect, or How to Do Law and Economics without the Coase Theorem.' Although KKT's interpretation has been challenged (Klass & Zeiler, 2013), these remain serious contentions against a theorem that 'crystallized' and 'legitimized' law and economics and that is often described as the 'canon', genesis, 'foundation', 'cornerstone', and 'heart of the field'.<sup>3</sup> Furthermore, arguments that reject the Coase theorem on similar grounds have started to appear in other fields (Laitos, 2017).

Are Medema's and Korobkin's conclusions supported by KKT's experimental evidence? In a decade in which most laboratory tests of the Coase theorem corroborated it, the KKT result appears to be an outlier. While the KKT experiment differs from earlier ones with respect to the type of good and how structured bargaining is, it appears to satisfy the assumptions of the generic Coase theorem. So when a discordant result emerges it must be scrutinized to ensure there is enough similarity to warrant comparability with the other experiments.

Given the support the KKT result provided to critics, we think it is important to methodologically re-visit their experiment. Our starting point is KKT's discordant finding – the fact that they do not corroborate the invariance-efficiency outcome. We shall present their experiment in the context within which it appeared and proceed to offer four distinct explanations not all of which disconfirm the theorem. We suggest that KKT's finding does not necessarily refute the unstructured bargaining version of the Coase theorem. The argument is two-pronged and can be traced back to Coase's writing. Our first case hinges on the assumption of rationality and the second on Coase's implicit adoption of Pareto efficiency.<sup>4</sup> In the first argument we posit that imperfect self-knowledge entails

that the rationality assumption is not met and that transaction costs are likely positive. In other words, if subjects do not maximize utility, this is not necessarily an indictment of the unstructured bargaining version of the theorem because one of its assumptions is not satisfied. In our second argument, we posit that had KKT satisfied all the assumptions of the unstructured bargaining version of the Coase theorem in their experimental design, their finding can still be consistent with the final allocation of goods being Pareto efficient. In fact, by changing the outcome to Pareto efficiency we can reconcile the KKT experiment with the previous experiments conducted on the Coase theorem in the 1980s.

The outline of the paper is as follows. In section 2 we retrace the origins of the Coase theorem focusing on the historical aspects that help us shed light on the KKT experiment. In section 3 we offer a closer look at the KKT Coase experiment. In the following section we introduce our four distinct explanations of the KKT experiment. In section 5 we present the first argument: if bargainers are subject to imperfect self-knowledge the rationality assumption is not satisfied and transaction costs may be positive. In section 6 we argue that even if in their experiment KKT met all the assumptions of the theorem they are testing, their choice of outcome criterion is problematic and should be replaced with Pareto efficiency. Section 7 concludes.

## 2. Origins and ramifications of the Coase theorems

In the paper that led to the eponymous Coase theorem, Coase (1960) analyses the efficiency implications of economic activity by a firm (agent A) that harm another firm (agent B). Coase never referred to any theorem in the paper but questioned Pigou's claims in *The Economics of Welfare*. Coase was critical of the policy implications that arise from the divergence between private and social product contending that Pigou's solution (in which A compensates B) is not satisfactory because it neglects harm to A. Instead, Coase argues, the optimal solution ought 'to avoid the most serious harm' (p. 2) and 'it is one of the beauties of a smoothly operating pricing system that the fall in the value of production due to the harmful effect would be a cost for both parties' (p. 13). Coase emphasizes:

- (1) The symmetrical nature of such problems – both the harms and benefits to A and B ought to be accounted for in identifying the optimal allocations of resources (p. 2).
- (2) When the 'pricing system works smoothly', that is without transaction costs, it does not matter who is liable for damage – the most valuable economic goods will be produced in any case (p. 8).
- (3) With industries operating under perfect competition, profit maximization entails price equals marginal cost. Under liability for damages, the harmed firm (B) will not produce more because of the liability since additional units will be compensated (by A) at the market price which, beyond  $MC = P$ , generate losses (pp. 3–4). The same argument applies under no liability for damages – firm A will not produce beyond  $P = MC$  to avoid losses (pp. 7–8).
- (4) Coase is only concerned with bilateral bargaining and not the aggregate effects of the disturbance caused by entry (p.4).
- (5) Under zero transaction costs, liability for damage will affect the distribution of income and wealth (p.5) but not what is produced by firms. That is bargaining leads to transfer of rents or bribes between A and B.
- (6) There is no discrepancy between forgone income and received income: 'A receipt forgone of a given amount is the equivalent of a payment of the same amount' (p. 7).
- (7) It is unrealistic to assume no costs in conducting market transactions (p. 15). If so, the allocations of rights and liabilities by courts 'directly influence economic activity' (p. 19).

The nearest statement to a Coase theorem in the paper is the remark that 'the ultimate result (which maximizes the value of production) is independent of the legal position if the pricing system is assumed to work without cost' (Coase, 1960, p. 8). In other words, if the pricing system

is costless, the allocation of resources will be maximized independently of who is liable for the damages a first party impinges on a second party in the act of production.

