On fiscal illusion

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and

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Abstract
Fiscal illusion prevails if people are prone to systematic misperception of the tax burden. The empirical knowledge about possible causes and consequences of fiscal illusion is scant to date because of inherent limitations of field data. We present an experimental design to investigate these causes and consequences. We identify tax framing as a cause of fiscal illusion. We show that the tax burden associated with an indirect tax is systematically underestimated, whereas this is not the case with an equivalent direct tax. Furthermore, we show that fiscal illusion distorts democratic decisions and may result in “excessive” redistribution.

Keywords: Fiscal illusion, laboratory experiments, voting behavior, indirect taxation, redistribution
JEL-codes: C92, H22, D72

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1. Introduction

“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.”

John Stuart Mill (1848: 237)

Fiscal illusion prevails if people are prone to systematic misperception of the tax burden. A particularly relevant aspect of taxation that has been suggested to cause fiscal illusion is the relative “invisibility” of indirect taxes as compared to more “visible” direct taxes. This hypothesis about a cause of fiscal illusion has a long history (see James Buchanan 1967). For example, John Stuart Mill hypothesized (1848) that taxpayers systematically underestimate the tax burden from indirect taxes as compared to direct taxes. The reason for this underestimation may be that indirect taxes are incorporated into (and therefore “hidden” in) the prices of goods.

Fiscal illusion may have important consequences because of its potential to distort democratic decisions on fiscal issues. For example, the quotation from J. S. Mill suggests that fiscal illusion may lead to “excessive” public expenditure. Government spending is considered to be “excessive” if a tax-expenditure package is implemented which voters-taxpayers would have opposed had they correctly perceived the resulting tax burden. Therefore, fiscal illusion is a candidate explanation for the dramatic increase in government spending experienced in many countries during the 20th century. For example, U.S. government expenditures as a percentage of GNP have increased by approximately 500 percent over the last nine decades (Holsey and Borcherding 1997: 563). Of course, the massive government growth may have several causes. In fact, various explanations which do not refer to fiscal illusion, but are based on the assumption that all agents are rational have been suggested to account for this phenomenon (e.g. Becker and Mulligan 1998).

Despite the considerable number of empirical studies on fiscal illusion available to date, very little is known about the empirical validity of Mill’s hypothesis. As will be argued in section 2 in more detail, it is difficult to measure a misperception of the tax burden, and it appears to be impossible to unambiguously show with survey studies or field data that excessive government spending is a consequence of fiscal illusion (see Oates 1988, Dollery
and Worthington 1996 for detailed reviews). In particular, the available empirical research methods did not allow to distinguish between the rationality-based and the illusion-based explanations.

In view of these inherent limitations of empirical studies using field data, we suggest an experimental approach to test Mill’s hypothesis about the causes and consequences of fiscal illusion. Experimental techniques provide the means to control preferences and information conditions. As will be argued below, this control is necessary to discriminate between rationality-based and illusion-based explanations. We present an experimental design appropriate to investigate whether tax framing is a cause, and whether excessive redistribution is a consequence of fiscal illusion. To do so, we provide a novel combination of two well-established lines of experimental research. We combine a competitive experimental market (e.g. Smith et al. 1982) with an experimental voting study (see Palfrey 1991). In our experiment, subjects earn income in a competitive experimental market from trading. Then, subjects vote on a proposal to tax market transactions and to redistribute tax revenues. The tax is either framed as a “visible” direct tax or an “invisible” indirect tax. Except for the framing the two tax regimes are perfectly equivalent. Since we investigate how framing affects behavior in voting and market institutions (e.g. Russell and Thaler 1985), our study is also related to the behavioral economics literature.

With respect to the causes of fiscal illusion, our results show that the tax burden resulting from indirect taxation is systematically underestimated, whereas this is not the case with direct taxation. With respect to the consequences of fiscal illusion, we show that fiscal illusion is pronounced enough to distort democratic decisions. In particular, we show that individual voting decisions in many cases are distorted to such an extent that “excessive” redistribution results. That is, sufficiently many illusion-prone voters approve of a tax-redistribution proposal which is not in their material self-interest.

The paper is organized as follows: Section 2 discusses empirical problems in identifying the causes and consequences of fiscal illusion by means of survey studies and field data. Section 3 provides a description of the experimental design. Section 4 reports the results, and section 5 concludes the paper.
2. Why so little is known about fiscal illusion

This section discusses the requirements that have to be met by an empirical investigation to unambiguously show whether (i) fiscal illusion exists, (ii) fiscal illusion is caused by tax framing, and (iii) excessive government activity is a consequence of fiscal illusion. These requirements are very demanding. To our knowledge, neither survey nor econometric studies are available which fulfill all of the requirements. We claim that the experimental design presented in section 3 meets all of the requirements explained below.

(i) To be able to show that fiscal illusion exists, the individual perception of the tax burden resulting from a particular tax has to be measured. Several survey studies have investigated the “visibility” of various taxes (e.g. Schokkaert 1988, Cullis and Lewis 1985). Economists tend to be skeptical about the reliability of survey studies because respondents have no incentives to report their perception thoughtfully or truthfully. A more important limitation of survey studies is that they do not provide any indication of the extent of misperception of the tax burden. To evaluate whether there is misperception, one has to compare the true tax burden an individual bears with his or her perception of the tax burden. Unfortunately, even specialized economists disagree on the tax burden of indirect taxes (see e.g. the debate on the “double dividend” from indirect taxes on energy). Therefore, it appears to be difficult to establish even the very existence of fiscal illusion (however, for interesting attempts see Gemmell et al. 1999 or Fujii and Hawley 1988).

(ii) Suppose the problems mentioned in (i) could somehow be solved, i.e. suppose the misperception of the tax burden from a particular tax could be reliably measured. To be able to show that tax framing causes this misperception, the researcher would have to find two taxes that are identical with respect to the tax burden, and to compare the relative misperception associated with these taxes. This is so because a framing effect prevails if different representations of the objectively same situation provoke different cognitive evaluations of the situation (Tversky and Kahneman 1981). For example, a researcher would have to find a natural experiment in which taxpayers are first exposed to a direct tax, then to an indirect tax which is shifted to taxpayers to such an extent that the resulting tax burden is the same in both cases. He could then (in principle) measure and compare the misperception in both cases. Unfortunately, such a natural experiment appears to be difficult to find.
(iii) Suppose the problems discussed in (i) and (ii) could be solved, i.e. suppose that it is possible to identify tax framing as a cause of fiscal illusion. To be able to show that fiscal illusion indeed translates into distorted fiscal decisions, a researcher would have to analyze the effect of individual misperception on individual voting decisions. However, such individual-level data are usually not available because voting is frequently anonymous.

In view of the insufficient quality of available field data, Wallace E. Oates (1988: 66) concludes in his survey that the empirical “literature has not made a persuasive case for [the] existence and importance” of fiscal illusion.\(^1\) To illustrate some of the problems raised above, consider the “renter illusion”. In many countries the main revenue of local jurisdictions is the property tax which is assessed on property owners. The renter illusion hypothesis contends that the renters (tenants) are not (fully) aware of the property tax hidden in rental payments. If the renters outnumber the property owners, a proposal to increase property taxes to provide more public services would pass at the polls.

