Tax salience: an experimental investigation

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TAX SALIENCE: AN EXPERIMENTAL INVESTIGATION

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Abstract

A basic principle in public finance is tax incidence equivalence (well known as Liability Side Equivalence Principle, LES). This principle holds that the burden of a unit tax on buyers and sellers is independent of who actually pays the tax. Moreover, economic theory assumes an individual behaviour model in which subjects act *as if* they have to fully optimize changes in tax policies by correctly processing information in their possession. However, a wide empirical literature focused on some psychological issues that have as yet not been considered theoretically. It is easy to assume that the introduction of tax-inclusive prices and tax-exclusive prices could lead to price misperception. This means that individuals could not perceive the exact burden of a tax when it is not salient (as it could be in the case of tax-exclusive prices). We conduct a laboratory experiment that attempts to answer two relevant questions: (1) Do subjects' behaviour change with a less salient tax? (2) Is tax incidence independent of the responsibility to pay a more or less salient tax? Based on the results of Mann-Whitney U tests, concerning the first question we conclude that, in accordance to the theory of tax incidence, subjects' behaviour is not affected by salience. On the other hand, concerning the second question, contrary to theoretical predictions, we report evidence of stark differences in average trading prices for LSE principle analysis. Most notably, we observe that tax-on-seller treatment prices are systematically higher, thus revealing a plausible tax-shifting phenomenon.

Keywords: Tax incidence, Tax salience, Liability Side Equivalence, choice behaviour, laboratory.

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1. Introduction

Tax incidence is one of the most fundamental questions in public economics, since it implicates the economic burden of a tax. A basic principle in public finance is tax incidence equivalence (well known as Liability-Side Equivalence Principle, LES). This principle holds that the burden of a unit tax on buyers and sellers is independent of who actually pays the tax. In the Handbook of Public Economics, Fullerton and Metcalf (2002) distinguish between "economic incidence" and "statutory incidence": that is the person who had to pay tax legally may not be the person who bears the real tax burden. Thus the economic incidence of a tax is independent of the statutory incidence. Instead, the relative tax burden depends solely on the relative elasticity of supply and demand. Moreover, economic theory assumes an individual behaviour model in which subjects act *as if* they have to fully optimize changes in tax policies by correctly processing information in their possession. Substantially, subjects' behaviours will not be affected by the external environment or the manner in which decisions are made. According to some authors, this theory has shown a number of limitations over the years, especially in practice. Interestingly, DellaVigna (2007) detects empirically how individuals systematically deviate from the behaviour assumed by the standard theory in three classes of preference: nonstandard preferences, nonstandard beliefs and nonstandard decision making. A theory that seems to contradict economic postulates is the theory of "price presentation" (Biswas et al., 1993, Krishna et al., 2002). This theory has always been at the centre of marketing policies: the objective was to present prices in order to minimize the perceived burden of all expenses. It is based on the assumption that subject behaviour deviates systematically than preached by the standard economic theory. This would predict that subject response to equivalent price cuts should not depend on how the price cut is presented (price framing). With "price framing" the authors broadly mean how the offer price is communicated to the subject, for example, is the offered price given along with a reference price? Is the reference price plausible? Is a price deal communicated in dollars or percentage terms? Besides the actual price, how the price offering is presented to subjects also affects individual evaluation of the product offering as well as the purchase decision. There is a wide empirical evidence indicating that the "price framing" effect is a ubiquitous phenomenon documented in many fields of investigation such as medical and clinical decisions, perceptual judgments, responses to social dilemmas, bargaining behaviours, auditing evaluations (Levin et al., 1998). On the basis of such evidence, it is easy to assume that the introduction of tax-inclusive prices and tax-exclusive prices could lead to price misperception. This means that individuals could not perceive the exact burden of a tax when it is not salient (as it could be in the case of tax-exclusive prices). Where the theoretical literature is mainly based on the fact that the individual perceives the exact tax burden, as discussed below, some research has disproved this assumption revealing even, in some cases, large differences between the personal estimates and the actual amount of the tax burden[3]. Some psychological features seem to emerge in tax incidence empirical literature. Part of the literature examined whether individuals perceive the marginal income tax rate correctly (see Gensemer et al., 1965; Morgan et al., 1977; Fuji and Hawley, 1988; Rupert and Fisher, 1995). Results appear to be inconsistent, because in some surveys the marginal tax rate is underestimated while in others it is overestimated. In contrast, Rosen (1976) showed that white

[3] We can define the "perceived tax burden" as the tax burden that an individual estimates explicitly when he is called upon to make an economic decision, e.g. on labor supply, asset allocation, voting in elections.

married women react to tax rate modification rationally[4], revealing a limited "tax illusion"[5]. Another strand of literature investigates subjects' misperceptions in evaluating complex tax frameworks. In general, there is some vulnerability in contributors' understanding of tax systems due to their extreme complexity (McCaffery and Baron, 2006). Some experiments show that a correct perception of tax effects can be realized only by establishing a simple tax framework. In Boylan and Frishmann (2006) and Rupert et al. (2003) experiments, subjects trade fictitious goods, of which the gains are taxed. In each treatment the form of tax scale presentation is changed to gauge the "framing effect". Substantially, they note that higher tax complexity rules lead to misperceptions, and consequently a worse judgment and decision outcome. In many cases, an individual's decision making process relies on a heuristic approach, in which they choose to focus on salient objects by ignoring the most relevant information. This is contrary to the economic theory assumptions: individuals act according to full rationality. The field of cognitive psychology, with important roots in Herbert Simon's "bounded rationality" (1955), has shown how individuals deviate, often systematically, from ideal perceptions of rationality including consistency[6]. For example, de Bartolome (1995) finds that many individuals use the average rate *as if* it were the marginal tax rate in making economic decisions[7]. Other studies give attention to the LES Principle. Also in this case results seem to be different depending on the experimental design. The main finding is that the equivalence relation on the base of the LSE can only be achieved when subjects register a learning effect due to a sufficient number of trading periods. Kerschbamer and Kirchsteiger (2000) resort to an ultimatum game in which the proposer or the respondent assumes liability to pay the tax. In the absence of a learning effect that leads to equivalent pricing in the experimental treatments, they reject the LSE assumption. Furthermore, Sausgruber and Tyran (2005) investigate whether an incorrect tax perception can translate into distorted fiscal choices by using a referendum mechanism[8]. They show that if individuals have the opportunity to learn, they can properly assess their tax burden correctly. Similarly, Ruffle (2005) conducts an experiment in which participants are led to exchange a good in a pit market[9]. This analysis involves a tax or a subsidy implementation either on buyers or on sellers after some tax free periods. They show that, in general, the price variance decreases over several periods, thus confirming the LSE principle.

We conduct a laboratory experiment that attempts to answer two relevant research questions: (1) Do subjects' behaviour change with a less salient tax? (2) Is tax incidence independent of the responsibility to pay a more or less salient tax? Laboratory experiments are particularly well suited to the purpose at hand.

[4] In fact, Rosen shows that the cross-sectional correlation between marginal tax rate and work hours and wage rates and work hours is similar.

[5] The so-called phenomenon of "fiscal illusion" generally suggests that when government revenues are not completely transparent or are not fully perceived by taxpayers, the cost of government is seen to be less expensive than it actually is. Since some, or all, taxpayers benefit from government expenditures from these unobserved or hidden revenues, the public's appetite for government expenditures increases, thus providing politicians incentive to expand the size of government. In this case, "fiscal illusion" arises when the relative invisibility of indirect taxes is compared to more visible direct taxes. Tax payers may systematically underestimate the tax burden from indirect taxes as compared to direct taxes, because indirect taxes are incorporated into the price of goods.

[6] He proposed a model in which individuals face a cost of processing information and therefore rationally use simplifying heuristics to solve complex problems. As reported by Simon, assuming the psychological limits in computational and predictive ability, "the actual human rationality can at best be an extremely crude and simplified approximation to the kind of global rationality that is implied, for example, by game-theoretical models". In this way, it is possible that people make predictable mistakes in thinking about tax and public finance, areas of considerable complexity.

[7] Particularly, in a laboratory experiment, the author shows that many MBA students confuse the average rate with the marginal rate when they have to invest 1$ in a taxable or non-taxable project.

