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Are Income and Consumption Taxes Ever Really Equivalent? Evidence from a Real-Effort Experiment with Real Goods

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Abstract: The public finance literature demonstrates the equivalence between consumption and labor income (wage) taxes. We construct an environment in which individuals make real labor-leisure choices and spend their earned income on real goods. We use this experimental framework to test whether a labor income tax and an equivalent consumption tax lead to an identical labor-leisure allocation. Despite controlling for subjects' work ability and inherent labor-leisure preferences and not allowing for saving, subjects reduce their labor supply significantly more in response to an income tax than they do in response to an equivalent consumption tax. We discuss the economic implications of a policy shift from an income to a consumption tax.

Keywords: experimental economics, tax equivalence, income tax, consumption tax, behavioral economics.

JEL Codes: C91, H22, H24, H31.

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1 Introduction

Since Hobbes (1651) and continuing with Mill (1871), the question of whether to tax consumption or income has occupied a central place in tax policy debate. In January 2005, President George W. Bush commissioned a panel to provide recommendations that would simplify the existing federal tax code and render it more equitable, efficient and conducive to economic growth (President's Advisory Panel on Tax Reform 2005). The panel considered numerous national sales tax plans to replace the entire income tax system as well as a detailed value added tax program to allow for a reduction in individual and corporate income tax rates. The complexity of replacing the current tax code with a broad-based consumption tax system inhibited the panel from reaching a consensus. Notwithstanding, such a shift remains high on the tax reform agenda.

The classic Haig-Simons definition (according to which income equals consumption plus changes in wealth (savings)) highlights that the major distinction between an income tax (on all income sources) and a consumption tax is the former's taxation of savings. The taxation of savings distorts the taxpayer's intertemporal consumption allocation, an often-invoked argument in favor of shifting to a consumption tax. In a second-best setting, redistributive goals may justify the taxation of savings despite its distortive effects. A long public finance literature beginning with Atkinson and Stiglitz (1976) (AS) addresses the desirability of using commodity taxation for redistributive purposes as a supplement to an optimal labor income (wage) tax. Using Mirrlees' (1971) standard setting, AS show that when preferences over the set of consumption goods are separable from leisure, the optimal commodity tax must be uniform; namely, all consumption goods are subject to the same tax rate. An implication of this pioneering result is that future and present consumption should be taxed at the same rate. In other words, the taxation of savings is undesirable. AS and the subsequent

literature[1] are premised on the equivalence between a wage tax and a consumption tax.[2] In fact, wage taxes can be thought as pre-paid consumption taxes, while consumption taxes like the VAT and retail sales taxes are viewed as post-paid consumption taxes. In the absence of behavioral evidence of any sort, the literature regards these two taxes as equivalent.

In this paper, we offer an experimental test of the equivalence between consumption and wage taxes. We hypothesize that the differential timing in the imposition of these two taxes leads to different labor-leisure choices, thereby violating the equivalence. Wage taxes are collected upon receipt of one's labor market income, while consumption taxes are deferred until one spends this income. A behavioral literature on myopia and present-biased preferences (see, e.g., O'Donoghue and Rabin 1999; Angeletos et al. 2001) suggests that when the rewards from an activity are experienced immediately but the costs are borne later, individuals engage excessively in the activity. Overeating and the widespread phenomenon of credit card debt funded consumption are two outcomes of such myopia. Similarly, we anticipate that individuals will work more when they derive a benefit early on (i.e., earned income) and only later incur a cost (i.e., tax levied on consumption) rather than when the cost is incurred simultaneously with the receipt of the benefit, as in the case of a wage tax.

We test whether the theoretical equivalence between labor income and consumption taxes is upheld or whether our behavioral hypothesis regarding the differential timing of the taxes finds support. We introduce an incentivized, two-stage individual choice problem that requires subjects to allocate their time between leisure and a real-effort task. Their performance at the real-effort task earns them income, which they allocate in the second stage

[1] Deaton (1979) shows that even when labor income tax is restricted to be linear (flat rate cum universal demo grant), separability and homotheticity of preferences render commodity taxation redundant. More recently, Saez (2002) extends the AS framework to allow for preference heterogeneity and Kaplow (2006) demonstrates that commodity taxation may be redundant even when the labor income tax schedule is not set at the optimum.

[2] In a neo-classical framework, any two tax schedules that yield the same choice set for a rational individual should have no impact on individual choice (nor on government fiscal considerations) and hence should be equivalent for tax design. The public finance literature demonstrates the equivalency of several other pairs of tax instruments that are *prima facie* different. Notable examples include social security taxes levied on employees and employers and commodity taxes imposed on producers and consumers.

between two consumption goods. We design equivalent labor income tax (IT) and consumption tax (CT) treatments. In IT, a 50-percent flat wage tax is imposed on earned income. In CT, a 100-percent ad-valorem tax is levied on both consumption goods. Notice that both tax regimes entail a 50-percent erosion in the individual's purchasing power without changing the relative prices of the consumption goods. Controlling for differences in labor market productivity and inherent labor-leisure preferences using pre-tax treatments, we test whether these two equivalent tax regimes in fact lead to identical labor-leisure choices.

Our results reveal that the temporal separation between an individual's labor market allocation and subsequent consumption decisions leads individuals to work longer when faced with a consumption tax than with an equivalent wage tax.[3] This differential labor supply response across tax treatments holds over the entire range of labor market abilities and is persistent over time. This finding bears major implications for tax policy design by establishing a novel argument for shifting to a consumption tax base.