The Coase result evolved over the next decades generating considerable discussion on its validity as a theorem and as an empirical proposition (Medema, 2017). Some issues raised in the very diverse and broad literature around the theorem should nevertheless be understood to adequately contextualize the KKT experiment. Early interpretations of the result assumed competitive conditions and focused on bargaining over production externalities (Buchanan & Stubblebine, 1962; Demsetz, 1964). Stigler (1966, p. 113) replicates and expands this interpretation calling it the ‘Coase theorem’ arguing that it demonstrates that ‘under perfect competition, private and social costs will be equal’. For Stigler, the theorem is no longer about two economic agents bargaining but a significant number of economic agents that will maximize surplus equalizing (relative) market prices of goods and their social cost. The corollary of Stigler’s Coase theorem is that the composition of output is not affected by the way the law distributes liabilities (for damage). Stigler’s Coase theorem is ignored by Calabresi (1968) who refers to the ‘Coase conclusion’ or ‘Coase axiom’ (p. 68) as tautologies that posit all misallocation of resources and externalities will be internalized and remedied when transaction costs are zero and agents rational. As we shall see, the assumption of rationality emerges as critical in the interpretation of the theorem as a benchmark from which deviations are tested. Regan (1972) later acknowledges there is now a Coase theorem which demonstrates that under perfect competition, perfect information, and zero transaction costs an efficient and/or an invariant-efficient outcome obtains. But according to Regan, the Coase theorem is a proposition in the theory of games not traditional markets/competitive equilibria and that these results are not, as Calabresi argued, tautological because they are contingent on the definition of rationality which determines individual bargaining behavior. Regan, therefore, rejects the idea that the theorem is true by definition and instead argues the theorem’s truth is contingent on the definition of rationality, a point we will further elaborate on in section 5. For Zerbe (1976, p. 29), the theorem states that ‘in a world of perfect competition, perfect information, and zero transactions costs, the allocation of resources will be efficient and invariant with respect to legal rules of liability’. He points out that this definition offers a useful benchmark not a testable hypothesis and considers its context not game theoretic – as Regan did – but, as Stigler suggested, a proposition in perfect competition whereby markets for externalities exist.

More recently, Medema (1999) acknowledges ‘there is no singular Coase theorem’ while offering a version which (he claims) closely follows its spirit: ‘if rights are fully specified and transaction costs zero, parties will bargain to an efficient and invariant outcome regardless of the initial specification of rights’ (p. 213). Medema then argues the theorem

- (1) ‘Is a positive statement with no direct normative implications – an “is” statement, not an “ought” statement – going to the presence or absence of efficiency under particular conditions’ (pp. 229–30).
- (2) The concept of efficiency it employs is Paretian (p.213).
- (3) Is correct if its assumptions are met but that this is not an important result: Instead, the theorem is important because of the ‘detailed nature of the assumptions regarding transaction costs and property rights’ (p. 228) which are necessary to make it correct.
- (4) Is a useful fiction. Medema in fact considers that most experiments of the Coase theorem are without merit as tests of the theorem even when they find supporting evidence (as Hoffman & Spitzer, 1982, 1985, 1986 do).

In his essay celebrating the approaching 60 years since the publication of *The Problem of Social Cost*, Medema (2017) updates his statement of the Coase theorem to the following

if agents are rational and the costs of transaction are zero, resources will be allocated efficiently independent of how rights over those resources are initially distributed. Moreover, if utility functions are uniformly affine and the registration of subjective values is not wealth-constrained, this allocation is independent of the initial rights structure. (p. 37)

Several points raised in the previous paragraphs are relevant to our subsequent discussion. First is Zerbe's contention that the theorem is a benchmark, a claim latter made by Medema (2017) to explain how theorems may be empirically tested. Second is the idea that externalities are like other goods – there is nothing special about externalities that rules out bargaining over them – and the Coase theorem should not be limited to bargaining over externalities (Calabresi, 1968; Dixit & Olson, 2000; Foss & Foss, 2005; Medema, 1997, 2017; Samuelson, 1985). Third, the assumption of rational agents by Calabresi, Regan, and Medema renders the benchmark interpretation fecund to empirical testing by behavioral economists. Rationality has either been added to the Coase theorem as a standalone assumption or incorporated into transaction costs as a decision cost. Whichever the case, the implications are similar. So if in one experiment bargaining agents do not behave rationally, and the (deviation from the benchmark) theorem being tested assumes rationality, the experimental result has no implications and the refuting outcome is neither a direct indictment of the theorem (which, of course, can only be disproved if efficiency and invariance–efficiency fail to obtain when *all* assumptions are met) nor a rejection of the theorem in deviation form the benchmark.

The objective of this short review of older and more recent statements of the Coase theorem suggests that its scope is quite broad: Some consider the theorem deals with both resources that generate externalities and resources that do not generate externalities (Calabresi, 1968; Medema, 1997; Samuelson, 1985), with just resources that generate externalities (Demsetz, 1964; Stigler 1966; Schweizer, 1988), or with just resources that do not generate externalities (Regan, 1972; Zerbe, 1976). In addition, not all commentators agree there is bargaining involved since under perfect competition there is no bargaining between firms (Roth, 1985, p. 1). Finally, the theorem generates two distinct outcomes: efficiency and invariance–efficiency. The resulting heterogeneity has allowed the theorem to travel along different paths some of which involve neither externalities nor bargaining. There is, at any rate, no immaculate Coase theorem but instead Coase theorem worlds (Medema, 2015).

### 3. Refuting the bargaining Coase theorem: KKT's experiment 8

In 1979, a couple of years before the first bargaining experiments on the Coase theorem were conducted, Kelman (1979) published a novel critique in which he argued people do not treat opportunity cost income in the same way as realized income. Kelman also observed that tastes are not independent of rights, that is as soon as rights are assigned tastes change. Soon after Kelman's critique, Hoffman and Spitzer (1980) rebutted it for lacking the necessary empirical evidence. Hoffman and Spitzer (1982, 1985, 1986) subsequently experimentally tested the Coase theorem and corroborated its efficiency result. However, eleven years after its publication, Kelman's critique is experimentally tested by Kahneman et al. (1990) who confirm his contention that the allocation of rights over goods affects preferences.