[8] Subjects can earn income from trade activities and are then given the opportunity to express a vote on a proposal to tax market transactions with a direct tax or indirect tax respectively in two experimental treatments.

[9] A "pit market" can be defined as a market in which trade activities among participants are not conducted anonymously. That is to say that every person is free to choose his business partner who does not remain anonymous during the negotiation.

They are performed in a controlled environment in which it is possible to avoid many econometric problems of observational data analysis. In this way we can be assured that resulting experimental data cannot be useless or misleading in testing theory assumptions. We design a laboratory experiment with between-subject variations, in which subjects trade a fictitious good in a double-auction market as pioneered by Smith (1962). We compare ST (Salient Tax) with NST (Non-Salient Tax) treatments to answer our first research question and then tax-on-buyer with tax-on-seller treatments to answer our second research question. The remainder of this work is organized as follows. The next section describes two prominent works strictly close to our research questions, whereas the subsequent sections present our experimental design in detail (section 3), and discuss our findings (section 4). Section 5 concludes.

2. Related experiments

Chetty et al. (2009) define the salience of a tax as "the simplicity of calculating the gross-of-tax price of a good"[10]. Tax salience and the implication of tax perception was firstly recognised by John Stuart Mill (1848), who stated that:

"Perhaps […] the money which [the taxpayer] is required to pay directly out of his pocket is the only taxation which he is quite sure that he pays at all. […]. If all taxes were direct, taxation would be much more perceived than at present; and there would be a security which now there is not, for economy in the public expenditure."

On the basis of Mill's intuition that stated the lower salience of an indirect tax, Chetty et al. (2009) demonstrate how individuals in their purchasing activities are not aware of the tax burden imposed. They conduct a field experiment in a grocery store where they published the tax-inclusive price for 750 products subject to sales tax. Normally, in this store, prices posted on the shelf exclude sales tax of 7.375%. If the good is subject to sales tax (cosmetics, hair care accessories and deodorants), it is added to the bill only at the cashier. After showing the tax-inclusive price below the original pre-tax price tag for a three week period, the register data analysis revealed that this led to a reduction in demand for these products by 8% compared to the two controlled groups of other similar items in the same aisle (with only tax-exclusive prices) of the treatment store and items in two other stores of the same chain located in nearby cities[11]. They therefore conclude that the tax is totally ignored until the moment the subject reaches the cashier to make the payment. In fact, by showing prices with tax and without tax, the consumer is provoked into properly assessing the total price of the product (tax inclusive). This clearly indicates that indirect taxes that are only applied at the checkout are less salient. However, the authors proceed to a second empirical investigation to verify whether these findings are confirmed by the observational data on alcohol consumption between 1970 and 2003. In the United States, alcohol is subject to a double taxation with excise tax included in the posted price and *ad valorem* tax that is added at checkout. The increase of either should theoretically lead to the same behavioural responses. An analysis of the elasticity of demand for alcohol in the long run actually reveals how the salience matters: the increases in excise tax reduces alcohol consumption more than *ad valorem* tax decreases it. In order to confirm this important evidence, the authors conduct an interview with customers entering the store to

[10] More precisely, we can say that tax policy A is more salient than tax policy B, if the calculation of the gross-of-tax price of the first fiscal policy is less complex than that for the gross-of-tax of the second policy (Chetty et al., 2009).
[11] The treatment effect of publishing tax-inclusive prices is statistically significant using both t-tests and other nonparametric tests.

check if they know what goods are subject to *ad valorem* tax. As the average individual responded correctly to 7 out of 8 products investigated and declared an average tax rate of within 0.5 percentage points of the true rate, the authors concluded that subjects chose not to calculate the tax-inclusive price when making their purchases, thus confirming salience magnitude.

We know that a fundamental preposition in tax incidence theory is the independence of the assignment of the liability to pay tax over a long-term analysis of competitive markets: a fundamental principle according to which a general equilibrium tax incidence equivalence implies that the incidence is independent of which side of the market is levied. Therefore assigning legal liability to pay tax should not affect tax incidence in the long run. Another key issue in economic literature is the potential influence of the type of market institution on tax incidence. Effectively, there are many different types of markets, each of which has different properties and mechanisms for determining the price and the quantity traded between sellers and buyers. It is plausible that different market configurations lead to different incidence results. This insight is the basis of the work conducted by Cox et al. (2012). Their paper research questions are essentially two: (A) Is tax incidence independent of the assignment of the liability to pay tax in experimental markets? (B) Is tax incidence independent of the market institution in experimental markets? In a laboratory experiment the authors compare two different market institutions: a double-auction market (DA) and a posted-offer market (PO)[12]. The experimental design was specifically designed to test whether the change of market institution or the assignment of the liability to pay tax may cause different results in terms of incidence. The first hypothesis tested is the technical prediction regarding the influence of market institutions on tax incidence. For this reason, the authors propose changing the market institution from DA to PO, maintaining the same condition of liability to pay tax. Subsequently, they change the assignment of liability to pay tax from the seller to the buyer, keeping the market institution the same. In this way, the experimental design is composed of four treatments:

1. A double-auction market with a unit tax on the buyer (DATB);
2. A double-auction market with a unit tax on the seller (DATS);
3. A posted-offer market with a unit tax on the buyer (POTB);
4. A posted-offer market with a unit tax on the seller (POTS).

In each treatment subjects were randomly divided between buyers and sellers. Each treatment consists of four independent markets, in turn composed of 5 buyers and 5 sellers who trade simultaneously. The subjects are asked to perform 5 trading periods of practice to help them become familiar with the software. Subsequently, there are 30 periods of real exchange for each treatment. At the beginning of each trading period, each buyer or seller gets 5 infra-marginal units of a fictitious good to buy or sell. The experimental design follows that of Smith (1962, 1982) very closely. The assignment of liability to pay tax and the amount of the unit tax (12 ED[13]) are announced to the subjects at the beginning of the treatments. To ensure simplicity, costs, values and unit tax remain the same throughout the experiment. The theory of tax incidence says that there should be no difference between the average prices of the buyer in, both, the DA and PO treatments. The comparison between the CDFs of average buyer prices

[12] In experimental double-auction markets buyers and sellers are free to declare a price quote for one unit of the fictitious commodity within certain time constraints. Each exchange covers a single unit of commodity and is realized when one of the parties accepts the price quote proposed by the other party. In posted-offer markets the seller publishes the prices of goods possibly limiting the amount for sale and the buyer decides to buy this good on the basis of a comparison between the prices published by different sellers.

[13] Experimental Dollars

from DATB and DATS treatment and from POTB and POTS treatment lead the authors to reject the hypothesis that tax incidence is independent of the assignment of liability to pay. Also the comparison between the two CDFs of the average buyer prices from DATB and POTB treatments and from DATS and POTS treatments lead to rejecting the hypothesis that tax incidence is independent of the market institution[14]. All these findings are incompatible with standard theoretical predictions. Moreover, the PO treatments have produced an equilibrium quantity of 10 units compared to 15 units predicted by the theory. This highlights the possible tax over-shifting. This is more likely to occur in PO markets as confirmed by a number of studies (see for instance Ashenfelter and Sullivan, 1987; Harris, 1987; Keeler at al., 1996; Hanson and Sullivan, 2009).