While ours is the first test of the equivalence between an income and a consumption tax, several authors have tested experimentally the equivalence between the economic and statutory incidence of a unit commodity tax (also known as liability side tax equivalence theorem) (see Borck et al. 2001, Kerschbamer and Kirchsteiger (KK) 2000, Riedl and Tyran 2005, Ruffle 2005, and Sausgruber and Tyran 2004). The results from these papers suggest that whether the economic incidence of a unit tax is, in fact, independent of the side of the market that bears the statutory incidence, as the theory predicts, depends on the

[3] Our paper contributes to a recent fast-growing strand in the public finance literature on the misperception of taxes. Krishna and Slemrod (2003) offer a general discussion of the efficiency-enhancing role of various tax frames in the presence of individuals' misperception. Sausgruber and Tyran (2004) demonstrate that buyers systematically underestimate the tax burden of a tax levied on sellers and the consequences of this misperception for preferences for redistribution. Liebman and Zeckhauser (2004) and Feldman and Katuscak (2006) focus on individuals' misperception of the difference between marginal and average tax rates. Chetty et al. (2007) show that posting tax-inclusive prices reduces consumer demand. Our paper also relates to an underdeveloped experimental literature on the responsiveness of labor supply decisions to changes in the income tax system. Sillamaa (1999) shows that a top marginal income tax rate of zero increases work effort. Sutter and Weck-Hannemann (2003) find that tax revenues in a real-effort experiment support the existence of a Laffer curve.

competitiveness of the market.[4]

The organization of the paper is as follows. In the next section we detail the experimental design. Section 3 presents the main results. In section 4, we present a simple theoretical framework consistent with our findings and discuss policy implications. Section 5 concludes.

2 Experimental Design and Procedures

To test the equivalency between labor income and consumption taxes, we design two tax systems that yield identical after-tax budget lines, thereby creating identical labor-leisure incentives. In a between-subjects design, we determine whether subjects indeed make the same labor-leisure allocation as predicted by the theory or whether, according to our alternative hypothesis, subjects choose to work more in the consumption-tax condition. This comparison of labor-leisure choices in equivalent labor income tax and consumption tax treatments is the third part of our three-part experiment. The first two parts of the experiment are designed to measure and control for subjects' work ability and inherent labor-leisure preferences, respectively. We detail in turn each of these three parts below. The experimental instructions for all three parts appear in the Appendix.

2.1 Three Parts of the Experiment

a. Part One (Work Ability)

The common element to all three parts of the experiment is the real-effort work task: each subject solves by hand two-digit by two-digit multiplication questions. Part One serves to measure each subject's innate ability or productivity at this task. Our objective is to create a labor income tax and a theoretically equivalent consumption tax treatment balanced in terms of subjects' work abilities.

[4] KK represents the lone violation of the theory and their test uses a bilateral-monopoly market structure.

To measure each subject's work ability, subjects are asked to solve as many multiplication problems as they can in three minutes. To incentivize subjects, they are paid 0.5 shekel for each correctly answered question.[5] Throughout this and the other two parts, the subject may observe both his numbers of correctly and incorrectly answered multiplication questions and his cumulative earnings. (See the screenshot for Part One in the Appendix.)

At the completion of Part One, while subjects proceeded to Part Two, the software ranked subjects according to the number of correctly solved multiplication questions. We applied the rank-sorting algorithm displayed in Table 1 to assign each subject to either the labor income tax or consumption tax treatment in Part Three. At the beginning of Part Three, each subject receives the instructions only for the treatment to which he has been assigned. Subjects are not made aware of the ranking algorithm, their overall ranking or the existence of the other treatment in which they do not participate.

[insert Table 1 here]

The algorithm balances the two tax treatments in terms of the rankings of subjects' work abilities. Table 1 indicates how this balance is achieved: the subjects with the highest and fourth highest abilities are assigned to the consumption tax treatment (CT), while the second and third highest ranking subjects are assigned to the labor income tax treatment (IT). This "snake" pattern of subject assignment continues until all subjects are exhausted. The result is that if the number of subjects in a session is a multiple of four, the average ability ranking of the two treatments is identical; otherwise, the average ranking differs by a mere fraction for sessions with at least 17 subjects (applicable to all four of our sessions).

b. Part Two (Labor-Leisure Preferences)

The second part of the experiment measures subjects' (pre-tax) labor-leisure preferences.

[5] One $USD equals about four Israeli shekels. To control for question difficulty across subjects, all subjects saw the same series of randomly chosen multiplication questions in the same order. To minimize the variance in question difficulty across questions, we excluded integers ending in "0" or "1".

This second part consists of a two-stage, full-information, individual choice problem. In the first labor-leisure-allocation stage, the individual decides how much of the available three minutes to devote to work in the form of solving multiplication problems. For each correctly answered question, the subject earns two points that may be exchanged for either of the two consumption goods in the second stage (as explained below). The subject may stop working at any time during the three-minute round by pressing the "Stop" button. For each 15 seconds that the individual chooses not to work (leisure), he earns one unit of the leisure good (a voucher for a bottled soft drink).[6] (Fractions of 15 seconds left on the clock are worthless.) In the second, consumption stage of the round, the individual decides how to allocate the points earned from the labor task between the two consumption goods (vouchers redeemable for falafel sandwiches or pizza slices). In this pre-tax treatment, each point earned can be exchanged for a half falafel sandwich or one pizza slice.[7]

Compared to Part One, this second part complicates the subject's decision task in two respects: the subject must first decide how to allocate his three-minute endowment between labor and leisure, and he must subsequently decide how to allocate his earned income between the two consumption goods. Due to these additional complexities, we want to allow the subject to repeat Part Two. At the same time, we recognize that solving multiplication questions is mentally fatiguing and that this part's main purpose is really to provide a control for subjects' preferences. We resolved these tradeoffs by having each subject play two rounds of Part Two.

c. Part Three (Income tax or Consumption tax)

Part Three of the experiment is identical to Part Two, except that the subject now faces either a labor income tax or a consumption tax, depending on the treatment to which he is

[6] Because subjects are confined to the lab for the duration of the experiment, the use of a leisure good ensures that they indeed derive utility from the time not spent working.