According to KKT, the Coase theorem states that the 'allocation of resources to individuals who can bargain and transact at no cost, should be independent of initial property rights' (pp. 1339–40). This, it should be noted, is not an unusual interpretation of the theorem.<sup>5</sup> Their Coase experiment is one among others they conduct over mugs, chocolate bars, pens, and cash redeemable tokens. In most of their experiments, though not in the one that tests the theorem, half the subjects are randomly selected and given a good (they will be the sellers) whereas the other half are given the opportunity to purchase the good (they will be the buyers). KKT claim that by 'conventional economic analysis' they expect half the goods should be traded.<sup>6</sup> This means that half the owners should be willing to sell their good whereas half the buyers should be willing to buy the good. Since KKT find evidence of under trading (and excessive WTAs) in bargaining, auctions, and simulated markets, an interfering factor is generating this discrepancy. This factor, according to KKT, is the so-called endowment effect, first reported by Thaler (1980).

Thaler (1980) describes the endowment effect in a series of case studies and experiments that reveal a gap between selling and buying prices for the same good. He argues that while income effects and transaction costs can explain such gaps, the distinction between opportunity and out-

of-pocket costs is more parsimonious. The differential behavioral impact of opportunity and out-of-pocket costs is caused by the endowment effect which is in turn explained by loss aversion and inertia. Tversky and Kahneman (1991, pp. 1041–2) report that the gap in selling and buying prices ‘reflects an endowment effect which is produced, apparently instantaneously, by giving an individual property rights over a consumption good’. Initial entitlement matters and the rate of exchange between goods varies if they are ‘given up’ or ‘acquired’. Such valuation gaps, Tversky & Kahneman suggest, persist with zero transaction costs and controlling for income effects.

After nearly a dozen experiments that corroborate the endowment effect using simulated markets and auctions, KKT introduce experiment 8 which, unlike the others, uses bilateral unstructured bargaining sessions between 35 pairs of buyers and sellers. The objective of experiment 8 is to test whether the allocation of property rights over some consumer goods generates an inefficient outcome in which not all expected trades are realized. They argue that if the marginal rate of substitution (MRS) between goods is affected by the endowment effect, then subjects assigned the property right are more likely to retain it. It is clear that this is an experiment in which no externalities are involved but in which total utility over consumer goods is to be bargained over.

Experiment 8 starts with a game of nim. Winners of the game are given a Swiss chocolate bar as prize whereas losers are compensated with a token that has a redeemable cash value of \$3 at the end of the experiment. The nim game winners are then informed that if they strike a deal with their partner they can purchase the token and cash it for \$5, generating a \$2 surplus. Partners were given an unlimited amount of time to bargain. Of the 35 pairs, 29 agreed to exchange the tokens for an average price of \$4.09. Since this outcome is considered efficient, it is a corroboration of the unstructured bargaining version of the Coase theorem. However, after completing the token exchange, most nim game losers had some cash. Bargaining partners then entered a second session in which the chocolate bars were offered for sale by the nim game winners. In contrast to the bargaining sessions over tokens, only seven chocolate bars were sold (down from an optimal 17.5 or half of 35). KKT note that this reluctance to trade is concomitant with a WTA/WTP gap and must be caused by the endowment effect.<sup>7</sup> Thus, for the theorem to be corroborated, KKT expected a unique number of trades (about 17.5) which was not realized. Accordingly, theirs is a strong version of the theorem in which efficiency and invariance are expected. Given also that there is only one efficient number of trades (17.5) efficiency and invariance are one and the same thing.

In summary, subjects in the KKT experiment were less willing to sell just because they had the property right over the good. The distribution of property rights over chocolate bars has modified the MRS of sellers and a less than optimal outcome obtains. Medema (1999, p. 22) agrees that their experiment entails ‘the type of bargaining envisioned by the Coase theorem may well be dramatically curtailed, if not virtually precluded altogether ... [their] experiments found substantial under-trading relative to the theorem’s predictions.’

We reconstruct KKT’s explanatory chain in [Figure 1](#). Bargaining in tokens has zero transaction costs because the efficient number of exchanges obtains; since the same bargaining mechanism is used to trade chocolate bars, zero transaction costs should also obtain in these sessions; however, chocolate bars, unlike tokens, are market goods that when owned are added to one’s endowment; if the preference ordering over chocolate bars is randomly distributed in the population of students, possibly as a binary random variable (Like/Dislike), half the chocolate bars ought to be sold; this result is not observed in experiment 8 – the chocolate bars are added to the subject’s endowment generating loss aversion and inertia which lead to a reluctance to trade by sellers and a sub-optimal number of

Good placed in endowment → loss aversion → inertia → WTA/WTP gap → sub-optimal number  
of exchanges

**Figure 1.** KKT’s explanatory pathway to the refutation of the Coase theorem in experiment 8.

exchanges ensues. The only remaining explanation for the reluctance to trade is the endowment effect.

Although the definition of transaction costs is an important source of contention in the Coase theorem literature, KKT render it seamlessly unproblematic. The ubiquity of transaction costs can, however, explain why the theorem is difficult to test in both the laboratory and the field (Bertrand, 2011). The question of concern to us is how do experimental designs justify zero transaction costs? Arguably, the laboratory provides a controlled environment in which transaction costs can be manipulated (Medema, 1997). This may help explain the appeal of the laboratory in testing the theorem in the early 1980s. KKT, however, do not define transaction costs but infer their absence in the chocolate bar bargaining sessions from the induced-tokens bargaining sessions. Their argument is that if bargaining sessions with tokens are efficient they are zero transaction costs environments. Subsequent bargaining sessions using the same mechanism but market goods instead of tokens should also be zero transaction cost environments. Accordingly, if a reluctance to trade and a valuation gap between sellers and buyers is observed in bargaining over chocolate bars, KKT rule out transaction costs explanations because the allocation mechanism is the same as the one for tokens. But KKT still need a benchmark to gauge whether the outcome of bargaining sessions over market goods is efficient. This benchmark is 50% of goods.<sup>8</sup>