3. Experimental design

3.1 An overview

We conduct a laboratory experiment with a between-subjects design in which subjects trade one unit of a fictitious good in a double-auction market. The experiment[15] was programmed and conducted with the software z-Tree (Fishbacher, 2007). The experimental design consists of nine treatments performed in the following order (see Table 1):

Table 1: Summary of Experimental Treatments

#treatment	Treatment Tag	Treatment Description
1	NT	No Tax treatment
2	STB4	Salient Tax on Buyer (4 ECU)
3	STS4	Salient Tax on Seller (4 ECU)
4	STB8	Salient Tax on Buyer (8 ECU)
5	STS8	Salient Tax on Seller (8 ECU)
6	NSTB4	Non-salient Tax on Buyer (4 ECU)
7	NSTS4	Non-salient Tax on Seller (4 ECU)
8	NSTB8	Non-salient Tax on Buyer (8 ECU)
9	NSTS8	Non-salient Tax on Seller (8 ECU)

1. A treatment in which subjects face an induced stationary demand and supply schedule[16] with no tax imposition (NT);
2. A treatment with subjects facing a demand schedule with reserve prices that are implicitly reduced by the amount of a 4 ECU excise tax on buyers (STB4);
3. A treatment with subjects facing a supply schedule with cost values that are implicitly incremented by the amount of a 4 ECU excise tax on sellers (STS4);
4. A treatment with subjects facing a demand schedule with reserve prices that are implicitly reduced by the amount of an 8 ECU excise tax on buyers (STB8);

[14] Particularly, the change in market institution has a greater impact on tax incidence than a change in the assignment of the liability.
[15] Figure 1A in the appendix depicts a screenshot of the experimental market place for a seller in the treatment with no tax imposition.
[16] All treatments in each session refer to supply and demand schedules of no tax treatment (first treatment) although they are suitably modified in ST treatments to ensure theoretical equivalence conditions with NST treatments.

5. A treatment with subjects facing a supply schedule with cost values that are implicitly incremented by the amount of an 8 ECU excise tax on sellers (STS8);
6. A treatment in which subjects face the no tax treatment schedules with the explicit imposition of a 4 ECU excise tax on buyers (NSTB4);
7. A treatment in which subjects face the no tax treatment schedules with the explicit imposition of a 4 ECU excise tax on sellers (NSTS4);
8. A treatment in which subjects face the no tax treatment schedules with the explicit imposition of an 8 ECU excise tax on buyers (NSTB8);
9. A treatment in which subjects face the no tax treatment schedules with the explicit imposition of an 8 ECU excise tax on sellers (NSTS8).

Particularly, in ST treatments it is assumed that showing a price or a cost value incorporating the excise tax makes it more perceptible and therefore more salient. However, in NST treatments, values do not include tax, and consumers face a cognitive cost of computing the actual price or cost in the presence of a lower tax salience. The definition of two different amounts of the excise tax (4 and 8 ECU) will allow us to determine whether a higher tax may lead to different effects on traders' behaviour *ceteris paribus*. In this way, we can be assured that ST treatments will have the same parameterizations of NST treatments and will be comparable from a theoretical standpoint. In fact, the translation of supply and demand schedules due to explicit tax imposition in NST treatments will lead to equivalence with ST treatment schedules. Clearly, the ST treatments can accurately represent situations in which the "in-front-of-the-shelf" consumer is shown the tax-inclusive price. Conversely, NST treatments represent situations in which the consumer is shown the tax-exclusive price. In this case, as frequently happens, the tax will be added (and hence it will be more salient) only at the checkout.

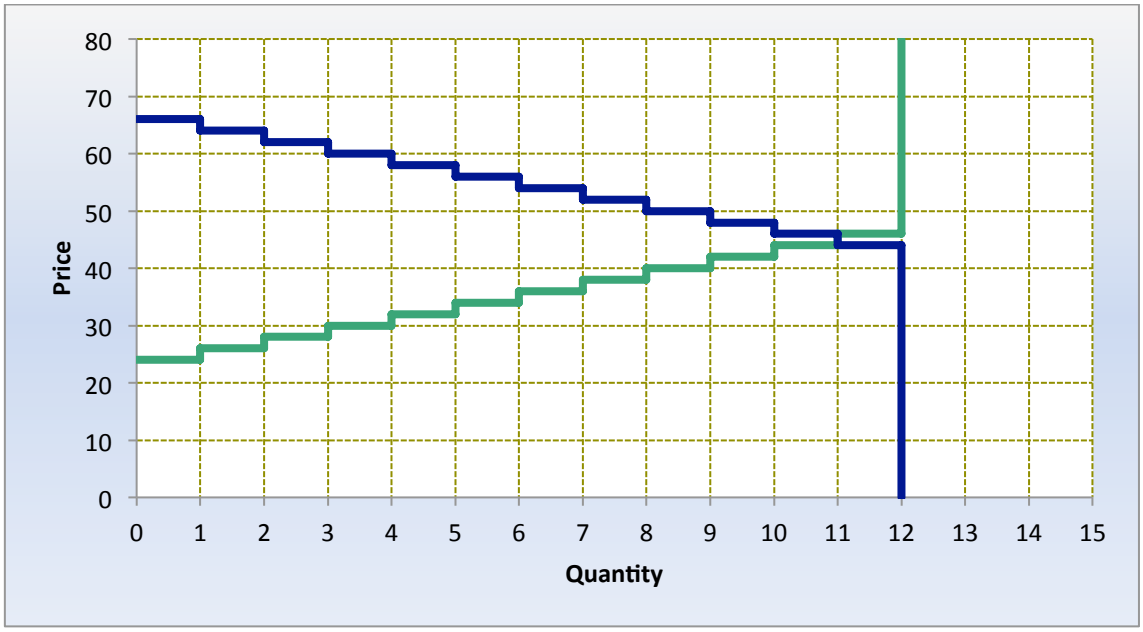
The experiment was conducted in the "Lee" Laboratory for economic research at the University "Jaume I" of Castellón (Spain). Participants were 138 undergraduate students, particularly freshmen. We ran six sessions over some regular days in September 2014. Each session consisted of the nine treatments reported above and lasted about 100 minutes. The subjects' role as well as costs and values were randomly assigned at the beginning of each treatment and were the same throughout the entire treatment, but they differed across treatments. At first, subjects were given a hard copy of the instructions. Subjects were allowed to ask questions either publically or privately to clarify any doubts. Trading activities were performed by adopting Experimental Currency Units (ECU) as the currency during the experiment. At the end of each session, subjects are paid their cumulative earnings according to the conversion rate 10 ECU=1€.

3.2 Session description

In each session buyers and sellers trade the good in a double-auction market that is opened for 90 seconds in each trading period. The trading screen of all participants always displays the lower "ask" and the higher "bid". The contract is concluded only if a seller accepts the standing "bid" or a buyer accepts the standing "ask". Traders are sited in a manner that protects their privacy, and are not allowed to communicate with each other. This procedure is identical for all treatments. Each session includes 9 treatments. In each treatment both buyers and sellers have 1 unit of a fictitious good to trade. All subjects first trade in 2 practice periods and then in 7 relevant periods in a given treatment. We induced different

demand and supply curves for each market. The demand and supply schedule remain fixed across periods in a given treatment, but they differ among treatments to gauge tax salience impact. In the first treatment, subjects trade with the stationary demand and supply schedule in the absence of tax (NT) as shown in Figure 1.

Figure 1: Demand and Supply schedule in NT treatment (Session1)



The predicted equilibrium occurs where the curves intersect the quantity equal to 11, and the price between 44 and 46 (we assumed 45 as the equilibrium price for surplus calculus). As mentioned above, in the following four treatments (ST treatments), the amount of the excise tax has been deducted from values or added to costs, depending on the legal responsibility to pay. In the second treatment the demand schedule is shifted by 4 ECU compared to the previous setting. This means that the tax is imposed on the buyer and values have been adjusted for the respective tax amount. In this case the equilibrium occurs with a quantity equal to 10 and a price equal to 43 ECU (see Figure 1A in the appendix). In terms of incidence, the third treatment is theoretically equivalent to the previous treatment (see Figure 1B in the appendix). The supply schedule is shifted by 4 ECU because the tax is paid by the sellers. The equilibrium occurs with a quantity equal to 10 and a price equal to 47 ECU. The introduction of an 8 ECU excise tax determines an equilibrium quantity equal to 9 for both treatments and an equilibrium price equal to 41 ECU for the fourth treatment and 49 ECU for the fifth treatment. The supply and demand schedules relating to these treatments are shown respectively in Figures 1C and 1D.