[7] Pizza and falafel are the two most popular fast foods in Israel. Pizza is sold whole and by the slice; falafel sandwiches are served in a half or full pita bread.

assigned (according to the sorting algorithm described in Part One). In the labor income tax treatment (IT), a 50% wage tax is imposed on subjects' earnings, meaning that for each correctly answered multiplication question the subject earns one point (instead of two).[8] The prices of half falafel sandwiches and pizza slices remain the same as in the pre-tax treatment, namely, one point each.

Alternatively, in the consumption tax treatment (CT), a 100% consumption tax is imposed on each of the two consumption goods, meaning that a half falafel sandwich and a slice of pizza now each cost two points (instead of one point each). As in the pre-tax treatment, the value of a correctly answered question is two points.

The key feature of these two tax treatments is that the subjects in each treatment face the identical post-tax budget line: a half falafel sandwich and one pizza slice each cost one correctly answered multiplication question, while each soft drink costs 15 seconds not spent on solving multiplication questions.[9]

The decision complexity of Part Three suggests that allowing subjects to repeat it will provide us with more informed estimates of their preferences. At the same time, mental fatigue and the intensity associated with solving multiplication problems under time pressure severely limits the number of feasible repetitions. Given the centrality of this part of the experiment, we chose to have each subject play three rounds.

[8] This treatment exemplifies the need to convert correct answers to smaller units. If we had paid subjects directly in correctly answered questions, a subject who answers an odd number of questions would be left with a fraction of a question after the wage tax.

[9] To illustrate the equivalence, consider a subject who correctly answers five questions in 120 seconds, leaving 60 seconds on the clock. In both IT and CT, the 60 seconds not devoted to the work task earn the subject four units of the leisure good, bottled soft drinks. In IT, five questions pay five after-tax points, exchangeable for five half falafel sandwiches, five pizza slices or some combination thereof. In CT, five questions pay ten points, but the 100% tax on consumption goods make them exchangeable also for five half falafel sandwiches, five pizza slices or some combination thereof.

2.2 Logic underlying Design Choices

Our experimental design is non-standard in several respects. Perhaps the most distinctive feature of our design is the payment in kind, rather than in cash. We steered away from cash or cash equivalents such as cell-phone credit in the choice of goods in order to avoid a corner solution in subjects' labor-leisure allocation. Put differently, if either the leisure good or one of the consumption goods were overly attractive, subjects may have exclusively chosen this good and remained insensitive to the imposition of a tax.

We include two consumption goods along with the leisure good to capture in the simplest way the two typical tradeoffs faced by individuals: time allocation between labor and leisure and earned-income allocation between commodities. We selected in-kind goods that are similarly attractive to one another for a wide range of students, again to avoid a corner solution. Months prior to the experiment, we conducted a questionnaire to determine the set of goods to include in our design. The questionnaire elicits subjects' preferences over different bundles of goods. The results revealed that falafel and pizza are equally well liked substitutes and neither is chosen to the exclusion of the leisure good, soft drinks, which serves as a complement.[10]

Payment according to subjects' cumulative earnings across all rounds would invite satiation, which would lead to different labor-leisure-consumption choices across rounds. This between-round variation is undesirable since it is an artifact of the payment calculation. Accordingly, each subject was paid based on his results from one randomly chosen round from each of the second and third parts of the experiment. This payment method serves to avoid scenarios in which subjects concentrate their labor supply in one round and opt for leisure in the remaining round(s) of the treatment.

[10] The questionnaire asked each subject to allocate a hypothetical income among three goods in each of the distinct bundles of goods. We conducted this questionnaire on 69 students at locations (Tel Aviv University and Sapir College) different from the site of our experiments (Ben-Gurion University) to avoid any subjects from participating in both the questionnaire and subsequent experiment. The detailed findings from the questionnaire are available upon request.

The first part allows us to balance the work-ability composition of the IT and CT treatments and to explain a subject's labor-leisure choice as a function of his observed labor productivity. The second part provides an own-subject control for inherent labor-leisure preferences. The time difference the subject devotes to the work task between the tax and the pre-tax treatments will serve as one of our dependent measures.

2.3 Subjects and Payments

To ensure that our results are not attributable to subjects' misunderstanding of the rules of the experiment or the implications of the tax, we gave subjects a short quiz prior to beginning Parts Two and Three to verify their knowledge of the prices of all goods.[11] (Appendix A includes these quizzes for the referees.) More important for understanding, we limited participation to economics students. Eighty undergraduate majors in economics participated in one of four sessions at Ben-Gurion University. The entire experiment took about one hour and 45 minutes. The average cash payment from Part One was 3.0 NIS, while the average payments in vouchers based on one randomly chosen round from both Parts Two and Three were 7.7 bottled drinks, 6.3 half falafel sandwiches and 7.0 pizza slices. The vouchers were valid for redemption for up to one year.

3 Results

Descriptive statistics for the two tax treatments (IT and CT) appear in Table 2. The first row confirms the effectiveness of the ability-sorting algorithm in balancing the two tax treatments in terms of subjects' abilities. The average ability in IT is 5.87 questions compared to 5.60 questions in CT. A t-test of means (p = 0.64) and the non-parametric Wilcoxon-Mann-

[11] The subject answered the same set of questions in either IT or CT as in the previous no-tax treatment. The fact that the answers change from the no-tax to the tax treatment highlights for the subject the effect of the tax on prices.

Whitney test of distributions ($z = 0.427$, p = 0.67) both indicate abilities are similarly distributed in the two tax treatments.