Had we adopted KKT's implicit definition of transaction costs, would that suffice to support their finding against the Coase theorem? We do not think so because their invariance-efficiency criterion is not without problems as we elaborate in section 6. For now, let us note that KKT's experiment 8 uses the same method to compute the number of efficient exchanges as their market and auction experiments. But unlike the first stage induced bargaining sessions where close to 100% of the exchanges are expected, in bargaining over goods only 50% ought to be exchanged – half the chocolate bars won in the nim game. An immediate concern is that in experiment 8 the chocolate bars are won in the nim game and not randomly assigned. Hoffman and Spitzer (1985) found that bargaining behavior is sensitive to the model of property right allocation: subjects behave in more self-regarding ways when they earn the property right than when it is allocated randomly. Loewenstein and Issacharoff (1994) found a similar effect: prizes awarded for a classroom exercise were more highly valued than prizes distributed randomly. This 'source dependence', Loewenstein & Issacharoff discover, is close in strength to the endowment effect. However, in the KKT design, since the chocolate bars were won as prizes in nim games, their owners may be subject to a 'source dependence' effect which explains the high WTAs they request as well as their reluctance to trade.<sup>9</sup>

KKT's bargaining sessions over tokens in Experiment 8 generated results consistent with the game theoretic bargaining experimental literature (Roth & Malouf, 1979; Siegel & Fouraker, 1960) and the Coase bargaining experiments conducted by Hoffman et al cited earlier. The divergence occurs in the second stage of the KKT experiment when subjects bargain over chocolate bars as buyers and sellers. Here the KKT result loses some comparability with the bargaining experiments conducted earlier. What are the implications of the switch to consumption goods, unstructured bargaining between buyers and sellers, and a novel invariance-efficiency criterion?

#### 4. Four different explanations of experiment 8

The specificities of the KKT experiment have information and efficiency implications which we exploit to generate four distinct explanations of their result. The effects of the switches are mapped onto a  $2 \times 2$  matrix in Table 1. Each case specifies a deviation from the benchmark theorem and none of them can be considered a direct test. It should be emphasized that when we state that KKT met all the assumptions of the theorem, the theorem in question is a deviation of the benchmark theorem which, as we explained in the introduction, cannot be directly empirically tested.

The first quadrant is KKT's (implicit) conception of transaction costs and their prediction of invariance-efficiency (case 1). KKT, however, do not include rationality as an explicit assumption. Accordingly, since their version of the theorem only assumes well defined property rights and zero

**Table 1.** A  $2 \times 2$  matrix of the KKT Coase experiment.

Efficiency	Rationality assumption	
	Excluded	Included
Percentage of trades (50%)	Case 1	Case 2
Pareto	Case 3	Case 4

bargaining and transaction costs, it rejects the theorem as all assumptions are satisfied yet the invariance-efficiency result does not emerge. Bargainers afflicted with the endowment effect will not generate an optimal outcome in terms of an exact number of efficient trades. The second quadrant (case 2) introduces rationality explicitly either as a separate assumption or as part and parcel of transaction costs. Combined with KKT's criterion of invariance-efficiency, in the second quadrant we are in fact arguing that if invariance-efficiency does not obtain it is because the rationality assumption, either directly or via positive transaction costs, is not met. If this is so the KKT result cannot invalidate the theorem. In the third quadrant we contend (as in case 1) that KKT met all the assumptions, however, we replace the invariance-efficiency criterion with Pareto efficiency (case 3). Here we are in fact arguing that if we agree with KKT that their experiment meets all the assumptions of the unstructured bargaining Coase theorem, their result corroborates its weak version or its efficiency Paretian prediction. The experimental evidence in case 3 is not sufficient to determine whether this result is unique and therefore we remain agnostic on whether the strong version is also corroborated. The fourth quadrant adopts both rationality as an assumption and Pareto efficiency as the outcome of bargaining (case 4). This is the most complex case because we are claiming that one of the assumptions is not met and yet Pareto efficiency obtains. Some versions of the theorem do suggest that it is robust to positive transaction cost and that bargainers will exploit any surplus as long as the gains from exchange are superior to the transaction costs (Farber, 1997; Dixit & Olson, 2000; Posner, 2014; Robson, 2014; Turvey, 1963). The first quadrant (case 1) was discussed in section 3 and is KKT's interpretation of experiment 8. In the next section we focus on case 2 and in section 6 on case 3 (and comment on 4).

## 5. Case 2: Imperfect self-knowledge and invariance-efficiency

Many commentators have argued that the Coase theorem breaks down with private information (Arrow, 1979; Farrell, 1987; McKlevey & Page, 2000; Starrett, 2003; see discussion in Medema, 2017). Hahnel and Sheeran (2009) take an additional step adding 'self-knowledge' as a necessary condition for the theorem to hold. They claim that subjects (in a game) can possess 'perfect knowledge' or 'complete information'. Perfect knowledge is regularly assumed in economics and entails 'each party knows "perfectly" what its own preferences or technologies are ... it is an assumption about perfect self-knowledge' (Hahnel & Sheeran, 2009, p. 225). Complete information has then two components: knowledge about the other party and self-knowledge. Hahnel & Sheeran then argue that, in the absence of complete information, the Coase theorem fails to generate efficient outcomes. But if it fails when bargainers lack complete information, it will also fail when the weaker assumption of self-knowledge is not met that is when bargainers no longer know how they will be affected if certain outcomes obtain. Hahnel & Sheeran's claim is that unless there is complete information (self-knowledge plus knowledge about others) the theorem will not yield efficient outcomes.

In the first alternative explanation of experiment 8 (case 2), we first render explicit the rationality assumption: for the invariance-efficiency outcome to obtain bargaining subjects must be rational utility maximizers. If, however, we can show that in the KKT experiment bargainers have incomplete information that is at least one bargainer does not have knowledge of own or of the other party's utility or profit function, the rationality assumption is not satisfied and the unstructured bargaining version of the Coase theorem is not tested.