In contrast, NST treatments always resort to no-tax treatment demand and supply schedules. We know from theory that the imposition of an excise tax will shift schedules to the exact tax amount, as subjects must necessarily consider taxes in their personal assessment. In particular, if the tax is imposed on the buyer, the maximum that he is willing to pay will be equal to the sum of the good's price and the tax. Likewise, if the tax is imposed on the seller, the tax will be considered as an additional cost to those already incurred in the production and/or sale activities. This implies for example that if the buyer is aware of the application of an excise tax, then rationally he should consider paying the tax in the

maximum assigned value resulting in a downward shift of its demand curve. On the other hand, in the presence of perfect rationality, the seller will consider the tax as an additional cost that will raise its supply curve. In this way, ST and NST treatments are theoretically equivalent and allow proper assessment of the effects of greater or lesser tax salience. More precisely, the second treatment will be equivalent to the sixth treatment, the third treatment will be equivalent to the seventh treatment, the fourth treatment will be equivalent to the eighth treatment and the fifth treatment will be equivalent to the ninth treatment. In the appendix, we list all theoretical and experimental values of price, quantity, total surplus, as well as buyers' and sellers' surplus in reference to the first session setting (see Table 2-13).

4. Experiment results

4.1 Markets efficiency analysis

An initial data analysis is intended to ascertain whether the subjects' surplus reflects theoretical prediction. Theoretically, as we have already seen, the equivalence relations on the basis of ST and NST treatments requires that all buyers and sellers shall equally share profits from trading activities. Clearly, the design setting described above requires a different calculation of the surplus for different treatments. As in the first treatment and in the following four treatments, subjects face tax-inclusive values (more salient tax), therefore the surplus is equal to

$$S_b = v - p$$

for buyers and

$$S_s = p - c$$

for sellers, where S_b and S_s are buyers' and sellers' surpluses, respectively, v denotes private values, p is the unit price and c is the marginal cost. In NST treatments, subjects face tax-exclusive values and have to support a cognitive cost of calculating the actual price or cost. In these cases, buyers' surplus will be

$$S_b = v - (p + \tau)$$

and sellers' surplus will be

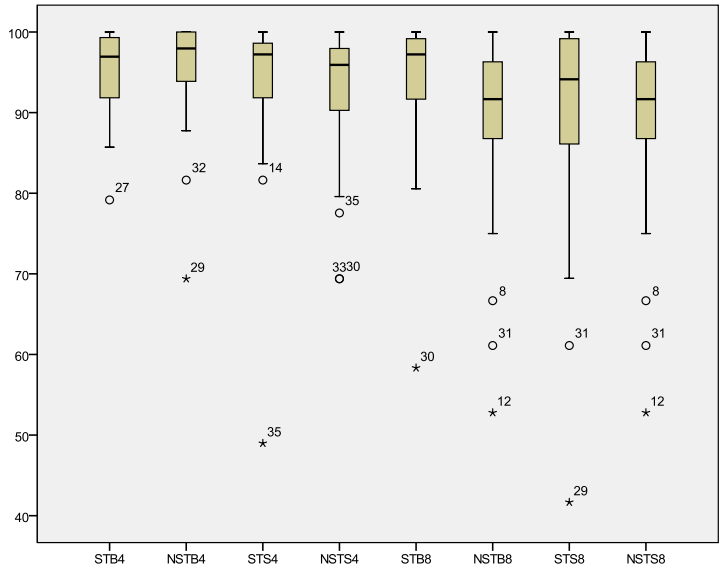
$$S_s = p - (c + \tau)$$

where τ denotes the unit tax. To provide an insight into market collective efficiency, we use the coefficient of allocative efficiency introduced by Gode and Sunder (1997). This is a measure of performance of an entire market. It is given in the following equation and it is defined as the ratio of total actual profit and theoretical profit. Total actual profit is the sum of profits made by each trader while the theoretical profit is the sum of buyers', s_b, and sellers', s_s, surplus.

$$e = \frac{\sum_{i \in traders} pr_i}{s_s + s_b} \times 100$$

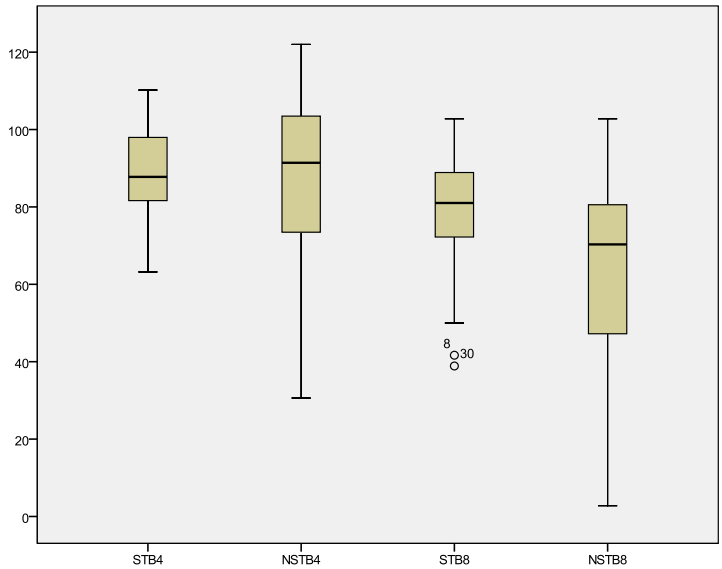
where pr_i is the profit of trader i, which is all his successful transactions. An analysis of allocative efficiency values distribution per treatment can be useful to gauge a "salience" effect. Figure 2 presents a boxplot indicating the comparison between treatments.

Figure 2: Allocative efficiency coefficients distributions



The distributions do not exhibit significant differences[17] in achieving allocative efficiency among ST and NST treatments. However, it may be useful to separate the allocative efficiency coefficient in two components: buyers' allocative efficiency and sellers' allocative efficiency. They are measured as the ratio between the actual surplus realized in trading activities and the theoretical surplus (equal to 50% of the market total surplus).

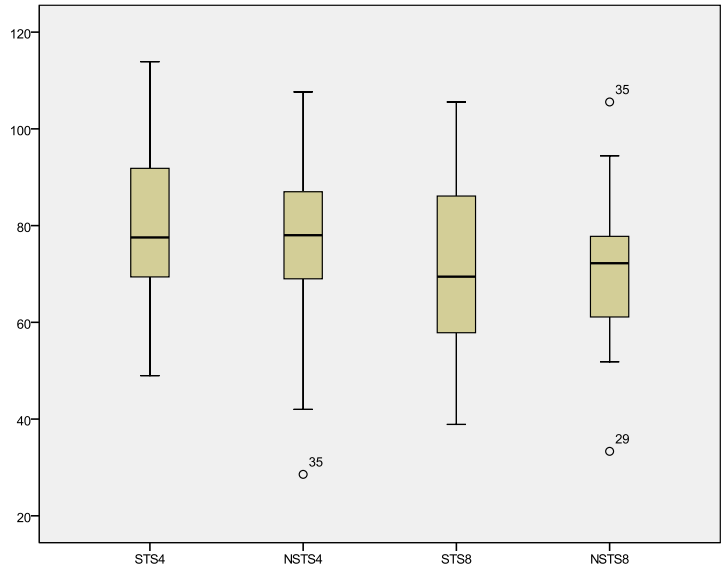
Figure 3: Buyers' allocative efficiency coefficients distributions



[17] A Mann-Whitney test rejects the null hypothesis at a 1% significance level.

An examination of the buyers' coefficients distribution from the first comparison (STB4 *vs.* NSTB4) verifies a certain similarity between treatments[18]. However, a significant difference between STB8 and NSTB8 treatments can be seen where it seems that a greater excise amount (8 ECU) brings about a "salience" effect (see Figure 3).

Figure 4: Sellers' allocative efficiency coefficients distributions



4.2 Prices breakdown

To give insight into market convergence to equilibrium prices among control and treatment groups, we computed the coefficient of convergence α, introduced by Smith (1962), for each trading period. It measures how close a group of traders trade to the theoretical equilibrium. It is defined as the standard deviation of the actual trade price p from the equilibrium price p_0 as a percentage of it.