[insert Table 2 here]

The next three rows indicate the overall average time (in seconds) devoted to labor supply in the pre-tax treatment (before subjects knew of their assignment to, or even the existence of, the tax treatment), the tax treatment and the change between these two treatments, respectively. These numbers reveal that on average the substitution effect dominates any possible positive income effect: subjects respond to the imposition of a tax by significantly reducing their labor supply in both treatments ($p < 0.01$ for both IT and CT). Of greater interest, subjects reduce their labor supply by 1/3 or 44.5 seconds on average in IT compared to the no-tax treatment, while in CT the decrease is only about 15% of the no-tax amount or a 20.3-second decline on average. Treating each subject's average response to the tax as the unit of observation, both a t-test of means (p = .02) and the Wilcoxon-Mann-Whitney test (p = .03) show that subjects' labor supply is significantly more responsive to the income tax than the consumption tax, as hypothesized. This differential response to the type of tax can be seen in the distribution of subjects' average labor supply responses displayed in Figure 1. A higher fraction of subjects in IT reduce their labor supply and by a larger amount in response to the tax than in CT.

[insert Figure 1 here]

The figure also reveals that about a quarter of the subjects (21/80) curiously increase their time devoted to the work task following the introduction of the tax. Also in line with our hypothesis, 13 of these participated in CT compared to only eight in IT.

We examined the two groups to determine whether observable differences may explain their differential reactions to the tax. Table 3 shows no significant differences in terms of

gender composition, labor market ability, pre-tax labor supply or leisure choices between those who lowered and those who raised their post-tax labor supply. The similarity of these two groups in terms of ability and labor supply contradicts the conventional depiction of the backward-bending portion of the labor supply curve as applicable to high-income individuals: there is nothing distinctive about the subjects with a negative income elasticity.[12]

[insert Table 3 here]

Turning to a more formal analysis of the response to the two taxes, we begin with the following OLS regression specification,

$$\Delta\overline{worktime}_i = constant + \beta_1 \cdot ability_i + \beta_2 \cdot IT + \epsilon_i$$

where $\Delta\overline{worktime}_i$ denotes the difference between subject i's time devoted to the labor task in the tax treatment averaged over all three rounds minus this subject's time devoted to the labor task in the pre-tax treatment averaged over both rounds; $ability_i$ is the number of multiplication questions subject i correctly answered in Part One, while IT is an indicator variable equal to one for the income tax treatment and zero for the consumption tax treatment.

[insert Table 4 here]

The highly significant coefficient of -24.2 in regression (1) of Table 4 confirms our main hypothesis: subjects reduce their labor supply by an additional 24 seconds on average in response to the income tax compared to the equivalent consumption tax. Repeating the exercise with the subject's own ability as a control yields a similar result: the coefficient of -23.9 on IT in (2) is significant at the 3% level.

[12] One explanation for this seemingly irrational behavior is that the subject aspires to a target income in order to purchase a specific number of falafel sandwiches or pizza slices. To achieve this, the subject works longer in the presence of the tax than in its absence. Camerer et al. (1997) found that New York City cab drivers – another not particularly high income group – set a daily earnings target, which led them to work longer hours on slow days and to quit early on busy days.

Let us now make use of the entire panel dataset for all 80 subjects, each of whom participated in two no-tax rounds and three tax rounds facing either an income tax (IT) or a consumption tax (CT). Table 5 reports the regression results with subject i's worktime in round t as the dependent variable. The random-effects regression results in (3) reveal that subjects reduce their labor supply by 39 seconds on average when exposed to the income tax, while those who face the consumption tax work 21 seconds less compared to their pre-tax labor supply. Both of these coefficients are significantly different from the (omitted) no-tax labor supply and significantly different from each other at less than the 1% level. These coefficients remain unchanged when the subject's own ability at the labor task is included in regression (4). The $ability_i$ variable is not significantly different from 0 in this or any other regression we ran, nor is it or $ability_i^2$ ever significant when the latter is included. In (5), we interact $ability_i$ with both the no-tax and the tax-inclusive rounds to allow for a subject's labor productivity to affect differently his labor supply in the presence of the tax. A substitution effect would render the distortive effect of a tax more pronounced for high-ability individuals, with an income effect potentially offsetting this pattern to some extent. The insignificance of the $ability_i * tax$ coefficient suggests these two forces offset one another. In fact, neither of the interaction terms (or their squared terms when included) is significant, while the gap in the labor supply between the two tax treatments remains highly significant ($p < .01$).

[insert Table 5 here]

Learning is a common phenomenon in individual choice experiments. With successive rounds a subject may become more adept at solving multiplication questions or more fatigued. To determine whether subjects' labor supply decisions display a time trend, round-specific dummy variables are included in all of the above regressions in Table 5. However, since none of the round dummies is significant in any of the regressions, they are not reported. As a robustness test, regression (6) excludes the first round in both the no-tax and the tax

treatments to account for possible learning and focus on the second no-tax round and last two after-tax rounds. The coefficients on IT (-41.1) and CT (-25.5) both increase slightly compared to (4) and the main conclusions remain the same: both coefficients continue to be significantly different from 0 at the 1% level and significantly different from each other at the 5% level, despite using only 3/5 of the data.

To account for the fact that the decision space in our experiment is censored from below at 0 seconds and from above at 180 seconds, we report the marginal effects from random-effects, double-censored Tobit regressions in (7) and (8). Eleven percent of the total observations (45 of the total 400 rounds) are right-censored with subjects devoting all of their time to the labor market. The observation that the majority of these observations (26/45) appear in the no-tax rounds (despite there being only two such rounds) attests to subjects' labor supply sensitivity, even for the subjects' most devoted to the work task. Ten additional right-censored observations appear in CT with the remaining nine observations in IT.