Field studies in fact frequently find a positive correlation between the percentage of renters in a local jurisdiction and the level of public expenditures. Some authors suggested that this expansion of public activity is due to the underestimation of the taxes incorporated in the rents (e.g. Bergstrom and Goodman 1973). Other authors claim to be able to explain this evidence by assuming fully rational behavior of renters. It is, for example, argued that the market for housing may be characterized by inelastic supply, elastic demand, or both. Such market conditions do not allow the shifting of the entire property tax and, as a consequence, renters’ tax shares would be moderate. Another claim is that renters tend to spend less on housing than homeowners of the same income class which also implies a relatively low tax burden for renters (Martinez-Vasquez 1983). To the extent that these variables cannot be measured (or controlled), it is not possible to distinguish between these competing hypotheses. Therefore, field observations, which appear to be consistent with the fiscal illusion hypothesis, are usually also consistent with hypotheses based on the assumption of fully rational agents (e.g. Marshall 1991).

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\(^1\) Dollery and Worthington (1996) reconfirm this conclusion.
3. **An experimental approach to fiscal illusion**

Section 3.1 provides a general description of the design and research hypotheses. It is explained why this experimental design has been chosen to investigate fiscal illusion. Section 3.2 describes the parameters and procedures in detail.

3.1 **Experimental design and hypotheses**

This experimental study compares behavior in two treatments. In both treatments, subjects first participate in a competitive experimental market where they earn market income from trading. In both treatments, subjects vote in a referendum on a proposal to tax market transactions and to redistribute tax revenues. If the proposal passes, the tax-redistribution scheme is implemented. If the proposal fails, trading continues as before. The two treatments exclusively differ by whether redistribution is financed by a transaction tax levied on the buyers or on the sellers. As a consequence of our parameter choices, the transaction tax cannot be shifted if levied on the buyers, but is fully shifted in equilibrium if levied on the sellers. By definition, direct taxes are taxes which cannot be shifted, whereas indirect taxes can be shifted.\(^2\) Therefore, the two treatments exclusively differ by whether redistribution is financed by a direct tax or by an indirect tax.

Figure 1 serves two purposes. First, it is used to illustrate the basic idea of our experiment. Second, the figure is drawn using actual parameters. These will be explained in detail in section 3.2, and the figure serves as a reference for that discussion. In both treatments, subjects first trade under the same market conditions (induced supply and demand \(S_0, D_0\)). If a transaction tax is levied on the buyers (left part of figure 1), the demand schedule is shifted down to \(D_1\). Since demand and supply intersect in the perfectly inelastic range of demand, the imposition of the tax does neither affect the equilibrium price nor the equilibrium quantity. Since the direct tax cannot be shifted in equilibrium, the entire tax burden is borne by the buyers.

\(^2\) According to Atkinson and Stiglitz (1980: 427), this incidence-based distinction between direct and indirect taxes is the one that is most common in the public finance literature. However, criteria based on the method of administration of tax payments or on the possibility to adjust the tax payment to individual characteristics of the taxpayer are also used in the literature to distinguish between direct and indirect taxes.
If a transaction tax is levied on the sellers (right part of figure 1), the supply schedule is shifted up to $S_1$. The imposition of the tax does not affect the equilibrium quantity, but causes equilibrium prices to rise exactly by the amount of the tax. That is, the indirect tax is fully shifted to the buyers, and the entire tax burden is borne by the buyers. Therefore, the tax burden is the same in both treatments, and the two treatments are perfectly equivalent in economic terms. This result is an application of the fundamental tax liability side equivalence. According to this tax liability side equivalence, the same rent distribution prevails in equilibrium irrespective of whether the tax is levied on the buyers or on the sellers (see e.g. Kotlikoff and Summers 1987).

**Figure 1:** Induced supply and demand

<table>
<thead>
<tr>
<th>Transparent Treatment (TT)</th>
<th>Intransparent Treatment (IT)</th>
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</thead>
<tbody>
<tr>
<td>$D_0$</td>
<td>$D_0$</td>
</tr>
<tr>
<td>$D_1$</td>
<td>$S_1$</td>
</tr>
<tr>
<td>$S_0$</td>
<td>$S_0$</td>
</tr>
</tbody>
</table>

When subjects vote in the referendum whether to introduce the tax and redistribute a part of the revenues, they know all market parameters and the terms of the redistribution proposal in detail. Therefore, they possess sufficient information to take a rational voting decision. In particular, subjects know that the amount of money redistributed to subjects is smaller than the tax revenue in both treatments. A rational voter approves of the proposal if the proposal increases his net income. Since the entire tax burden is borne by buyers and their per capita income from redistribution is smaller than their per capita tax burden in equilibrium, rational buyers will reject the proposal in both treatments.
Even though the treatments are identical in terms of equilibrium incomes, they may not be cognitively identical. We hypothesize that the framing of taxation (i.e. direct vs. indirect taxation) systematically affects the perception of the tax burden. In particular, we hypothesize that the tax burden resulting from direct taxation is “transparent” whereas the tax burden resulting from indirect taxation is “intransparent” to subjects. The reason for this intransparency is that subjects have to perceive that the indirect tax will be incorporated into prices. As a consequence, we call the treatment with direct taxes the Transparent Treatment (TT), and the treatment with indirect taxes the Intransparent Treatment (IT). More specifically, we hypothesize that the tax burden from indirect taxation will be underestimated compared to a perfectly equivalent direct taxation. If this underestimation is pronounced enough, some buyers may hold the illusionary belief to gain from redistribution. This illusionary belief may then induce them to vote for redistribution when it is financed by indirect taxes, but not when it is financed by direct taxes.

In the following, we argue that our design is appropriate to investigate whether (i) fiscal illusion exists, (ii) tax framing causes fiscal illusion, and (iii) fiscal illusion distorts fiscal choices in a referendum.

(i) To investigate whether there is fiscal illusion at all, we have to measure a subject’s actual perception of the tax burden and be able to determine to what extent this perception is erroneous. Subjects are asked to provide expectations about market prices and quantities in case of rejection and acceptance of the referendum. From these expectations the expected change in net income can be calculated (see section 4.2 for details). As will be shown below, we do observe systematic differences between perceived and actual changes in net income in the two tax frames. We propose fiscal illusion, i.e. a cognitive limitation to account for these differences. However, standard economic theory excludes such cognitive limitations by assumption. In fact, standard economic theory relies on three canonical principles to generate predictions: rationality, self-interest, and equilibrium. To be able to clearly isolate the causes and consequences of fiscal illusion, we have to create an environment in which the other two tenets of economics hold.

(ii) To isolate tax framing as a cause of fiscal illusion we need to implement a ceteris paribus treatment variation in which only the representation but not the rent distribution is varied. For the two types of taxes to produce identical economic outcomes, the tax liability side equivalence must hold. For this equivalence to hold, markets must equilibrate. As a
consequence, we chose an experimental market institution that rapidly converges to competitive equilibrium outcomes.

(iii) To isolate the consequences of fiscal illusion, i.e. to be able to show that fiscal illusion distorts voting decisions, we have to eliminate other factors which may also distort voting decisions as far as possible. The design was chosen to foster voting consistent with material self-interest. This consistency may fail to hold for two reasons. First, voters may not vote consistent with material self-interest even though material self-interest is their only motive. For example, voters may cast their votes randomly because they may believe that their individual vote will not affect the outcome of the referendum. This type of behavior is more probable if the electorate is large. To minimize the incidence of this type of random voting, we chose a relatively small electorate. Second, voters may not vote consistent with material self-interest because they have non self-interested motives. Suppose, for example, that the pre-proposal distribution of rents is such that buyers earn higher market incomes than sellers. If a buyer is inequality averse he or she may vote for redistribution in order to reduce income inequality. To avoid this type of confound, we use automated sellers instead of human subjects in the role of sellers. These automated sellers trade according to pre-specified and commonly known rules on the market (see section 3.2 for details), but they do not vote.