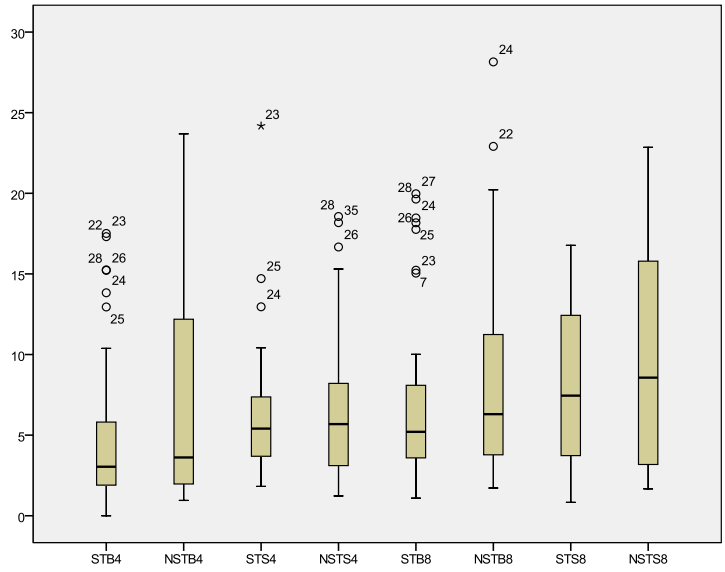
$$\alpha = \frac{100}{p_0}\sqrt{\frac{1}{n}\sum_{i=1}^{n}(p_i - p_0)}$$

Hence α provides a measure of exchange price variation relative to the predicted equilibrium exchange price. This means that the smaller the α the greater will be the convergence to the market equilibrium price.

As is seen in Figure 5, α tends to increase marginally in NST treatments and to present a greater variability than ST treatments. It would seem that treatments with lower tax salience present a lower convergence to equilibrium. However, distributions are roughly similar and no significantly extreme differences are detected (except for the first comparison).

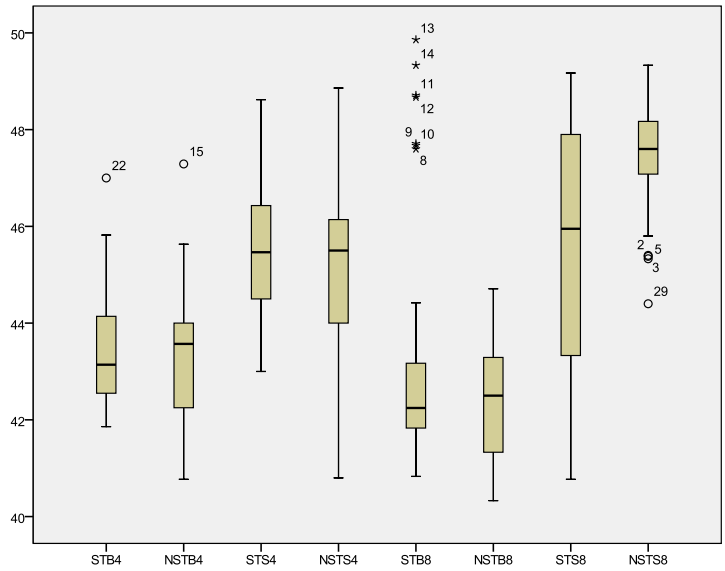
[18] A Mann-Whitney test rejects the null hypothesis at a 1% significance level.

Figure 5: Coefficient of convergence distributions



Our first research question was "Do subjects' behaviours change with a less salient tax?" We make comparisons of the average trading price distributions from the eight relevant treatments (STB4 *vs.* NSTB4, STS4 *vs.* NSTS4, STB8 *vs.* NSTB8, STS8 *vs.* NSTS8). According to the theory of tax incidence, there should be no difference between the average trading prices in ST treatment compared to NST treatments. Figure 6 clearly depicts how the distributions of average trading prices from ST and NST treatments are very similar to each other. Although the imposition of an 8 ECU excise tax on sellers seems to determine different subjects' behaviours with prices notably higher in the treatment with a lower tax salience.

Figure 6: Average trading price distributions for salience assessment

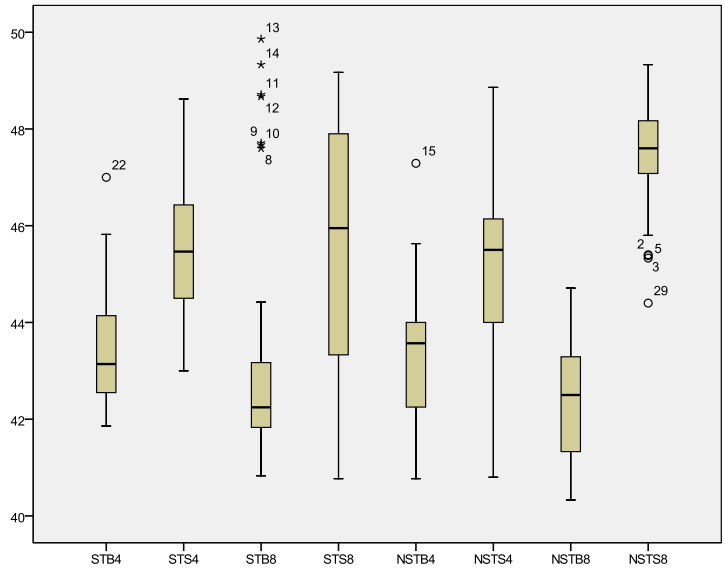


To confirm these results we use the Mann-Whitney *U* test for two independent samples. Comparing STB4 *vs*. NSTB4, STS4 *vs*. NSTS4, STB8 *vs.* NSTB8 we cannot reject the null hypothesis of equality of

distributions[19]. However, by comparing STS8 *vs.* NSTS8, the two distributions are statistically different at any significance level, in this case we can reject the null hypothesis of equality of distributions. Summarizing these results, we can confirm that theoretical predictions hold valid in our laboratory experiment. We do not detect any significant difference between trading price distributions in ST and NST treatments, although we found a systematic price increase in the latter.

Our second research question was "Is tax incidence independent of the responsibility to pay a more or less salient tax?" We make comparisons of the average trading price distributions from the eight relevant treatments (STB4 *vs.* STS4, STB8 *vs.* STS8, NSTB4 *vs.* NSTS4, NSTB8 *vs.* NSTS8) to test liability-side equivalence principle. This is a fundamental issue that can be considered as a main principle of public finance: a general equilibrium tax equivalence implying that the tax incidence is independent of which side of the market is levied. In other words, the price paid by the buyers will be the same no matter whether the buyers or the sellers have to pay the tax; similarly the price that the sellers receive (which equals the price that buyers pay minus the tax amount) will be the same independent of who pays the tax. Therefore, according to the theory of tax incidence, there should be no difference between the average trading prices in tax-on-buyers and tax-on-sellers treatments. Contrary to theoretical predictions, Figure 7 clearly shows how distributions of average trading price from tax-on-buyers, and tax-on-sellers treatments are always different to each other.

Figure 7: Average trading price distributions for LSE principle assessment



Additionally, in this case, we used the Mann-Whitney test to confirm such relevant findings. By comparison of STB4 *vs.* STS4, STB8 *vs.* STS8, NSTB4 *vs.* NSTS4, and NSTB8 *vs.* NSTS8 the test fully confirms the conclusions discussed above. The average trading price distributions are significantly different, at any statistical significance level; indeed the trading prices in the case of a tax on sellers are higher than those in the case of a tax on buyers. Distributions are always statistically different to each other. As in Cox (2012), these results seem to confirm that the assignment of liability to pay taxes in competitive markets can produce a statistically significant effect in terms of tax incidence: taxes can be easily shifted to buyers when the obligation of liability to pay is on the seller.

[19] One-tailed p-values are 0.469, 0.180, and 0.256 respectively.

5. Conclusion

We analysed data generated in an economic laboratory experiment and addressed two questions regarding tax salience: (1) Do subjects' behaviours change with a less salient tax? (2) Is tax incidence independent of the responsibility to pay a more or less salient tax?

To provide insight into experimental markets collective efficiency, we first computed an allocative efficiency coefficient for each period in each treatment. We found that coefficient distributions were very similar and there were no relevant differences in achieving allocative efficiency among ST and NST treatments. We proceeded to split the allocative efficiency coefficient into its two components: buyers' and sellers' allocative efficiency. We still found a certain resemblance between higher and lower salience treatments except for STB8-NSTB8 comparison.