At the other extreme, because consuming all leisure involves pressing three buttons in sequence, each located on a different location of the computer screen, it is physically impossible to stop the clock with the entire 180 seconds intact.[13] Still, the intention to consume all leisure is revealed in 21 instances in which the subject stopped the clock between 1 and 6 seconds after the round began and didn't answer a single question. Indeed, with no instance in which the clock was stopped after 7 to 10 seconds had elapsed, six seconds elapsed stands out as the natural threshold for subjects desiring to consume exclusively leisure.

Revealingly, 17 of the 21 instances in which the clock was stopped before 7 seconds elapsed occurred in IT; the other four observations occurred in CT with no single attempt to consume all leisure in the no-tax treatment. Put another way, all instances of voluntary unemployment occur after taxes are introduced, with over 80% of them in the income tax

[13] The subject first needs to press the "Start" button which starts the clock, then presses "Cancel" on the message box containing the multiplication question and finally presses the "Stop" button (see the screenshot in the Appendix).

treatment. A χ^2-test of proportions shows that these differences are highly significant ($p < .0001$, $df = 2$).

In Tobit regressions (7) and (8), the dependent variable $worktime'_{it}$ is adjusted to take on the value of 0 for all values 0 to 6 seconds and equals $worktime_{it}$ for all other values. As in the OLS regressions, the coefficients on IT and CT continue to differ significantly from zero and from one other at the 1% level. Again, none of the round dummy variables included (but not reported) in (7) is significant. Alternatively, we account for possible learning in Tobit (8) by excluding the first round in both the no-tax and the tax treatments, as we did in OLS regression (6). Labor supply in these later rounds of the tax treatments remain significantly lower than the second pre-tax round, and the highly significant gap in labor supply between IT and CT persists ($p < .01$).[14]

4 A Theoretical Explanation

In this section, we present a simple behavioral model of myopic agents. The model is consistent with our main finding that individuals choose a higher labor supply under a consumption tax than under an equivalent labor income tax. We employ this model to demonstrate that a shift from an income to a consumption tax reduces excess burden.

Consider a standard labor supply model with a representative individual whose utility is given by $U(c, \ell) = c - h(\ell)$, where c denotes consumption, ℓ denotes labor and h is assumed to be strictly increasing and strictly convex.[15]

The production function employs labor only and exhibits constant returns to scale. We

[14] The Tobit regressions are estimated using Gauss-Hermite quadrature with 12 points of evaluation (Stata's default). As a robustness check, we estimate (7) and (8) based on both 8 and 16 quadrature points. The coefficients on IT and CT change by less than 1% and remain highly significant. The $ability_i$ coefficient is more sensitive, shrinking by as much as 40% for higher accuracy of 16 points and increasing up to 59% in (8) (but still insignificant) when accuracy falls to 8 points.

[15] The quasi-linear specification (used by Diamond 1998, among others) is without loss in generality and is assumed for simplicity only.

denote by $w > 0$ the individual's hourly productivity (hence the competitive wage rate). We normalize the price of the consumption good to unity, with no loss in generality. The individual is faced with the following budget constraint:

$$\ell \cdot w \cdot (1 - t) + \tau = c \cdot (1 + \alpha \cdot s), \tag{1}$$

where $t < 1$ is the (flat) tax rate on labor income (wages), τ denotes a lump-sum transfer (a tax if negative) and s is the tax rate on consumption. The parameter $0 \leq \alpha \leq 1$ measures the individual's degree of myopia. When $\alpha = 1$ the individual is fully rational and perceives the consumption tax correctly, in accordance with neo-classical consumer theory. When $\alpha < 1$ the individual underestimates the burden associated with a consumption tax.[16]

We now demonstrate that when the individual underestimates the consumption tax burden, levying a consumption tax entails a smaller excess burden than that associated with an equivalent wage tax (while the individual is indifferent between the two tax regimes). Formally, we prove the following:

Proposition: When $\alpha < 1$, a shift from a wage tax to a consumption tax generates strictly higher tax revenues while leaving the individual's utility unchanged.

Proof: Consider a wage tax regime (B^{WT} in Figure 2); that is, we set $t > 0$ and $s = \tau = 0$. Denote the wage tax rate by t^{WT}. Let ℓ^{WT} and U^{WT} denote the individual's choice of labor supply under the wage tax regime and his corresponding utility level, respectively. Let ℓ^{NT} be the individual's choice of labor supply under a no-tax regime (i.e., setting $s = t = \tau = 0$, given by B^{NT} in Figure 2). By virtue of our quasi-linear specification, ℓ^{NT} equals the choice of labor supplied under a lump-sum tax regime (i.e., setting $\tau < 0$ and $s = t = 0$), which entails no deadweight loss. Note further that $\ell^{NT} > \ell^{WT}$, since labor supply is strictly increasing with respect to the net-of-tax wage rate. Denote by c^{NT} the implicit solution to:

$$U(c^{NT}, \ell^{NT}) = U^{WT}. \tag{2}$$

[16] Chetty et al. (2007) employ a similar formulation to study the role of tax salience in consumer decisions.

In words, c^{NT} is the level of consumption that yields the individual the same utility level as that obtained under a wage tax regime when the individual works ℓ^{NT} hours.

[insert Figure 2 here]

We first examine the simple case $\alpha = 0$. Consider a consumption tax regime (i.e., $s > 0$ and $t = \tau = 0$). Denote the consumption tax rate by s^{CT}, where s^{CT} is given by the implicit solution to:

$$\ell^{NT} \cdot w = c^{NT} \cdot (1 + s^{CT}). \tag{3}$$

In words, the consumption tax rate is set such that the consumption-labor pair, (c^{NT}, ℓ^{NT}), lies on the after-tax budget line B^{CT} shown in Figure 2. Since $\alpha = 0$ (implying the individual is oblivious to the tax), an individual faced with the consumption tax regime chooses to work ℓ^{NT} hours. His resultant utility equals U^{WT} according to (2). The tax revenues raised by the consumption tax regime thus equal the tax revenues that would be raised by a lump-sum tax regime (for the same utility level) which, by construction, are higher than the tax revenues from the wage tax regime. This completes the proof for the case $\alpha = 0$.