Rapid equilibration of the experimental market is not only important to isolate tax framing as a cause of fiscal illusion as explained in (ii) above. It is also important to unambiguously identify the consequences of fiscal illusion. We explained earlier that buyers lose net income in equilibrium if the proposal passes. This is not necessarily the case if markets do not equilibrate. Suppose, for example, that market prices adjust very slowly to the indirect tax. Suppose a buyer correctly anticipates such a disequilibrium price path and approves of the proposal. This voting decision is not the result of fiscal illusion (no misperception) but of a market in disequilibrium. To avoid this type of confound we chose a market institution which is known to equilibrate quickly.

3.2 Procedures and parameters

Subjects first participate in a competitive experimental market where they earn market income (see Phase 0 in figure 2). Subjects then go through 3 phases. Such a phase consists of two elements. The first element is a referendum on a proposal to tax subsequent market transactions and to redistribute the revenues from this tax to market participants. The second
element of a phase is a series of 15 market periods in which subjects earn market incomes, and receive income from redistributed tax revenues if the proposal has been accepted. If the proposal has been rejected the same conditions as in phase 0 prevail.

**Figure 2:** Sequence of voting and trading

![Sequence of voting and trading](image)

The phases exclusively differ by the way the transaction tax is levied, and as a consequence participants vote on referenda with a different wording in different phases. In phases 1 and 2, participants vote on a referendum to finance redistribution by a direct tax, whereas in phase 3 they vote on a referendum to finance redistribution by an indirect tax.

**Experimental market**

The competitive experimental market is a computerized two-sided auction with 4 human buyers and 2 automated sellers (see instructions in appendix A). Each of the 4 buyers can buy at most two units having a value of 140 points each, and total supply by the 2 automated sellers is 12 units (see figure 1 and table 1). The equilibrium quantity is \( q^* = 8 \) units. The equilibrium price is \( p^* \in [100, 105] \) points in phase 0 as well as in phases 1 to 3 if the proposal is rejected. If the proposal passes, a transaction tax of 25 points is levied on the buyers (in phases 1 and 2) or on the sellers (in phase 3). During the experiment all payoffs are denoted in points. At the end of the experiment point incomes are converted into US$ at the exchange rate of $0.05 per 10 points.

In both treatments, buyers bear the full tax burden and lose net income in equilibrium. The following calculation shows that this is indeed the case, using TT as an example (see also table 1). Suppose the equilibrium price is \( p^* = 100 \) (105) points. In this case, a buyer’s net income is 80 (70) points if the proposal is rejected. If it is accepted, market income falls by the amount of the transaction tax of 25 points on each of the two units to 30 (20) points. The redistribution income is obtained by dividing the total tax revenue of 200 (= 8 units times 25
points) by the number of agents in the market (6 = 2 sellers plus 4 buyers). As a consequence, a buyer’s net income falls from 80 (70) points to 63.33 (53.33) points per period if the proposal is accepted. Therefore, the acceptance of the proposal induces a net income loss of 10 to 33 percent for each buyer.

**Table 1:** Overview over parameters in the Transparent Treatment (TT) and the Intransparent Treatment (IT)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Transparent Treatment (TT)</th>
<th>Intransparent Treatment (IT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of buyers ((n))</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Number of automated sellers ((m))</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Number of market periods ((t = 1, \ldots, T))</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Equilibrium quantity ((q^*)) (\text{if proposal accepted and if rejected})</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Equilibrium price ((p^*)) (\text{before proposal and if proposal rejected})</td>
<td>100 to 105</td>
<td>100 to 105</td>
</tr>
<tr>
<td>Transaction tax ((\text{Tax})) (\text{if proposal accepted})</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Transaction tax levied on</td>
<td>Buyers</td>
<td>Sellers</td>
</tr>
<tr>
<td>Equilibrium price if proposal accepted</td>
<td>100 to 105</td>
<td>125 to 130</td>
</tr>
<tr>
<td>Equilibrium tax burden (\text{per period } t) (\text{on each buyer } i \text{ if proposal accepted})</td>
<td>-50</td>
<td>-50</td>
</tr>
<tr>
<td>Equilibrium redistribution income ([R_i(t)]) (\text{per period } t) (\text{for each buyer } i \text{ if proposal accepted})</td>
<td>+200 / 6</td>
<td>+200 / 6</td>
</tr>
<tr>
<td>Equilibrium net tax burden ((\Delta E_i[Inc(t)])) (\text{per period } t) (\text{on each buyer } i \text{ if proposal accepted})</td>
<td>-16.66 (= -50 + 200 / 6)</td>
<td>-16.66 (= -50 + 200 / 6)</td>
</tr>
</tbody>
</table>

In the intransparent treatment (IT), the indirect tax causes a uniform upward shift of the induced supply schedule. Since demand is perfectly inelastic, the equilibrium quantity remains at \(q^* = 8\) units and the equilibrium price increases by 25 points to \(p^*(\text{IT} | \text{tax}) \in [125, 130]\) (see right part of figure 1). It is important to note that the two treatments are perfectly equivalent in economic terms. In particular, the acceptance of the proposal induces the same net tax burden in both treatments (see table 1).

The competitive market we use is a uniform price sealed bid/offer auction. In this auction, human buyers can submit integer numbered bids for each unit they can buy. The

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3 See e.g. Smith et al. (1982) for a detailed description of the sealed bid/offer auction. We did not use the double auction (which is well-known for its capacity to generate competitive equilibria) because it is very difficult to simulate buyers in this auction.
automated sellers are programmed to submit offers for each unit equal to the true unit costs. After the decision time\(^4\) has elapsed, the bids are ordered from highest to lowest, and the offers from lowest to highest. The first \(q\) bids higher or equal than the first \(q\) offers are accepted. If bids are tied priority is given randomly. The uniform market-clearing price is set equal to the \(q^{th}\) (= last accepted) bid, and the number of transactions is \(q\). Note that the instructions (see appendix A) provide subjects with full information on all market parameters, the programming of the automated sellers, and the price and quantity determination rule.

**Proposal and voting rules**

At the beginning of each of the 3 main phases, buyers vote on a proposal (see figure 2). Subjects are handed out instructions explaining the proposal and the rules of the referendum in great detail (see appendix B). The proposal is to tax market transactions and redistribute tax revenues equally among all market participants, i.e. among buyers and sellers. Only the 4 buyers can vote, and the referendum is anonymous. Each voter either approves or disapproves, abstentions are not possible. If at least two voters approve of the proposal, the redistribution scheme is implemented for the following 15 market periods. If the proposal is rejected, trading goes on as in phase 0. Subjects are given 12 minutes to study the instructions and to think about the proposal. Meanwhile, subjects can access data from the past 15 trading periods. The computer shows individual information (unit values, individual purchases, accumulated and per period earnings) as well as information on the market as a whole (market quantity and price for each period).

Before subjects cast their votes in the computerized ballot, they have to answer correctly several control questions. In particular, they have to calculate their individual redistribution income and their tax payment in case the proposal passes assuming that the equilibrium quantity prevails (see appendix C). Subjects have to report their expectations about market prices and quantities for the subsequent periods 1, 4, 7, 10, and 13. Subjects report their expectations before the results of the referendum are announced, and they do so for both possible outcomes of the referendum. Expectations are motivated by monetary incentives.\(^5\)

\(^4\) Decision time was gradually reduced from 60 seconds (first market period) to 25 seconds (last market period).