As Medema (1997, p. 126, 2017) recalls, the Coase theorem rests on the assumptions of zero transaction costs and of rational, utility maximizing, agents. Such bargainers treat rights over externalities in the same manner as they treat rights over consumer goods. However, Medema's (1997, p. 127) point is that the assumption of rationality is questionable and bargainers 'do not behave in the manner contemplated by the Coase theorem'. If this is correct, then one of the assumptions of the theorem is not met. There are two paths for this argument. The first is through the adoption of a separate rationality assumption and the second is through the inclusion of rationality in the zero transaction costs assumption. Both paths are supported in different versions of the Coase theorem.<sup>10</sup> The clearest statement of the second path is due to Williamson (1974, p. 1444) who, following Simon (1954), defines bounded rationality in terms of the 'neurophysiological limits on the capacity to receive, store, retrieve and process information without error'. Williamson (1974, p. 1494) argues that the transaction costs approach 'expressly makes allowance for elementary attributes of human decision makers – in particular, bounded rationality and opportunism' and that 'economizing on transaction costs essentially reduces to economizing on bounded rationality' (Williamson, 1986, p. 110).

In case 2 therefore our interpretation of experiment 8 concurs with KKT's findings that all mutually beneficial exchanges were not realized – some surplus is not exhausted. Our contention, however, is that this deadweight loss is caused by imperfect self-knowledge and bargaining subjects are not behaving rationally as utility maximizers. The challenge is to make a case for the explanatory power of imperfect self-knowledge, or as we shall see, bounded rationality and the imprecision of preferences. If imperfect self-knowledge explains or intervenes in the explanation of the reluctance to trade, the rationality assumption is not met in the KKT experiment. There is no need to dismiss the endowment effect for case 2 to hold for it can also be seen as a form of imperfect self-knowledge.

We shall briefly discuss elements of the literature on imperfect self-knowledge that can explain the (buying-selling price) gap and the reluctance to trade. Specifically, imperfect self-knowledge can be integrated in two distinct and not mutually exclusive forms: (i) **Imprecision of preferences**: Bargainers are utility maximizers that lack information or are misinformed on own preferences – additional information or experience would correct the imprecision of their preferences; (ii) **Bounded rationality**: Bargainers face decision costs that render utility maximizing implausible. While under both (i) and (ii) utility is not maximized, with bounded rationality maximal outcomes may not obtain even if bargainers have all the available information.

A few aspects about how bargainers whose decisions are subject to imperfect self-knowledge are reluctant to trade merit further consideration.

- (1) One hypothesis is that the buying-selling or WTA/WTP price gap arises from uncertainty about the value of a commodity which can be a market good or a lottery. The only type of commodity which does not generate decision costs are cash redeemable tokens. Whether it is lotteries or market goods, our claim is that bargainers are unable to generate accurate preferences about them. The difficulties in valuing chocolate bars are similar in terms of mechanisms to valuing lotteries as risk preference is implicitly incorporated in subjective utility (Rasmusen, 2007, p. 51). This type of uncertainty, according to Heiner (1983, p. 571), 'results from a gap in an agent's decision competence relative to the difficulty in selecting more preferred alternatives, so that error and surprises cannot be avoided'.
- (2) The operationalization of uncertainty is through the concept of self-knowledge of own preferences and how the theory and empirics of imperfect self-knowledge potentially explain the gap and the reluctance to trade. Cyert and Degroot (1975) introduced 'adaptive utility' functions to reflect similar difficulties in terms of a discrepancy between expected utility and experienced utility that cannot be completely reconciled because bargainers do not possess well defined utility functions. According to Cyert and Degroot (1975, pp. 226–7), the parameters of the utility function cannot be exactly known because of random elements.

- (3) We lack a single tight model or explanatory chain that integrates imperfect self-knowledge in explaining the gap and the reluctance to trade. Often, the overlap between competing models is substantial which makes it difficult to disentangle them empirically.<sup>11</sup> The hypothesis of preference imprecision, in particular, remains poorly understood and the literature is still growing theoretically and empirically (Cubitt, Navarro-Martinez, & Starmer, 2015). It will, nevertheless, suffice for us to show that imperfect self-knowledge, theoretically or empirically, could intervene at some point in the explanatory chain of experiment 8.
- (4) We can adopt a broad conception of imperfect self-knowledge or an exact one. In the broad conception, the endowment effect is a form of imperfect self-knowledge: loss aversion hinders owners from selling the good and maximizing surplus. In such a broad specification, the endowment effect reflects a form of imperfect self-knowledge to the extent that it hinders utility maximization. The connection between the endowment effect and decision costs, in fact, originates in Thaler (1980) who explained the behavioral differences between opportunity cost and out-of-pocket costs in terms of the endowment effect. A more exact account of imperfect self-knowledge posits imprecise preferences or bounded rationality at the start of the explanatory chain. In this more exact specification of imperfect self-knowledge, the relationship between bounded rationality, imprecise preferences, and the reluctance to trade may be mediated by psychological variables such as regret aversion, uncertainty aversion, transaction disutility, or of course, loss aversion. Note again that it is not necessary to eliminate the endowment effect from the more exact explanatory chain to integrate imperfect self-knowledge. As Korobkin (2014) acknowledges, the endowment effect can be explained with transaction disutility and regret aversion, not just loss aversion. Which psychological factors, therefore, mediate between imperfect self-knowledge, rationality, and transaction costs, is in part an empirical question.
- (5) Some of the psychological mechanisms that can explain the gap and the reluctance to trade, including loss aversion, may be considered anomalies but they are not necessarily irrational (Zamir, 2015; Zeiler, 2017). In case 2 we consider bounded rationality and imprecise preferences as leading explanations for bargainers not maximizing utility. In case 3, however, we consider a different possibility, namely, that loss aversion maximizes utility (Tversky & Kahneman, 1991).