We turn next to the case $0 < \alpha < 1$. Denote by $\ell^{'}$ the amount of labor chosen by an individual faced with a consumption tax rate given by the implicit solution to (3). Due to the strict concavity of the utility function, the marginal tax rate associated with the consumption tax regime is lower than that associated with the wage tax regime; formally, $\frac{1}{1+s^{CT}} > 1 - t^{WT}$ (alternatively, B^{CT} is steeper than B^{WT}). Thus, $\ell^{WT} < \ell^{'} < \ell^{NT}$. The first inequality follows from both the fact that the labor supply is strictly increasing with respect to the net-of-tax wage rate and the individual's misperception of the consumption tax; whereas the second inequality follows from both the positive slope of labor supply with respect to the net-of-tax wage rate and $\alpha > 0$. Let $c^{'}$ represent the individual's consumption level from $\ell^{'}$. It follows that $U(c^{'}, \ell^{'}) > U^{WT}$. In other words, the bundle ($c^{'}$, $\ell^{'}$) lies above the indifference curve U^{WT} (see Figure 2).

Consider now an alternative consumption tax regime. Denote the consumption tax by s^{WT}, where s^{WT} is given by the implicit solution to:

$$\ell^{WT} \cdot w = c^{WT} \cdot (1 + s^{WT}). \tag{4}$$

That is, we set a consumption tax rate that yields an after-tax budget line identical to that of the wage tax regime (B^{WT}). Denote by c'' and ℓ'', respectively, the consumption level and the amount of labor chosen by the individual faced with the consumption tax regime in (4). Similar to the above reasoning, it follows that $\ell^{WT} < \ell'' < \ell^{NT}$. Thus, $U(c'', \ell'') < U^{WT}$. In other words, the bundle (c'', ℓ'') lies below the indifference curve U^{WT} (see Figure 2). Since the utility function is continuous, the intermediate value theorem implies that there exists some consumption tax rate, $\hat{s}$, where $s^{CT} < \hat{s} < s^{WT}$, with the individual's corresponding consumption and labor choices given by $\hat{c}$ and $\hat{\ell}$, such that $U(\hat{c}, \hat{\ell}) = U^{WT}$ (given by point A in the figure). Moreover, $\ell^{WT} < \hat{\ell} < \ell^{NT}$. A shift from a wage tax to a consumption tax at the rate $\hat{s}$ moves the individual along the indifference curve U^{WT} towards the bundle (c^{NT}, ℓ^{NT}) chosen under a lump-sum tax (set to maximize tax revenues, by construction). Consequently, the tax revenues from the consumption tax $\hat{s}$ are strictly higher than those from the wage tax t^{WT}. □

From the proof of the proposition, we observed that a shift from a wage tax to a theoretically equivalent consumption tax induces a myopic agent ($\alpha < 1$) to work longer. This shift yields higher tax revenues, but, at the same time, reduces the agent's utility (the bundle (c'', l'') lies below the indifference curve U^{WT}). We demonstrated that by lowering the consumption tax rate below this theoretically equivalent level, tax revenues remain higher than those obtained under the wage tax while restoring the agent's utility to U^{WT}. This establishes the efficiency gain from a shift to a consumption tax.

5 Concluding Remarks

Two often-raised arguments in favor of a shift to a consumption tax are the administrative advantages it offers over an income tax (i.e., simplicity of measuring consumption versus labor income and ease of collection and enforcement) and the elimination of the inter-temporal distortion of consumption allocation caused by the taxation of capital income. Our paper uncovers evidence for an additional perceptual advantage: post-paid consumption taxes encourage higher labor supply than equivalent pre-paid wage taxes. This finding holds for both men and women and across the spectrum of labor market productivities. Consumption taxes also appear to reduce the likelihood of voluntary unemployment. Whether these conclusions would hold over the longer run remains an open research question. For our part and constrained by the tiresome nature of our real-effort task, we permitted learning by having each subject repeat the same labor-leisure choice over several rounds. Over this horizon, the observed significantly higher labor supply under a consumption tax endures.

The mechanism at work appears to be similar to behavioral explanations for overeating and the excess credit card debt phenomenon. Myopic individuals underestimate the future costs of current consumption decisions. Similarly, we observe that taxpayers underestimate the costs to be incurred from taxes levied on their deferred consumption when they make their labor-leisure choices.[17]

Myopia in our setting, as in the above-mentioned examples, harms the individual by leading to sub-optimal choices (overworking in our case). This creates the potential for a welfare-improving government response. Indeed, our results bear major implications for tax policy design. The public finance optimal tax literature is premised on the equivalence between a wage tax and a consumption tax. We demonstrate a major difference between two types of consumption tax: a pre-paid consumption tax such as the individual cash-flow

[17] We submit that our findings (based on economics students) understate the extent to which labor income taxes hurt labor supply relative to consumption taxes. A population without economics training is likely to be even more susceptible to the myopia underlying the differential labor supply responses to the two taxes.

tax (that could take the form of a traditional Section 408 Individual Retirement Account), which is essentially a wage tax, and a post-paid consumption tax (such as VAT). While much of the policy reform debate in the U.S. focuses on the former as a leading candidate to replace income tax, our evidence makes a case for adopting the latter, since post-paid consumption taxes appear to mitigate labor disincentives, thereby enhancing the efficiency of the tax system. In particular, we show that for any wage tax rate, one can appropriately choose a consumption tax rate below the theoretically equivalent level to achieve higher labor supply and therefore higher tax revenues, while maintaining the individual's utility.