\(^5\) A subject receives 30 points of additional earnings, if the expected price does not deviate by more than 5 points from the actual price in the corresponding period. In addition, 30 points are paid if the expected quantity is equal to the actually traded quantity.
4. Results

Eleven laboratory markets were conducted on April 26 and 27, 2000 at the Economic Science Laboratory at the University of Arizona. Participants were 44 non-economics students from the University of Arizona. The average subject earned $32 (including a $7 show-up fee) within approximately 2.5 hours. The experiments were programmed using the software zTree (Fischbacher 1998).

4.1 Tax liability side equivalence and tax framing

With respect to the aggregate-level we state the following main result:

Result R1 The experimental market equilibrates quickly and reliably. Equilibration prevails irrespective of tax framing, i.e. the tax liability side equivalence holds. Therefore, redistribution caused considerable net income losses.

In phase 0 the parameters represented by $D_0$ and $S_0$ in figure 1 were implemented. The corresponding equilibrium price prediction is in the range from 100 to 105. Figure 3 shows the per-period prices averaged across all 11 markets. As can be seen, the auction mechanism has a very strong capacity to produce competitive equilibria already in early periods of phase 0. 88 percent of transaction prices fell within the equilibrium price range. Market efficiency in a period is measured by the sum of rents divided by the sum of equilibrium rents. The average market efficiency in phase 0 was 98 percent.

Figure 3 shows that average transaction prices almost always remained in the predicted range in phases 1 and 2 irrespective of whether the proposal to finance redistribution by direct taxation was accepted or rejected. The proposal was accepted in 4 out of 11 markets in phase 1 and in 1 out of 11 markets in phase 2. In phase 3, equilibrium prices rise by 25 points to the range of 125 to 130 if the proposal to finance redistribution by indirect taxation is accepted. This was the case in 6 out of 11 markets. In these cases average transaction prices immediately and almost perfectly adjusted to the predicted range and remained in that range throughout phase 3 (see figure 3).

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6 Market 10 is an outlier in the sense that this market did not converge nicely. If this market is excluded, 99% of all periods were in equilibrium.
Overall, equilibrium prices and quantities prevailed in almost all periods, irrespective of whether taxation was direct or indirect. In markets in which a direct tax was levied, 100 percent of transactions were traded at the equilibrium price, and average efficiency was 99 percent. In markets in which an indirect tax was levied, 96 percent of all transactions were traded at equilibrium prices, and average efficiency was 89 percent.

To test whether the tax liability side equivalence holds, we compare the 3 markets that experienced a direct tax as well as an indirect tax. The net incomes of these 12 subjects were not significantly different in the two cases according to a Wilcoxon signed rank test ($p = 0.2$). We conclude that the tax liability side equivalence in fact holds. As a consequence, the two treatments indeed are different representations of the same decision situation.

**Figure 3:** Average transaction prices (11 markets per phase)

Since markets equilibrated almost perfectly irrespective of tax framing, the acceptance of the tax-redistribution scheme in fact resulted in considerable net income losses in both treatments. Redistribution caused a loss of 18 percent of net income to the average buyer in the transparent treatment TT, and a loss of 22 percent in the intransparent treatment IT. These percentages are calculated in reference to the average income in no-tax markets.

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7 This finding is in line with Kachelmeier et al. (1994), and Borck et al. (2000) who show that the tax liability side equivalence holds in a competitive experimental market. Kerschbamer and Kirchsteiger (2000) show that tax liability side equivalence may fail to hold in a bargaining context.
4.2 Perception of the tax burden

Our main finding with respect to the perception of the tax burden is stated in result R2.

**Result R2**  Misperception of the tax burden is widespread. Misperception of the tax burden is much more pronounced and more prevalent in the intransparent treatment than in the transparent treatment. Therefore, tax framing causes fiscal illusion.

To provide support for result R2, we calculate a measure of misperception of the net tax burden from individual expectation data. Subjects report expectations on market prices and quantities for periods $t = 1, 4, 7, 10$ and $13$ of the current phase in case the proposal is accepted and in case it is rejected. From these data, we calculate for each subject a measure of the perceived net tax burden, i.e. the expected change in net income from the acceptance of the proposal. We use the following notation:

- $e_p(t|j)$: Subject $i$’s price expectation for period $t$, provided the proposal is accepted ($j = 1$), or rejected ($j = 0$).
- $e_q(t|j)$: Subject $i$’s expectation about market quantity in period $t$, provided the proposal is accepted or rejected.
- $(1/n) e_q(t|j)$: Measure of subject $i$’s expectation about quantity bought by buyer $i$ in period $t$, provided the proposal is accepted or rejected. $n$ : number of buyers ($= 4$). \(^8\)
- $Tax$: Per unit transaction tax of 25 points.
- $R_i(t)$: Measure of subject $i$’s expected redistribution income.
- $R_i(t) = Tax \cdot e_q(t|1) \cdot (1/(n+m))$. $m$: number of sellers ($= 2$).
- $\Delta E_i[Inc(t)]$: Measure of subject $i$’s expected change in net income in period $t$ from implementing the proposal.

In the transparent treatment TT, the expected change in net income from redistribution in period $t$ for buyer $i$ is

(1)  \[ \Delta E_i[Inc(t)|TT] = (1/n)[ e_p(t|1) \cdot e_q(t|1) - e_p(t|0) \cdot e_q(t|0)] + R_i(t) - (1/n) e_q(t|1) \cdot Tax . \]

The corresponding expression for the intransparent treatment IT is

(2)  \[ \Delta E_i[Inc(t)|IT] = (1/n)[ e_p(t|1) \cdot e_q(t|1) - e_p(t|0) \cdot e_q(t|0)] + R_i(t) . \]

\(^8\) Subject $i$’s indication of the expected market price in a particular period $e_p(t|j)$ is a perfect measure of the price subject $i$ expects to pay since all subjects pay the same price for all transactions in each period (uniform price auction). Even though all subjects are symmetric by design, subjects may trade different quantities (in disequilibrium). The measure $(1/n) e_q(t|j)$ therefore is an imperfect proxy for individual quantity expectations.
According to (1) and (2), the expected net tax burden consists of three elements: the change in expected market income, the expected redistribution income, and (in TT) of an expected tax payment. From the per-period measures (1) and (2), we calculate for each subject $i$ a measure of the net tax burden over all $T = 15$ periods of the respective phase ($\Delta E_i[Inc(T)]$). To do so, we simply average expected net income changes over reported periods.

Suppose a subject expects no change in market income due to direct taxation. In this case, the first term in (1) is equal to zero. That is, the net tax burden in the transparent treatment is the difference of the expected redistribution income $R_i(t)$ and the expected tax payment:

$$\Delta E_i[Inc(T)|TT; p,q = \text{const.}] = [(1/(n+m)) - (1/n)] \cdot e \cdot q(t) \cdot Tax < 0 \quad \text{for } m > 0.$$  

It is easy to see formally that (3) is always negative if $m > 0$. The intuition for this result is that the tax is paid and borne exclusively by the $n$ buyers whereas the tax revenue is redistributed to all $m + n$ market participants, including the $m$ sellers.