A first price analysis was conducted by calculating Smith's coefficient of convergence for each period in each treatment. We noted that a lower salience treatment resulted in a slower convergence to market equilibrium, although convergence coefficient distributions appeared no different from each other. To answer our first research question we used the Mann-Whitney *U* test for two independent samples in order to examine statistical differences in average trading price distributions between ST and NST treatments. According to the theory of tax incidence, we detected no significant difference except for STS8-NSTS8 comparison. This difference could be explained by relevant cognitive effort in computing actual costs when sellers have to face a higher tax amount (8 ECU). However, we do not have additional data confirming our assessments, so it would be interesting to conduct further experiments in this direction.

To test Liability Side Equivalence Principle (LSE) we used the Mann-Whitney *U* test to verify statistical significance differences between tax-on-buyer and tax-on-seller treatments. Contrary to theoretical predictions, we report evidence of stark differences in average trading prices. In particular, we observed that prices are systematically higher in tax-on-sellers treatments, thus revealing a plausible tax shifting phenomenon in, both, ST and NST treatments.

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Appendix

Figure 1A: Screenshot of the experimental market place for a seller in the treatment NT

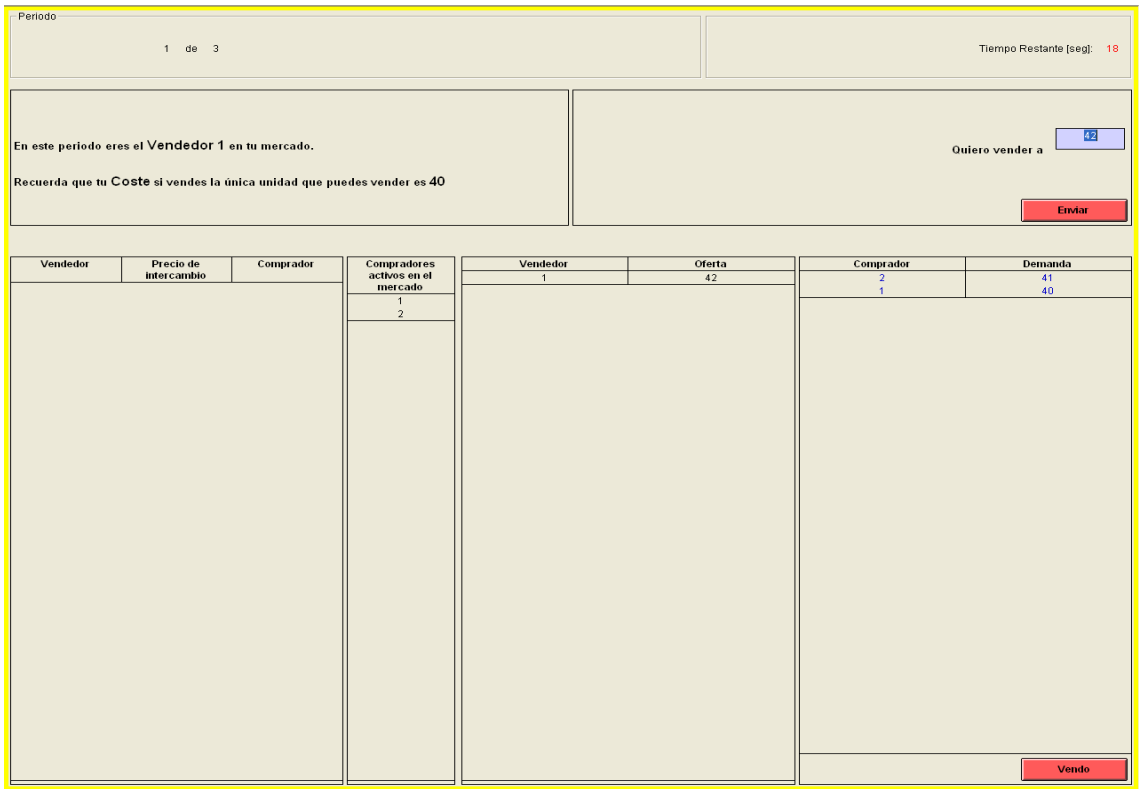

Figure 1A: Demand and Supply schedule in STB4 treatment

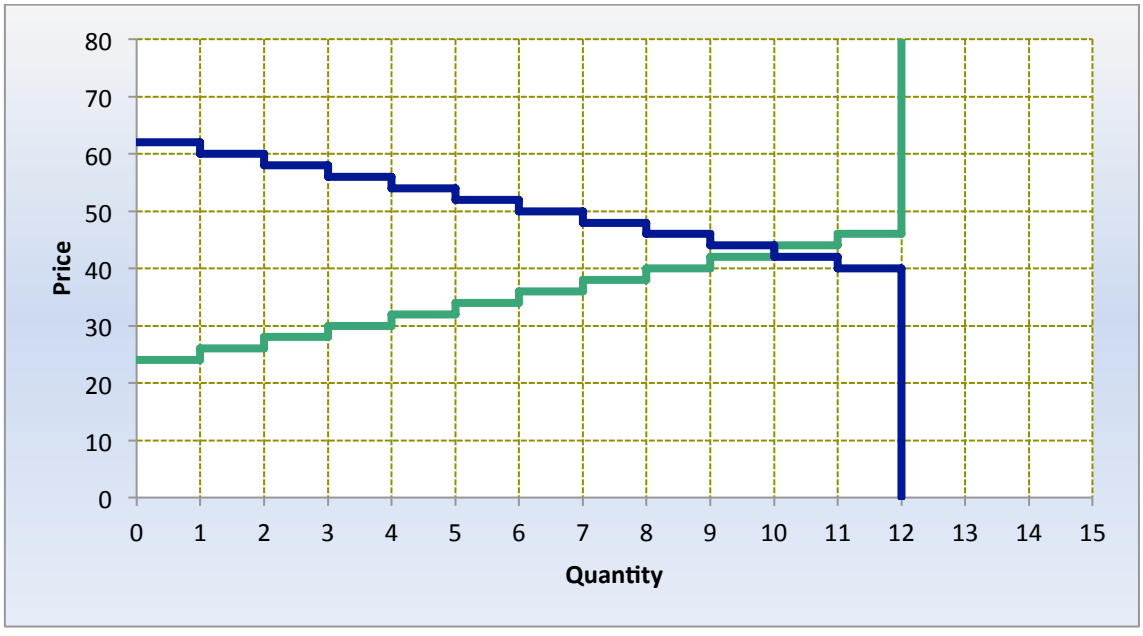

Figure 1B: Demand and Supply schedule in STS4 treatment (Session 1)

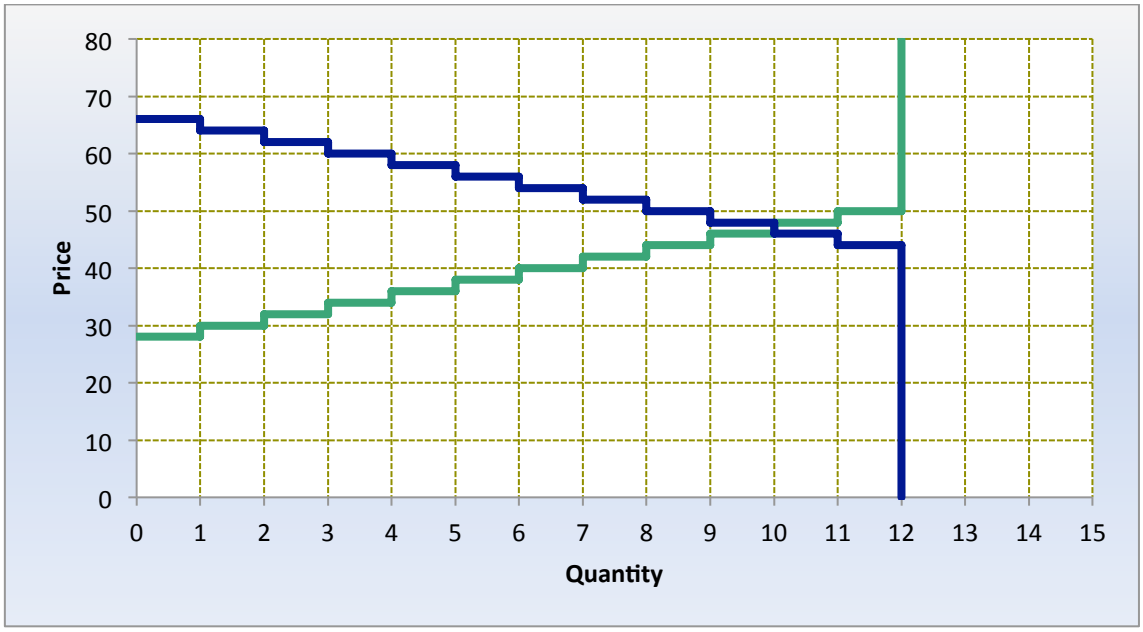

Figure 1C: Demand and Supply schedule in STB8 treatment (Session 1)