### **Possible response by KKT**

Kahneman et al. (1990) may rule out the imperfect self-knowledge hypothesis in their experiment 1 where they attached price tags to ballpoint pens to be traded in a repeated simulated market. The addition of the price tag still led to a reluctance to trade – the endowment effect is not eliminated. Sayman and Onculer (2005) conduct a meta-analysis of factors that may explain the gap and found that price revelation is not correlated with the gap. Information on the price of the good to be exchanged entails that sellers and buyers receive unambiguous information on the market value of the good. However, is this sufficient to eliminate the imperfection of self-knowledge hypothesis? It is important to distinguish here between correct price revelation and the manipulation of the reference price (Thaler, 1985). In experiment 1 KKT reveal to subjects the price of the good. This additional information may not reduce the uncertainty about expected utility if subjects wish to consume the good or, if they are considering resale after the experiment, they still face uncertainty about resale price (Zhao & Kling, 2001). Furthermore, the relationship between the gap and price revelation is not straightforward. Weaver and Frederick (2012) predict that the gap arises from sellers benchmarking their WTA to a reference price. By experimentally manipulating reference prices between moderate and high, Weaver & Frederik can reproduce or eliminate the gap. Their explanation is aversion to transacting under unfavorable terms: Sellers experience transaction disutility when they sell at a price lower than their valuation whereas buyers experience disutility when they buy at a price higher than their valuation.

In summary, when property rights are complete, as they are in the KKT experiment, transaction costs can either be zero or positive. However, according to KKT they are zero yet not all beneficial exchanges were made. Since not all beneficial exchanges are realized, as we also assume in case 2, some friction is generating a reluctance to trade. Departing from KKT's interpretation, we assume that rationality is necessary to test the Coase theorem and that subjects are not maximizing utility because of imperfect self-knowledge. It follows that one of the assumptions of the theorem – rationality – is not met and the theorem is not refuted even if invariance-efficiency fails to obtain.

## 6. KKT's Coase theorem with Pareto efficiency

In this section we suppose that in experiment 8 KKT met all the assumptions of the unstructured bargaining Coase theorem. The assumptions are two: zero bargaining and transaction costs and well defined property right. However, if the bargaining efficiency criterion is Paretian instead of 50% of goods allocated, it is no longer clear that the Coase theorem is not corroborated. The result KKT obtained in fact is not sufficient to rule out a Pareto optimal outcome. Our alternative explanation suggests therefore that bargainers not hampered by transaction costs and with well-defined property rights will bargain to exhaust all surplus attaining Pareto efficiency. The fact that the number of transaction is less than KKT's theoretical expectation (half the chocolate bars should have been sold) does not rule out that, at the end of experiment, an efficient Pareto allocation is attained.

The invariance-efficiency criterion adopted by KKT is similar to Smith's (1976) theory of induced design where 'the essence of experimental methodology' is control. Control, according to Smith, is achieved by 'using a reward structure to induce prescribed monetary value on action, or the principle of non-satiation'.<sup>12</sup> Citing Coase (1960), Smith lists three qualifications to the non-satiation postulate including that of

subjective costs associated with market decisions. In a competitive market experiment a subject may find it arduous to monitor and make quotations, and to execute transactions. If such considerations are not negligible, then we lose control over the process of induced valuation (Smith, 1976, p. 276).

Smith then adds that this problem can be dealt with by examining

the experimental results to see if the quantity exchanged is less than predicted. If it is, this is consistent with significant transactions cost. Awareness of such transactions cost may provide valuable clues to understanding why certain experiments may fail to produce predicted results (ibid 276).

We should note that Smith (1976) argues transaction costs are positive if there is a way to identify that the quantity exchanged is less than predicted. How do KKT assess that the quantity of chocolate bars is less than predicted? As we argue next, their approach to determine the efficient number of exchanges is problematic. Induced markets are considered efficient by Plott and Smith (1978, p. 139) if subjects extract maximum surplus from the experiment. This is unambiguously achieved in bargaining over tokens in experiment 8. But can one apply the same benchmark in richer environments such as those where chocolate bars are used? Smith (1976, p. 278) warns that by adding realism (and giving experimental commodities a name or mimicking certain markets) control over valuation may be lost. Specifically, in enriched experiments there is no obvious way to compute the maximum amount of money to be extracted, or the optimal number of goods exchanged, without knowing the distribution of preferences.

While Smith's efficiency benchmark is used by KKT in experiment 8 to argue that there is a reluctance to trade in goods, most tests of the Coase theorem adopt Pareto efficiency. We already noted that Coase implicitly favors Pareto efficiency and that the experimental literature before KKT also employs Pareto efficiency. A Pareto efficient allocation obtains when no more beneficial gains from exchange (that do not cause welfare loss for someone else in the distribution) are possible. Choosing another criterion to test the theorem, as KKT do, requires justification, or at least

explanation. Specifically, with zero transaction costs, well defined property rights, and voluntary exchange, bargaining internalizes un-earned surplus and the final allocation is on the efficiency frontier. In fact, there is no evidence in the KKT experiment that the outcome is not Pareto efficient given (unknown) individual preferences over chocolate bars.

Experiment 8 still reports a WTA/WTP gap which now needs to be reconciled with a final allocation of chocolate bars that is Pareto efficient. There are two routes. Either we argue with Tversky and Kahneman (1991, p. 1057) that loss aversion and inertia are not necessarily irrational: 'A bias in favor of the status quo can be justified if the disadvantages of any changes will be experienced more keenly than its advantages'. A justified status quo, in other words, means that the loss aversion generating the endowment effect is not irrational (Zamir, 2015; Zeiler, 2017). In this case, if the alleged optimal number of chocolate bars had been sold (half of 35) total utility would not be maximized because those who in experiment 8 refrain from selling by raising WTA enjoy more utility by keeping the chocolate bar. Reluctant sellers kept the bars because the net utility of giving up the good at say WTP is negative or, if positive, it is less than the utility from keeping the good. In case 3, therefore, bargainers are utility maximizers as sellers set WTAs to insure their net utility would not decrease if the buyer accepts the price.