Now consider the intransparent treatment IT. Suppose again a subject expects his or her market income to remain unaffected by the tax. In this case, the assumption of constant market income would lure a subject to believe that he or she gains from redistribution:

$$\Delta E_i[Inc(T)|IT, p,q = \text{const.}] = R_i(t) > 0 \quad \text{for } e \cdot q(t) > 0.$$  

Therefore, to correctly perceive that he or she loses from redistribution (i.e. $\Delta E_i[Inc(T)|IT] < 0$), a subject has to perceive that market income falls at least by $R_i(t)$, or that prices rise at least by two thirds of the imposed indirect tax $[= n / (n+m) \cdot Tax]$.  

As will be explained below (see table 2), most subjects failed to perceive that they lose from redistribution in the intransparent treatment IT ($\Delta E_i[Inc(T)|IT] > 0$), but most subjects succeeded to do so in the transparent treatment TT ($\Delta E_i[Inc(T)|TT] < 0$). In fact, the average subject expected to lose $-15\%$ of net income in TT, but to gain $+16\%$ of net income in IT. Since subjects lost income if the proposal was accepted (see section 4.1), the average misperception of the net tax burden was much more pronounced in IT than in TT.

In table 2, subjects are sorted according to the sign of $\Delta E_i[Inc(T)]$ in the 2nd and the 3rd referendum. According to the assumption of full rationality, all subjects correctly perceive that redistribution reduces net income. That is, all 44 observations should be in the lower right cell of table 2. In contrast, only about a third (= 16/44) of subjects correctly perceived the net income loss from redistribution in both framings. Therefore, about two thirds (= 28/44) of
subjects were prone to misperception of the tax burden. However, this misperception was not random but was systematically affected by tax framing. In the transparent treatment, almost 85 percent (= 37/44) of subjects correctly perceived that redistribution reduces net income. In contrast, in the intransparent treatment almost 60 percent of subjects (= 26/44) misperceived the tax burden to such an extent that they expected to gain from redistribution. Of the 28 subjects that in some way misperceived the tax burden in the two proposals, 75 percent (= 21/28) correctly perceived the net income loss in the transparent treatment but failed to do so in the intransparent treatment. We conclude, therefore, that the intransparent tax framing caused massive misperception of the tax burden.

**Table 2:** Expected effect of redistribution on net income in the transparent and intransparent treatment ($n = 44$)

<table>
<thead>
<tr>
<th>Intransparent treatment (3\textsuperscript{rd} referendum)</th>
<th>Higher net income expected</th>
<th>Lower net income expected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher net income expected</td>
<td>5</td>
<td>21</td>
</tr>
<tr>
<td>Lower net income expected</td>
<td>2</td>
<td>16</td>
</tr>
</tbody>
</table>

In principle, tax framing could affect the misperception of the net tax burden through price or quantity expectations [see equations (1) and (2)]. A closer look at individual data reveals that there are no significant treatment effects with respect to quantity expectations $e_{iq}(T|j)$ ($p = 0.21$, according to a Wilcoxon signed-rank test). In fact, the lions share of misperception stems from underestimation of the effect of the indirect tax on prices in IT. A Wilcoxon signed-rank shows that price expectations deviated stronger from equilibrium in IT than in TT ($p = 0.006$). For example, a large majority of 63 percent expected prices below the equilibrium level [$e_{ip}(T|1) < 125$], and 36 percent of subjects believed that the tax would not be shifted to them at all IT.\(^9\)

\(^9\) On the other hand, 32 percent of subjects correctly expected equilibrium prices of 125 to 130 to prevail in IT (59 percent in TT), given the indirect tax is introduced. This finding indicates that the instructions were clear and information was sufficient to correctly perceive the net tax burden.
4.3 Voting decisions

The previous sections have shown that tax framing caused systematic misperception of the tax burden. This section analyzes whether this misperception translated into distorted voting decisions. Our main finding with respect to the consequences of fiscal illusion is stated in result R3.

**Result R3**  *The perception of the net tax burden significantly affects voting decisions. In particular, tax framing causes voters to reject the transparent proposal, but to accept the intransparent proposal.*

Support for result R3 comes from table 3. This table classifies subjects according to their voting decisions in the 2\textsuperscript{nd} and 3\textsuperscript{rd} referendum. In the intransparent referendum, 19 voted for redistribution. However, more than two thirds (= 13/19) of these subjects voted against redistribution in the transparent treatment. That is, two thirds of the voters who “got it wrong” in the intransparent treatment “got it right” in the transparent treatment. However, this cannot be taken as conclusive evidence that fiscal illusion causes distorted fiscal choices. The reason is that voters may have voted randomly. To be able to clearly isolate fiscal illusion as a cause of distorted voting, voting decisions should be consistent with perceptions of the net tax burden. Consistency requires those who expect to gain from redistribution to vote for the redistribution proposal, and those who expect to lose to vote against it.

**Table 3:** Voting decisions in the transparent and intransparent treatment, $n = 44$

<table>
<thead>
<tr>
<th>Intransparent Treatment (3\textsuperscript{rd} referendum)</th>
<th>Transparent treatment (2\textsuperscript{nd} referendum)</th>
</tr>
</thead>
<tbody>
<tr>
<td># YES 6 [0]</td>
<td># NO 13 [9]</td>
</tr>
<tr>
<td># NO 4 [0]</td>
<td># NO 21 [12]</td>
</tr>
</tbody>
</table>

The data shows that about two thirds of subjects voted consistent with their perception of the net tax burden in each phase.\textsuperscript{10} If we consider the 2\textsuperscript{nd} and the 3\textsuperscript{rd} referendum jointly, we observe 21 subjects who voted consistent with their perception in both referenda (see table 3, numbers in brackets). If we consider only these consistent voters, we find that 100 percent (=

\textsuperscript{10} Of the 44 subjects, 33, 29, and 29 vote consistent with perceptions in phases 1, 2, and 3 respectively.
9/9) of those who approved in the intransparent treatment (i.e. “got it wrong”) disapproved in the transparent treatment (i.e. “got it right”). Therefore, more than 40 percent (= 9/21) of voters approved of the tax-redistribution proposal in the intransparent treatment because they were prone to fiscal illusion. A McNemar Change test reveals a highly significant treatment effect \( p = 0.004 \). We conclude that fiscal illusion significantly distorts voting decisions.

Note that our test of Mill’s fiscal illusion hypothesis is very restrictive. We exclusively consider those voters who voted rationally, given their perception (i.e. consistent voters). As explained above, most voters were rational in this sense, but most voters also misperceived the effect of redistribution when financed by indirect taxes. Interestingly, this individual-level misperception does not translate into aggregate-level “irrational” (i.e. inefficient, disequilibrium) outcomes in competitive markets. As shown in section 4.1, experimental markets converged quickly and reliably to the equilibrium predictions irrespective of tax framing and regardless of whether the redistribution proposal passed. In contrast, individual-level misperception does translate into aggregate-level “irrational” (i.e. excessive redistribution) outcomes in voting. For example, the redistribution proposal was accepted in 6 out of 11 referenda in the intransparent treatment. Our results, therefore, lend support to the notion that competitive markets are much more robust with respect to individual-level irrationality (Gode and Sunder 1993) than democratic referenda.