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Instructions for Participant

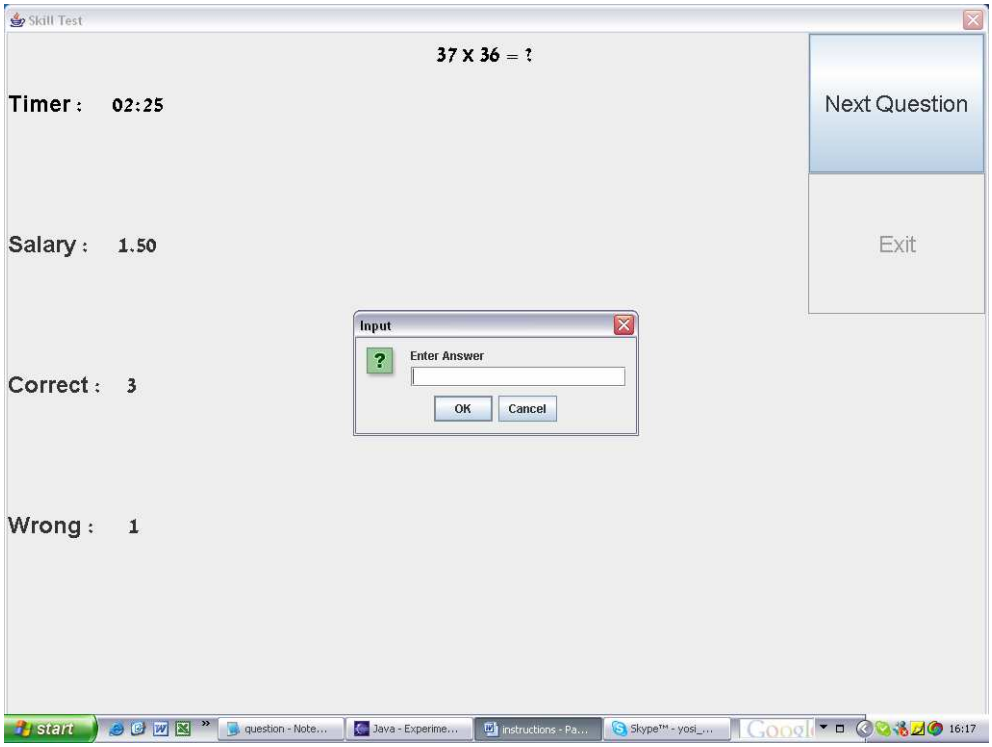
This is a decision-making experiment in time and resource allocation. Funds for this experiment have been provided by an external research foundation. Take the time to read carefully the instructions. A good understanding of the instructions and well thought out decisions during the experiment can earn you a considerable remuneration. Earnings from the experiment will be paid at the end of the experiment to you in cash and in vouchers exchangeable for goods. The experiment consists of three parts. Below are the instructions for the first of three parts.

Part 1

During the first part of this experiment, you will be given three minutes to solve as many two-digit by two-digit multiplication questions as possible. This preliminary exercise will allow you to familiarize yourself with the software in preparation for the second and third parts of the experiment. For each correctly answered question in this part, you will earn 0.5 shekel to be paid in cash at the end of the experiment

This completes the instructions for Part One of the experiment. If you have any questions, please raise your hand and a monitor will come to assist you.

Below is an example of a screenshot from Part One of the experiment.



Instructions for Participant

Part 2

Time-allocation Stage

This second part of the experiment consists of two stages, time and salary allocation stages. In the first time-allocation stage, you are given three minutes. You need to decide how much of this time you wish to devote to answering multiplication questions. For each correctly answered question, you earn two points. You will be able to redeem your total earned points for falafel sandwiches and pizza slices, as explained below. At any time during these three minutes, you may choose to stop answering questions by pressing "Cancel" instead of answering the question and then by pressing the "Stop" button. Whatever time remains from the initial three minutes is converted to bottled soft drinks according to the following exchange rate: every 15 seconds remaining on the clock is worth one bottled soft drink. Below is an example of a screenshot from the time-allocation stage. Please take a look at this now.

Point-Allocation Stage

You will now be asked to allocate the points you earned from the first time-allocation stage (at a rate of 2 points per correctly answered question) between half falafel sandwiches and pizza slices. Each point can be exchanged for either a two half falafel sandwiches or two pizza slices. You must spend all of your earned points on any combination you like of half falafel sandwiches and pizza slices. Note that the bottled soft drinks you earned in the first stage cannot be exchanged for falafel sandwiches or pizza slices. Below is an example of a screenshot from the point-allocation stage of the experiment. Please take a look at this now.