The other route is an economic explanation based on imperfect substitutes (Hanemann, 1991). The substitutes explanation is consistent with the allocation of chocolate bars in experiment 8 being Pareto efficient. According to the substitutes explanation, the gap is generated when the good is to be traded with an imperfect substitute. In the case of perfect substitutes and linear downward sloping indifference curves, no gap arises ( $WTA = WTP$ ); however, with downward sloping strictly convex indifference curves a gap can be reproduced ( $WTA > WTP$ ) (Shogren, Seung, Hayes, & Kliebenstein, 1994, p. 257). In experiment 8, cash and chocolate bars may be considered imperfect substitutes especially if the chocolate bar is branded or not widely available for sale or if subjects view it as *the* chocolate bar earned in the experiment. The hypothesis of imperfect substitutes has received some empirical support (Adamowicz, Bhardwaj, & Macnab, 1993; Shogren et al., 1994) especially in meta-studies on the causes of the WTA/WTP gap (Horowitz & McConnell, 2002; Sayman & Onculer, 2005).<sup>13</sup>

To complete our analysis, we should distinguish between cases 2 and 4. While both posit a theorem that assumes rationality, the difference is that in case 4 the outcome criterion (Pareto efficiency) is met whereas in case 2 the outcome criterion (50% of goods) is not met. One explanation of case 4 is that the decision costs arising from imperfect self-knowledge are treated in the same manner as production costs. As Demsetz (2011) notes, the neoclassical model can embed transaction costs and generate an efficient allocation with 'no special implication of inefficiency at equilibrium values of price and output' (Demsetz, 2011, p. 19). Thus, if transaction costs generated by imperfect self-knowledge are similar to other costs, they lead to shifts in supply and demand but otherwise do not disturb the allocation mechanism.

In another interpretation of case 4 – one in which decision costs are treated differently from production and transportation costs – the bargaining sessions allocated efficiently notwithstanding imperfect self-knowledge. In other words, even if the theorem assumes rationality, experimental subjects face decision costs arising from imperfect self-knowledge; yet the Pareto efficiency result obtains and the Coase theorem is more robust than expected. Following Smith's (1976) methodological recommendation, additional experiments will be needed to corroborate this, possibly using a counterfactual design with gradually higher decision costs and observing whether changes in allocation arise (Rhoads & Shogren, 1999). When the level of decision costs is the only counterfactual between bargaining sessions, there are two possible outcomes. If the number of exchanges falls as decision costs rise, there may be grounds to suspect that decision costs were too low to disturb the optimal allocation in the KKT bilateral bargaining sessions. However, another more complex possibility is that as decision costs rise the incentive to settle early rises too and a non-optimal Pareto outcome becomes less likely (Cooter, 1982, p. 23). This possibility, supported by Smith's (1976) observation that prices tend to be higher with complete information and that the efficient

equilibrium is less likely to prevail with lower decision costs, adds further layers of complexity to our explanations of the relationship between efficiency, rationality, and the Coase theorem. Future experimental work will have to manipulate imperfect self-knowledge and test how it interacts with Pareto efficiency. Most of the existing empirical work does not shed light on case 4 because it only manipulates knowledge of other subjects pay-offs. Specifically, future experiments will have to vary either bounded rationality or the imprecision of own preferences while keeping everything else constant.

## 7. Conclusion

In one of the most cited papers in economics, Coase (1960) did not formulate a theorem nor was he very specific on the assumptions that are needed to validate his argument that if property rights are well defined and transaction costs zero, maximum output will be produced. Six years later Stigler (1966) labeled this result the Coase theorem. A multiplicity of views emerged subsequently in a range of disciplines on which assumptions to include, what output criterion to select, and whether the theorem generates any testable predictions at all.

We have attempted to clarify three questions. First, since no theorem can be empirically refuted, how did KKT empirically challenge the Coase theorem? Second, if there are multiple versions of the Coase theorem, what version did KKT challenge? Third, if we adopt a different version of the Coase theorem, can their interpretation subsist?

Of course the assumptions of theorems cannot be exactly experimentally reproduced. Each laboratory experiment of the Coase theorem, instead, instantiates different assumptions which form deviations from the benchmark theorem. The benchmark interpretation of the Coase theorem entails there is no immaculate theorem but empirically testable Coase theorem worlds (Medema, 2015, 2017). KKT, specifically, test an unstructured bargaining version of the theorem with buyers, sellers, and consumer goods. They also claim that, to test the theorem, property rights must be allocated and bargaining and transaction costs ought to be zero. If these assumptions are met and the invariance-efficiency criterion does not emerge they can reject the theorem.

Our focus in this paper is on KKT's omission of the rationality assumption and their choice of outcome criterion. On the one hand, we argued that if rationality is necessary to test the theorem, but agents do not maximize utility in their experiment, their test of the theorem (not the theorem) is invalidated. On the other hand, their invariance-efficiency benchmark is inadequate because the goods were not randomly distributed; because market goods such as chocolate bars can lead to losing control over what the optimal number of exchanges ought to be; and loss aversion may not be irrational since the reluctance to sell may reflect the behavior of subjects maximizing utility.

While it is not in our scope to decide which set of assumptions and outcomes offer a valid test of the Coase theorem, we have argued that an exclusive reliance on case 1 reflects a partial view of the evidence. Though we claim rationality may be considered a necessary assumption for the result of the theorem to emerge there is unlikely to be a single correct choice of assumptions across contexts. Likewise, it is not our aim to posit one best outcome criterion. We, nevertheless, note that KKT's criterion generates difficulties related to experimental bargaining environments with market goods. As Smith (1976) warned, the introduction of such goods can lead to loss of control over the valuation process.