### 4.4 Anchoring and learning

The previous sections have shown that fiscal illusion exists, is caused by intransparent indirect taxation, and causes excessive redistribution in about half of the intransparently financed referenda. However, one may wonder whether these results are affected by the fact that our design relies on a within-subject comparison of behavior. That is, we observe whether the same subjects behave differently when exposed to the two tax frames. In a within-subjects design, the subjects necessarily are exposed to the two treatments in a particular sequence. To repeat, the sequencing of treatments was as follows (see figure 2): Phase 0, TT, TT, IT.

This sequencing may affect the results in one of two opposing directions. According to a ‘learning’ perspective, subjects do not take equilibrium decisions immediately, but learn to behave optimally over time. Therefore, behavior should be more in line with rationality predictions in later periods of the experiment than in earlier periods. Since the experimental market and the voting mechanism were held constant throughout the experiment, behavior in
IT should be more in line with rationality predictions than behavior in TT. As shown above, this is clearly not the case. From this perspective, our findings may appear to be even more convincing since we obtain such strong results despite the sequencing of treatments. However, from an ‘anchoring’ perspective, our strong findings may be thought to have resulted because of the sequencing of treatments. This perspective stipulates that subjects’ expectations have been ‘anchored’ on the price of 100 because subjects have experienced extended phases (45 periods in all) in which the same equilibrium prices prevailed.

To test whether our within-subjects design affected our conclusions one way or another, we ran a control treatment (3 markets, 12 subjects) with exactly the same parameters as described in section 3. This control treatment has the following sequencing of phases (compare with figure 2): 15 market periods (phase 0), 1st referendum (intransparent treatment) followed by 15 market periods (phase 1). This control treatment allows to compare the perception of the net tax burden and of voting decisions across subjects, i.e. when different subjects are provided the same opportunities to learn and anchor expectations.

Table 4 shows expected changes in net income in the 1st referendum in TT (n = 44), and the 1st referendum in IT (n = 12). As can be seen, almost 60 percent (= 7/12) misperceive the tax burden to such an extent that they expect to gain from redistribution in IT, whereas more than 80 percent (= 36/44) expect to lose from redistribution in TT. A Fisher exact test reveals that this treatment effect is highly significant (p = 0.000). The pronounced misperception of the net tax burden again translates into distorted voting decisions. In IT, more than 80 percent (= 5/6) of consistent voters approve of redistribution, whereas in TT more than 80 percent (= 27/33) of consistent voters disapprove. A Fisher exact test shows that tax framing had a highly significant effect on voting decisions (p = 0.004). We conclude that our main findings are robust with respect to the type (i.e. within-subjects vs. across-subjects) of comparison.

Table 4: Expected effect of redistribution on net income in the transparent (n = 44) and intransparent treatment (n = 44): Across-subjects comparison.

<table>
<thead>
<tr>
<th></th>
<th>Intransparent treatment (1st referendum)</th>
<th>Transparent treatment (1st referendum)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher net income</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>expected</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower net income</td>
<td>5</td>
<td>36</td>
</tr>
<tr>
<td>expected</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5. **Summary and conclusion**

The idea that constituents are prone to fiscal illusion is old and potentially important. For example, John Stuart Mill (1848) suggested indirect taxation as a cause, and distorted fiscal choices leading to excessive government spending as a consequence of fiscal illusion. However, the idea is also empirically highly controversial. The reason is that it appears to be difficult, if not impossible, to test Mill’s hypothesis with field data. As a consequence, the empirical literature on fiscal illusion failed to provide unambiguous evidence for the existence and relevance of fiscal illusion. There are two reasons for this failure. First, field studies are frequently beset with measurement problems, and a misperception is particularly difficult to measure. The second reason is more fundamental, and methodological in nature. There are three canonical principles in standard economics: rationality, self-interest and equilibrium. To clearly isolate fiscal illusion (which is a violation of the rationality assumption) one has to investigate an environment in which the other two principles apply. In naturally occurring economies, however, one usually cannot establish beyond doubt whether these principles fully apply. The ability to control preferences and information conditions, and to create simple environments in which these principles demonstrably hold is a key advantage of the experimental approach to fiscal illusion.

We claim that our experimental study meets the requirements to isolate the causes and consequences of fiscal illusion. To test for the existence of fiscal illusion, we elicit taxpayers’ estimates of the tax burden and compare these perceptions to the actual tax burden. To test whether tax framing causes fiscal illusion, we implement two treatments which exclusively differ with respect to direct vs. indirect taxation. In particular, the two tax regimes are identical with respect to efficiency and rent distribution. Our main hypothesis is that the tax burden resulting from indirect taxation is cognitively more difficult to perceive than the one from direct taxation because indirect taxes are incorporated in market prices. To investigate the consequences of fiscal illusion, we observe whether a misperception of the net tax burden translates into distorted voting decisions. In both tax frames, subjects vote on a proposal to redistribute tax revenues. In both treatments subjects are given sufficient information to perceive that they lose money from redistribution.
Our results clearly show that fiscal illusion exists. We find that about two thirds of subjects severely misperceive the tax burden. Moreover, the results show that tax framing causes fiscal illusion since the misperception of the tax burden is much more pronounced and prevalent with indirect than with direct taxation. Whereas almost 85 percent of the subjects correctly perceive to lose from redistribution when financed by a direct tax, almost 60 percent of subjects hold the illusionary belief to gain from redistribution when it is financed by an indirect tax. With respect to the consequences of fiscal illusion our results show that fiscal illusion indeed distorts fiscal choices and may lead to excessive redistribution. The intransparently financed redistribution proposal passes in about half of the referenda. In these cases, fiscal illusion in fact causes considerable income losses for voters.

Our study for the first time provides unambiguous evidence on fiscal illusion. To be able to isolate its possible causes and consequences, we created a simple, highly stylized decision environment. Despite the clear results of our study, we believe that further research on the causes and consequences of fiscal illusion in more complex environments is needed.

With respect to the causes of fiscal illusion, we show that indirect taxation is cognitively intransparent because the tax is incorporated (“hidden”) in the product price. However, the degree to which indirect taxes are cognitively intransparent in practice may depend on the particular “framing” of indirect taxes. For example, the tax payment is stated separately on receipts in some cases (e.g. VAT), but not in other cases (e.g. excise taxes).

With respect to the consequences of fiscal illusion, our design was chosen to distinguish fiscal illusion from other explanations of distorted voting. For example, our design minimizes the possibility that a concern for fair distribution affects voting decisions. However, fairness considerations may be important in voting. They may interact with fiscal illusion, and may exacerbate or mitigate its effects. Similarly, the long-run effects of fiscal illusion may depend on opportunities to communicate (see Frey and Bohnet 1994) and to learn. For example, we hypothesize that subjects would eventually learn to overcome the illusion in our experiment if they were repeatedly exposed to the intransparent treatment. The reason is that our experimental environment is simple and stable, and the information feedback we provide is rich and unambiguous. In natural, much more noisy environments it may, however, be much more difficult to overcome fiscal illusion.

This study investigated whether fiscal illusion translates into distorted fiscal choices by means of a (direct democratic) referendum. This is a natural choice since it is the simplest democratic mechanism, and it is in fact used in some places to determine fiscal choices (e.g.
Switzerland and some U.S. states, see Butler and Ranney 1994). However, fiscal choices are frequently made indirectly (representative democracy). It is an open empirical question whether the tendency of fiscal illusion to distort fiscal choices is exacerbated or mitigated in representative democracy (however, see Matsusaka 1995). The referendum in our design provided a direct connection of taxing and spending decisions. The separation of these decisions which is characteristic of most representative democracies may promote the effects of fiscal illusion and appears to contribute to increased spending (Winer 1983).