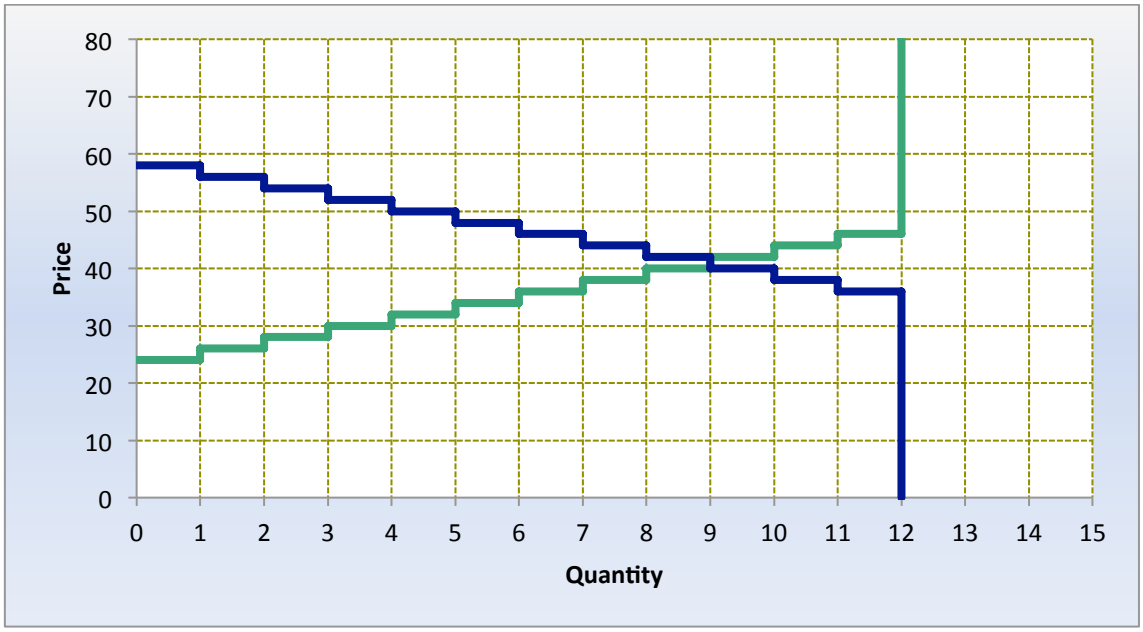

Figure 1D: Demand and Supply schedule in STS8 treatment (Session 1)

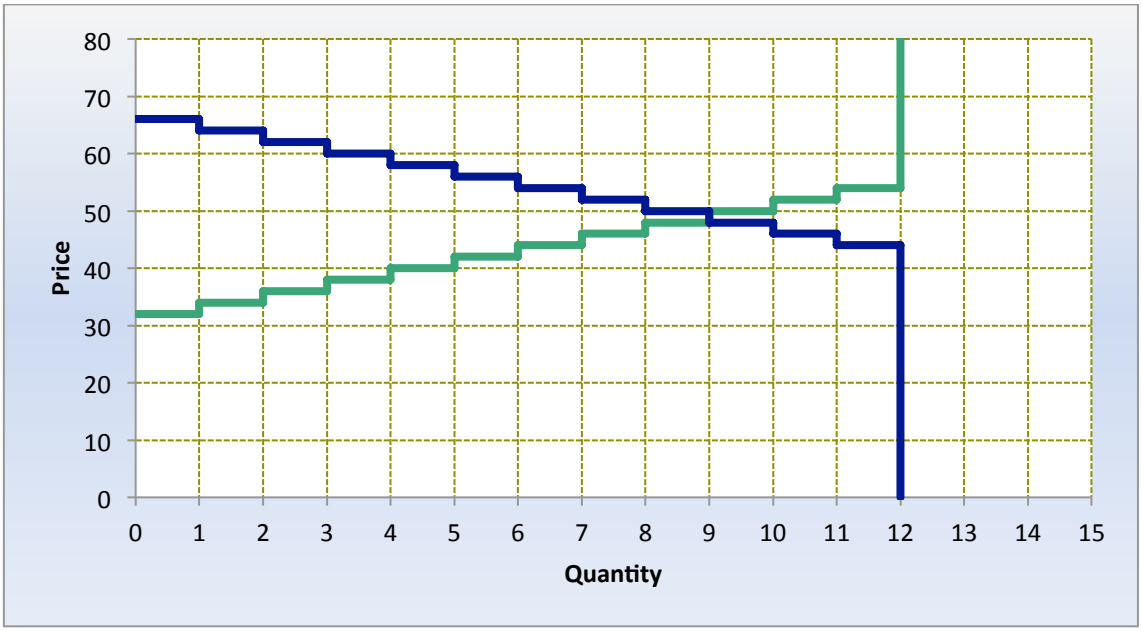

Table 2: Theoretical values from Session 1

Theoretical Values							
Treatment	Equilibrium Price	Equilibrium Quantity	Equilibrium Surplus	Buyers' Surplus	Sellers' Surplus	Buyers' Surplus (%)	Sellers' Surplus (%)
1	45	11	242	121	121	50	50
2	43	10	200	100	100	50	50
3	47	10	200	100	100	50	50
4	41	9	162	81	81	50	50
5	49	9	162	81	81	50	50
6	43	10	200	100	100	50	50
7	47	10	200	100	100	50	50
8	41	9	162	81	81	50	50
9	49	9	162	81	81	50	50

Table 3: Theoretical values from Session 2

	Theoretical Values						
Treatment	Equilibrium Price	Equilibrium Quantity	Equilibrium Surplus	Buyers' Surplus	Sellers' Surplus	Buyers' Surplus (%)	Sellers' Surplus (%)
1	45	8	128	64	64	50	50
2	43	7	98	49	49	50	50
3	47	7	98	49	49	50	50
4	49	6	72	36	36	50	50
5	41	6	72	36	36	50	50
6	43	7	98	49	49	50	50
7	47	7	98	49	49	50	50
8	49	6	72	36	36	50	50

9	41	6	72	36	36	50	50

Table 4: Theoretical values from Session 3

	Theoretical Values						
Treatment	Equilibrium Price	Equilibrium Quantity	Equilibrium Surplus	Buyers' Surplus	Sellers' Surplus	Buyers' Surplus (%)	Sellers' Surplus (%)
1	45	8	128	64	64	50	50
2	43	7	98	49	49	50	50
3	47	7	98	49	49	50	50
4	41	6	72	36	36	50	50
5	49	6	72	36	36	50	50
6	43	7	98	49	49	50	50
7	47	7	98	49	49	50	50
8	41	6	72	36	36	50	50
9	49	6	72	36	36	50	50

Table 5: Theoretical values from Session 4

	Theoretical Values						
Treatment	Equilibrium Price	Equilibrium Quantity	Equilibrium Surplus	Buyers' Surplus	Sellers' Surplus	Buyers' Surplus (%)	Sellers' Surplus (%)
1	45	13	338	169	169	50	50
2	43	12	288	144	144	50	50
3	47	12	288	144	144	50	50
4	41	11	242	121	121	50	50
5	49	11	242	121	121	50	50
6	43	12	288	144	144	50	50
7	47	12	288	144	144	50	50
8	41	11	242	121	121	50	50
9	49	11	242	121	121	50	50

Table 6: Theoretical values from Session 5

	Theoretical Values						
Treatment	Equilibrium Price	Equilibrium Quantity	Equilibrium Surplus	Buyers' Surplus	Sellers' Surplus	Buyers' Surplus (%)	Sellers' Surplus (%)
1	45	8	128	64	64	50	50
2	43	7	98	49	49	50	50
3	47	7	98	49	49	50	50
4	41	6	72	36	36	50	50
5	49	6	72	36	36	50	50
6	43	7	98	49	49	50	50
7	47	7	98	49	49	50	50