## Notes

1. Samuels (1974 [1992, p. 85]) argued the Coase theorem is a partial equilibrium model that neglects general equilibrium implications, a tautology that misconceives rights, a doctrine rather than a scientific theorem in which 'ideology [is] at one of its most esoteric levels'. More recent critiques by Farrell (1987) and Canterbury and Marvasti (1992) consider the theorem is circular while Usher (1998) claims it is either tautological, incoherent, or wrong and Ventura, Cafiero, and Montibeller (2016) that it is tautological or false. Halpin (2007) posits it is logically inconsistent. Medema (1996) responds to Canterbury & Marvasti whereas Allen (2015) responds to Usher and Halpin.
2. See Coursey, Hoffman, and Spitzer (1987), Harrison, Hoffman, Rutstrom, and Spitzer (1987), Hoffman and Spitzer (1982, 1985, 1986), Harrison and McKee (1985), Prudencio (1982), and Schwab (1988).

3. Claims made, respectively, by Farber (1997), Samuels (1974 [1992]), Hoffman and Spitzer (1993, p. 62), Rachlinski and Jourdain (1998, p. 1546), Zamir (2015, p. 22), and Medema (1997).
4. See Bertrand (2010, pp. 980–1), Coleman (2002: chapter 3), Medema (1999, p. 213), Samuels (1974 [1992]) for explanations as to why Coase implicitly uses Pareto efficiency.
5. A similar definition is adopted by Allen (2015, p. 379) ‘if transaction costs are zero, then the allocation of resources is independent of the distribution of property rights’ and Korobkin (2014, p. 1231) ‘if transaction costs are zero, the assignment of a legal entitlement by the state will not affect the ultimate ownership of that entitlement’.
6. Specifically, ‘a random allocation design was used to test for the presence of an endowment effect. Half of the subjects were endowed with a good and became potential sellers in each market; the other half of the subjects were potential buyers. Conventional economic analysis yields the simple prediction that one-half of the goods should be traded in voluntary exchanges. If value is unaffected by ownership, then the distribution of values in the two subgroups should be the same except sampling variation. The supply and demand curves should therefore be mirror images of each other, intersecting at their common median. The null hypothesis is therefore that half of the goods provided should change hands’ (Kahneman et al., 1990, p. 1328).
7. KKT repeat the experiment with mugs and envelopes with an unknown amount of money and find a similar reluctance to trade.
8. It is not 100% as in the bargaining session over induced-tokens because the utility surplus for market goods is related to individual preferences and some subjects may prefer money to chocolate or may dislike chocolate.
9. While the high WTAs were also reported in experiments where the good was allocated randomly by KKT, in these other experiments the exchange mechanism was not bargaining as it ought to be to test the unstructured bargaining version of the Coase theorem.
10. In section 2 we listed versions of the Coase theorem by Calabresi and Medema (but see also Hoffman & Spitzer, 1982) that account for rationality as a separate assumption from zero transaction costs. The inclusion of rationality as requirement for zero transaction cost can be found in Buchanan and Tullock (1962), Coase (1960, 1988), Cooter (1982), Calabresi (1991), Barzel (1985), Hovenkamp (1990, p. 787), Illing (1992), Pratten (1997), and Schlag (1989) among others. Coase (1981, p. 187), specifically, considers studying a world without transaction costs is equivalent to ‘augurs divining the future by the minute inspection of the entrails of a goose’. He later repeats that it is not worthwhile to spend much time studying a world without transaction costs (Coase, 1988, p. 15). One may speculate that Coase considers transaction costs ubiquitous because they include decision costs as he had originally argued in 1960: ‘In order to carry out a market transaction, it is necessary to discover who it is one wishes to deal with, to inform people that one wishes to deal and on what terms, to conduct negotiations leading up to a bargain, to draw up the contract, to undertake the inspection needs to make sure that the terms of the contract are being observed, and so on’ (Coase, 1960, p. 15). Coase (1988, p. 6) is even more specific subsequently and argues that transaction costs include ‘search and information costs, bargaining and decision costs, policing and enforcement’. Dahlman (1979), whose definition of transaction costs Coase approved, argued all transaction costs ‘have in common that they represent resource losses due to lack of information. Both search and information costs owe their existence to imperfect information about the existence and location of trading opportunities or about the quality or other characteristics of items available for trade ... Therefore, it is really necessary to talk only about one type of transaction cost: resources losses incurred due to imperfect information’ (Dahlman, 1979, pp. 147–8). More recent definitions re-emphasize that transaction costs should more specifically account for problems of rationality and knowledge (Calabresi, 1991, p. 1211). Barzel (1985, p. 5) contends transaction costs are determined by product information which are homogenized in Walrasian models to eliminate exchange costs. Schlag (1989, p. 1690) identifies information about the products, associated markets, and consumer preferences as the informational prerequisites for market based transaction cost analysis.
11. It appears to be a problem that plagues behavioral economics. For discussion see Wilkinson and Klaes (2012, pp. 204–205).
12. Smith’s postulate of non-satiation is that ‘given a costless choice between two alternatives, identical except that the first yields more of the reward medium (usually a currency) than the second, the first will always be chosen (preferred) over the second, by an autonomous individual i.e. utility is monotone increasing function of the monetary rewards’ (Smith, 1976, p. 275).
13. Horowitz and McConnell (2002) find that ordinary goods have lower gaps (with the highest gaps reported for health/safety and public non-market goods followed by ordinary private goods, lotteries and cash redeemable token and money). Similarly, Sayman and Onculer (2005) run a meta-regression with the gap as dependent variable and a range of explanatory variables among which the availability of substitutes. They find that the availability of substitutes is statistically significant and negative, the more substitutes the goods has the smaller the WTA/WTP gap.

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