In our view, our results raise serious doubts about the rationality of fiscal choices involving indirect taxation. Since indirect taxation (in the guise of value-added taxes, energy taxes, social security contributions etc.) is widespread and of growing importance in modern democracies, our findings are of great potential importance. In terms of policy advice, our findings support the venerable presumption that a transparent tax structure advances the rationality of political decisions.
References


Appendix A: Instructions on the auction

General Instructions for Participants

You are now taking part in an economics experiment. The purpose of the experiment is to analyze decision behavior in markets. You will be paid US $ 7 for showing up on time. If you carefully read the instructions and follow the rules you can earn additional money. This $ 7 and all other money earned during the experiment will be paid to you in cash immediately after the experiment. In this experiment you earn points. These points will be exchanged for US $ according to the following exchange rate:

\[ 10 \text{ Points} = 5 \text{ Cents (}$0.05) \]

During the experiment we ask that you do not speak to other participants. If you have a question, please ask us. We will gladly answer your questions individually. It is very important that you follow this rule. Otherwise the results of the experiment will be of no value from a scientific perspective.

The following is a short description of the experiment; detailed instructions will come later. You are now participating in a market experiment. In this market there are buyers and sellers who trade units of some commodity. You earn money by trading. How much you earn depends on your decisions and the decisions of others. The experiment consists of two practice periods and then a number of trading periods. In the practice periods you do not earn money but you should take these periods seriously since you will gain valuable experience for the paid trading periods.

Detailed Instructions for Buyers

In this experiment each participant is a buyer. You will buy units from automated sellers. These automated sellers will sell to you according to the rules of the market. There are several markets running at the same time during the experiment. What is happening on other markets is irrelevant for your market and hence for your earnings. In your market there are 4 buyers who can buy units from sellers in each of the trading periods.

What participants can do:

As a buyer you can submit ‘bids’ to buy from the sellers during a trading period. A bid is the maximum price that you are willing to pay for a unit. Each buyer will be assigned a certain number of ‘unit values’. Each buyer can at most buy as many units as the number of unit values assigned. You can submit a bid for each unit for which you have a value.

In every trading period, the sellers submit ‘offers’ to sell units to the buyers. An offer is the minimum price at which a seller is willing to sell a unit. Each seller will be assigned a certain number of ‘unit costs’. Each seller can at most sell as many units as the number of unit costs assigned.
**How the market works:**
At the end of each trading period the ‘market quantity’ and the ‘market price’ are determined. The market quantity is the total number of units traded in the market. The market price is a uniform price at which all units are traded in the market.

How the **market quantity** is determined:
First, the bids you and other buyers in your market have submitted are collected and ranked *from high to low*. The highest bid is ranked above the 2nd highest bid. The 2nd highest bid is ranked above the 3rd highest bid, and so on. If two or more bids are the same, ranks will be randomly assigned by the computer.
Second, all the sellers’ offers in your market are collected and ranked *from low to high*. The lowest offer is ranked above the 2nd lowest offer. The 2nd lowest offer is ranked above the 3rd lowest offer, and so on.

A first unit is traded if the 1st ranked bid is higher or equal to the 1st ranked offer. A second unit is traded if the 2nd ranked bid is higher or equal to the 2nd ranked offer. This process continues until bids are smaller than offers at a given rank. The total number of units that have been traded when the process stops is the ‘market quantity’.

**Example:**
Assume we collect four bids and four offers in a market period.
The highest bid is 145, the 2nd highest bid is 130, the 3rd highest bid is 110, and the 4th highest bid is 90.
The lowest offer is 60, the 2nd lowest offer is 80, the 3rd lowest offer is 95, and the 4th lowest offer is 105.
A first unit is traded since the highest bid (145) is greater than the lowest offer (60).
A second unit is traded since the 2nd highest bid (130) is greater than the 2nd lowest offer (80).
A third unit is traded since the 3rd highest bid (110) is greater than the 3rd lowest offer (95).
The process stops after the third trade since the 4th highest bid (90) falls below the 4th lowest offer (105). Hence, the market quantity is equal to 3 units.

**How the market price** is determined:
The market price is set at the bid for the last unit that has been traded before the process stopped. All units are traded at that market price.
In the example above three units have been traded. The bid for the last unit that has been traded is 110. Hence the market price is set equal to 110. It is important to note that all units in the market are traded at this same price of 110.

**How many units do you trade individually:**
The number of units you buy is determined by the number of bids you have submitted *above* the market price.
You do not buy the units for which you have submitted bids *below* the market price. You may or may not buy if your bid is exactly at the market price (your bid may randomly happen to be ranked below another bid at the market price so that the offer at that rank exceeds your bid). If you do not submit a bid on a unit (this is equivalent to submit a bid of 0), you never buy that unit.
The number of units the sellers sell is determined by the number of offers at or below the market price. The sellers do not sell the units they have offered above the market price.

**How your profit is computed:**

All participants can earn profits only if they buy units.

Your profit as a **buyer** is computed as follows:

\[
\text{Profit} = \text{unit value} - \text{market price}
\]

Note that if you buy a unit you will pay less than what you have bid for that unit unless your bid is at the market price. In our example, suppose that you submitted the bid of 130 for a unit you value at 150. This bid is above the market price of 110. Since you buy this unit at a market price of 110 your profit will be \(150 - 110 = 40\).

The profit of a **seller** is computed as follows:

\[
\text{Profit} = \text{market price} - \text{unit cost}
\]

Hence, sellers receive more than they have offered for their sold units unless the offer is at the market price.

**How the automated sellers make their offers:**

At any time the sellers follow two rules in offering:

1. ‘Submit an offer for each unit assigned’
   
   This means that the sellers will submit an offer for every unit they have been assigned a unit cost.

2. ‘Submit offers equal to the cost of a unit’
   
   This means that an offer to sell a unit is always exactly equal to the unit cost. Since the sellers do not sell the units that they have offered above the market price, a seller never trades at a loss.

**How is the trade presented on the computer screen?**

In each trading period a Decision Screen appears (Figure 1). At the end of each period an Outcome Screen appears (Figure 2). After 15 trading periods a History of Results appears (Figure 3). *All the numbers in the figures in the instructions serve illustrative purposes only. Actual numbers may be different.*
In the **uppermost area** of the Decision Screen on the left side you see the number of the current trading period (here: 2) and the total amount of trading periods (here: 15). Each trading period ends after a predefined **time limit**. The remaining time within a period is seen in the uppermost area to the right (here: 19 Seconds). In the beginning of the experiment, the available time for trading is generous and will be continuously shortened afterwards.

The **column in the middle** shows your values and your current bids for the units. In this example the buyer has values for two units. Hence, this buyer can buy two units at most. For this buyer the first unit has a value of 150. The second unit has a value of 140. Right under your value of the unit you see your current bid for that unit.

The **input field on the right** serves to enter your bids. To enter a bid you click with the mouse on the field labeled ‘Your Bid’ and type in a number. To submit that bid you have to click on the ‘Submit’ button.

In our example this buyer has already submitted a bid of 130 on his first unit. Consequently, this number is shown right below the value of the first unit. During the trading period the buyer can change his or her current bid on a unit. This buyer has already typed in a number to the input field of the 1st unit. Pressing ‘Submit’ will let appear a message box asking ‘Do you want to replace your current bid?’ Confirming by clicking ‘Yes’ will change your current bid.
Rules for bidding

There are three important rules that you have to follow in bidding:

1. ‘Submit bids in the order of the units’
   You have to bid in the order of units. If you have two units this means that you have to submit a bid on your 1st unit before you can submit a bid on your 2nd unit.