8	41	6	72	36	36	50	50
9	49	6	72	36	36	50	50

Table 7: Theoretical values from Session 6

	Theoretical Values						
Treatment	Equilibrium Price	Equilibrium Quantity	Equilibrium Surplus	Buyers' Surplus	Sellers' Surplus	Buyers' Surplus (%)	Sellers' Surplus (%)
1	45	8	128	64	64	50	50
2	43	7	98	49	49	50	50
3	47	7	98	49	49	50	50
4	41	6	72	36	36	50	50
5	49	6	72	36	36	50	50
6	43	7	98	49	49	50	50
7	47	7	98	49	49	50	50
8	41	6	72	36	36	50	50
9	49	6	72	36	36	50	50

Table 8: Experimental values from Session 1

	Experimental Values						
Treatment	Equilibrium Price*	Equilibrium Quantity**	Equilibrium Surplus ***	Buyers' Surplus	Sellers' Surplus	Buyers' Surplus (%)	Sellers' Surplus (%)
1	45	11	240	137	103	57	43
2	43	11	194	102	92	52	48
3	43	10	192	125	67	65	35
4	42	9	157	65	92	41	59
5	47	10	152	99	53	65	35
6	43	10	198	113	85	57	43
7	44	10	191	123	68	64	36
8	42	10	153	69	84	45	55
9	46	9	151	94	57	62	38

*median equilibrium price **median equilibrium quantity ***average equilibrium surplus

Table 9: Experimental values from Session 2

	Experimental Values						
Treatment	Equilibrium Price*	Equilibrium Quantity**	Equilibrium Surplus***	Buyers' Surplus	Sellers' Surplus	Buyers' Surplus (%)	Sellers' Surplus (%)
1	45	8	124	61	62	49	50
2	44	7	95	39	56	41	59
3	46	7	95	51	44	54	46
4	48,5	6	70	38	32	54	46

5	43	6	69	25	44	36	64
6	44	7	91	34	57	37	63
7	47	7	90	46	44	51	49
8	44	7	58	10	49	17	84
9	47	6	62	37	25	60	40

*median equilibrium price **median equilibrium quantity ***average equilibrium surplus

Table 10: Experimental values from Session 3

	Experimental Values						
Treatment	Equilibrium Price*	Equilibrium Quantity**	Equilibrium Surplus***	Buyers' Surplus	Sellers' Surplus	Buyers' Surplus (%)	Sellers' Surplus (%)
1	45	8	122	56	66	46	54
2	42	7	91	46	45	51	49
3	45	7	92	54	38	59	41
4	42	6	71	29	41	41	58
5	49	6	68	39	29	57	43
6	44	7	97	39	58	40	60
7	46	7	95	58	38	61	40
8	43	6	68	23	45	34	66
9	48	7	65	42	22	65	34

*median equilibrium price **median equilibrium quantity ***average equilibrium surplus

Table 11: Experimental values from Session 4

	Experimental Values						
Treatment	Equilibrium Price*	Equilibrium Quantity**	Equilibrium Surplus***	Buyers' Surplus	Sellers' Surplus	Buyers' Surplus (%)	Sellers' Surplus (%)
1	44	13	320	152	169	48	53
2	44	13	269	114	154	42	57
3	45	13	276	134	142	49	51
4	43	12	229	99	130	43	57
5	46	11	232	153	79	66	34
6	44	13	281	153	128	54	46
7	45	13	274	157	117	57	43
8	42	12	220	90	131	41	60
9	46	13	220	124	96	56	44

*median equilibrium price **median equilibrium quantity ***average equilibrium surplus

Table 12: Experimental values from Session 5

	Experimental Values						
Treatment	Equilibrium Price*	Equilibrium Quantity**	Equilibrium Surplus***	Buyers' Surplus	Sellers' Surplus	Buyers' Surplus (%)	Sellers' Surplus (%)
1	45	8	120	58	62	48	52

2	43	6	91	45	46	49	51
3	45	7	86	53	33	62	38
4	42	5	63	28	34	44	54
5	46	4	52	34	18	65	35
6	43	7	87	35	52	40	60
7	44	5	81	54	27	67	33
8	42	6	62	24	38	39	61
9	48	5	62	37	25	60	40

*median equilibrium price **median equilibrium quantity ***average equilibrium surplus

Table 13: Experimental values from Session 6

	Experimental Values						
Treatment	Equilibrium Price*	Equilibrium Quantity**	Equilibrium Surplus***	Buyers' Surplus	Sellers' Surplus	Buyers' Surplus (%)	Sellers' Surplus (%)
1	45	8	124	66	58	53	47
2	43	7	95	45	50	47	53
3	46	7	93	50	43	54	46
4	42	6	67	27	40	40	60
5	48	5	63	37	25	59	40
6	44	7	96	44	53	46	55
7	46	7	94	51	43	54	46
8	41	6	65	28	37	43	57
9	48	6	66	40	27	61	41

*median equilibrium price **median equilibrium quantity ***average equilibrium surplus

Table 14: Mann-Whitney test results for STB4-NSTB4 comparison

	averagetradeprice
Mann-Whitney U	873,000
Wilcoxon W	1776,000
Z	-,081
Asymp. Sig. (2-tailed)	,936
Exact Sig. (2-tailed)	,938
Exact Sig. (1-tailed)	,469
Point Probability	,002

Table 15: Mann-Whitney test results for STS4-NSTS4 comparison

	averagetradeprice
Mann-Whitney U	779,000
Wilcoxon W	1682,000
Z	-,922
Asymp. Sig. (2-tailed)	,357
Exact Sig. (2-tailed)	,360
Exact Sig. (1-tailed)	,180
Point Probability	,001

Table 16: Mann-Whiney test results for STB8-NSTB8 comparison

	averagetradeprice
Mann-Whitney U	808,000
Wilcoxon W	1711,000
Z	-,662
Asymp. Sig. (2-tailed)	,508
Exact Sig. (2-tailed)	,511
Exact Sig. (1-tailed)	,256
Point Probability	,001

Table 17: Mann-Whitney test results for STS8-NSTS8 comparison

	averagetradeprice
Mann-Whitney U	497,500
Wilcoxon W	1400,500
Z	-3,440
Asymp. Sig. (2-tailed)	,001
Exact Sig. (2-tailed)	,000
Exact Sig. (1-tailed)	,000
Point Probability	,000

	averagetradeprice
Mann-Whitney U	497,500
Wilcoxon W	1400,500
Z	-3,440
Asymp. Sig. (2-tailed)	,001
Exact Sig. (2-tailed)	,000
Exact Sig. (1-tailed)	,000
Point Probability	,000

Table 18: Mann-Whitney test results for STB4-STS4 comparison

	averagetradeprice
Mann-Whitney U	143,000
Wilcoxon W	1046,000
Z	-6,613
Asymp. Sig. (2-tailed)	,000
Exact Sig. (2-tailed)	,000
Exact Sig. (1-tailed)	,000
Point Probability	,000

Table 19: Mann-Whitney test results for STB8-STS8 comparison

	averagetradeprice
Mann-Whitney U	512,000
Wilcoxon W	1415,000
Z	-3,311
Asymp. Sig. (2-tailed)	,001
Exact Sig. (2-tailed)	,001
Exact Sig. (1-tailed)	,000
Point Probability	,000

Table 20: Mann-Whitney test results for NSTB4-NSTS4

	averagetradeprice
Mann-Whitney U	275,000
Wilcoxon W	1178,000
Z	-5,433
Asymp. Sig. (2-tailed)	,000
Exact Sig. (2-tailed)	,000
Exact Sig. (1-tailed)	,000
Point Probability	,000

Table 21: Mann-Whitney test results for NSTB8-NSTS8 comparison

	Averagetradeprice
Mann-Whitney U	1,000
Wilcoxon W	904,000
Z	-7,882
Asymp. Sig. (2-tailed)	,000
Exact Sig. (2-tailed)	,000
Exact Sig. (1-tailed)	,000
Point Probability	,000