2. The ‘Improvement-Rule’:
   A bid for a unit with a low value may not be above the current bid for a unit with a high value. If you have two units your bid on the 2nd unit may not be above your current bid on the 1st unit. In the example of Figure 1, the current bid on the first unit is 130. In this situation if the buyer wishes to bid on the 2nd unit his or her bid may not be higher than 130.

3. ‘Trading at no Loss’
   You may not submit a bid above your unit value. In our example of Figure 1, the buyer’s bid for the first unit must not be above 150. The bid for the 2nd unit must not be above 130.

If you violate any of these rules, a message box appears. You make this message disappear by pressing the ‘OK’ button. You can continue trading only after pressing the ‘OK’ button.

The Outcome Screen (Figure 2) appears at the end of the current trading period.

Figure 2: Outcome Screen

<table>
<thead>
<tr>
<th>Period</th>
<th>2 out of 15</th>
<th>Remaining time (sec.): 15</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Your Value</td>
<td>Your Bid</td>
</tr>
<tr>
<td>1st Unit</td>
<td>150</td>
<td>130</td>
</tr>
<tr>
<td>2nd Unit</td>
<td>140</td>
<td>0</td>
</tr>
</tbody>
</table>

The uppermost area of this screen appears same as the Decision Screen.

In the table below, you find your value, your bid, the market price, and your per-unit profit from buying each unit. If you have not bought a unit the per-unit profit is 0.

The three lines under the table show the total number of units traded in the market (Market Quantity), the number of units that you have bought (Your Quantity), and the sum over your per-unit profits (Your Period Profit).
The **History of Results** (Figure 3) shows the results of a trading phase. A phase consists of 15 trading periods. The field to the top right displays your unit values. In the table under that you find the market price, the market quantity, your quantity, and, finally, your profit for each of the periods in the past trading phase. Actual numbers will replace the ‘xx’ in real trading. The example of Figures 1 and 2 is continued in Figure 3.

The row under the table shows **Your Total Profit** on all paid periods within this phase. Your Total Profit is computed as the sum of your period profits. The periods labeled as ‘Trial’ are not considered in the computation of the total profit.
Information on unit values and unit costs for the 1st trading phase:
The following table lists the buyers’ unit values and the sellers’ unit costs in your market. **Important:** These numbers are not hypothetical anymore. These numbers are valid for the following 2 practice and 15 trading periods. Note that every buyer has the same value for two units each. The values and costs will be the same in each of the following 2 practice and 15 trading periods.

<table>
<thead>
<tr>
<th>Buyer ID</th>
<th>Unit Values</th>
<th>Unit Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>140</td>
<td>85</td>
</tr>
<tr>
<td>2</td>
<td>140</td>
<td>85</td>
</tr>
<tr>
<td>3</td>
<td>140</td>
<td>90</td>
</tr>
<tr>
<td>4</td>
<td>140</td>
<td>90</td>
</tr>
<tr>
<td>1</td>
<td>140</td>
<td>95</td>
</tr>
<tr>
<td>2</td>
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<td>95</td>
</tr>
<tr>
<td>3</td>
<td>140</td>
<td>100</td>
</tr>
<tr>
<td>4</td>
<td>140</td>
<td>100</td>
</tr>
</tbody>
</table>

If you now have questions, please, raise your hand and wait until an experimenter will come by to answer your question individually.
Appendix B: Instructions on the Proposal

Below we reproduce instructions for the transparent treatment TT and in brackets [] for the intransparent treatment IT.

Proposal

You and 3 (three) other buyers will now vote on a project. If at least 2 buyers approve of the project (i.e. vote “yes”), it is accepted. Otherwise it is rejected. All participants will be immediately informed of the outcome of the voting. However, none of the other participants will be informed about your own decision.

If the project is rejected, we will continue in exactly the same way as before for another 15 trading periods. If the project is accepted, the conditions explained below will be used for the next 15 trading periods. At the end of the experiment, your profit in points will be paid out in US Dollars according to the exchange rate given in the instructions.

What the project is about:
This proposed project carries certain costs and benefits to you. Now, we will discuss in detail the costs and benefits for you. Under the rules of the proposed project, the buyers [sellers] will pay a tax on each unit that they buy [sell]. Additionally, you will receive revenues depending on the total number of units that are bought [sold] in the market. Here is how the tax and the revenues will be calculated under the terms of the proposed project:

- You, like all other buyers [The sellers], will pay a tax of 25 points on each unit that you buy [they sell].
- You, like all other buyers, will receive a revenue that depends on the total number of units purchased [sold] (= market quantity). In particular, the project generates a total revenue of twenty-five (25) times the number of units purchased [sold].

Your individual share of the revenue generated by the project is the total revenue divided by six:

In sum, your individual revenue from the proposed project is:

\[ \text{Your individual revenue} = \frac{(\text{market quantity} \times 25)}{6} \]
How to compute your profit if the project is accepted:

If the project is accepted, your profit will be your earnings in the market (your unit value minus the market price), minus the tax of 25 points, plus your revenue from the project. To calculate your earnings in the market, take your unit value and subtract the market price, just as in the previous 15 trading periods. From these earnings, you will also subtract a tax of 25 points for each unit you purchased. Finally, at the end of the period, you will add your individual revenue from the project.

Therefore, if the project is accepted, your profit in any period is:

\[
\text{Your profit per period} = \text{unit value} - \text{market price} - \text{tax of 25 points per unit you buy} + \text{individual revenue from the project.}
\]

[Your profit per period = unit value – market price plus your individual revenue from the project.]

Remember: If the project is rejected, your profit is calculated just as before as follows:

\[
\text{Your profit per period} = \text{unit value} - \text{market price}.
\]

Note that whether the project is accepted or rejected, all unit values and unit costs will remain the same (see page 9 of instructions). Furthermore, all the rules that were explained to you previously continue to hold whether the project is approved or rejected.

For example, buyers [sellers] continue to trade at no loss.

Example: Suppose a buyer’s unit value is 150. In the past, this buyer was not allowed to submit a bid above 150. If the project is accepted, this buyer will not be allowed to submit a bid above 125 because of the tax to finance the project.

Example: Suppose a seller’s unit cost is 30. In the past, this seller has submitted an offer to sell this unit at 30. If the project is accepted, this seller will submit an offer of 55 because of the tax to finance the project.

Remember: Under the rules of the proposed project, you pay a tax of 25 points for each unit that you buy. You receive your individual revenue from the project only once per period.

Example: Suppose a seller’s unit cost is 30. In the past, this seller has submitted an offer to sell this unit at 30. If the project is accepted, this seller will submit an offer of 55 because of the tax to finance the project. Remember: You receive your individual revenue from the project only once per period.]
Appendix C: Control questions

(These questions had to be answered before the ballot)

Please answer the following questions now. Wrong answers do not have any consequences. If you have questions, please, raise your hand.

Suppose the proposal will be approved. Suppose, in addition, there will be 8 units traded (Market Quantity = 8).

What is the total revenue from the tax in this case?
What is your individual revenue from the project in this case?

Suppose you buy two units in a period (Your Quantity = 2)
What is the amount of taxes that you pay in this case?
[Suppose a seller sells two units in a period.
What is the amount of taxes that this seller pays in this case?]