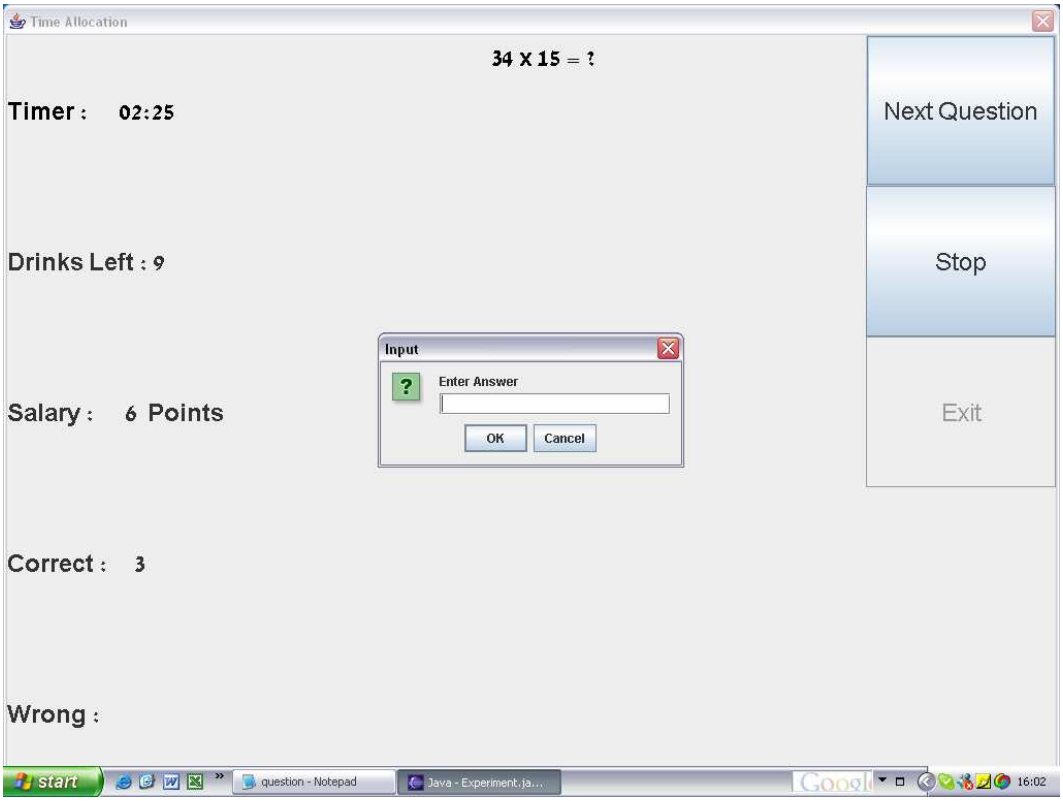
After you have decided how to allocate your earned points between half falafel sandwiches and pizza slices, press the "Confirm Choice" button, followed by the "Proceed to the Next Round" button. The time-allocation and point-allocation stages will be repeated once more.

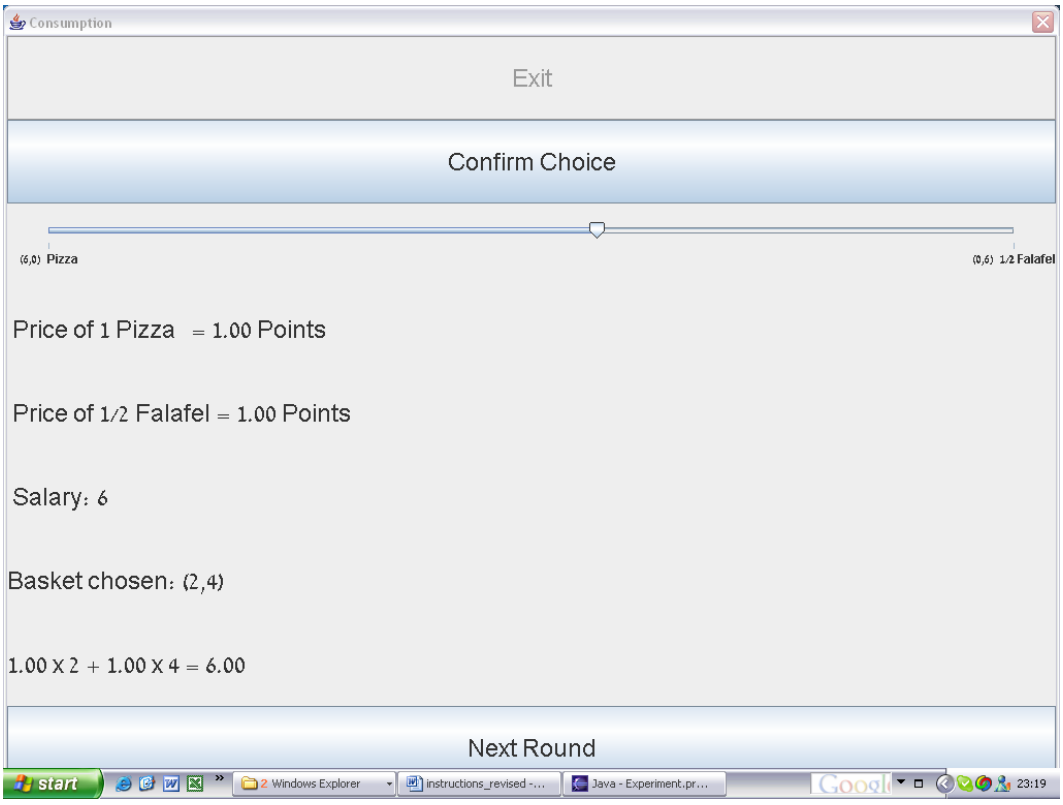
Payment

At the end of the experiment, you will be paid the money you earned from correctly solving multiplication questions in the first part. Of the two rounds of the second part, one round will be randomly chosen and you will be given vouchers for the number of bottled soft drinks, half falafel sandwiches and pizza slices that you earned in the randomly chosen round. The falafel vouchers are valid for redemption for up to one year at Falafel El HaNegev in Mercaz Oren. The pizza vouchers are valid for redemption for up to one year at American Pizza also in Mercaz Oren. The soft drink vouchers are redeemable for up to one year at either Falafel El HaNegev or American Pizza in Mercaz Oren.

This completes the instructions for Part Two of the experiment. If you have any questions, please raise your hand and a monitor will come to assist you.

Below are two examples of screenshots from Part Two, the first from the time-allocation stage and the second from the point-allocation stage.





Participant: _____

Instructions for Participant

Part 3 – Tax on Prices of Goods

Time-Allocation Stage

The time-allocation stage of the third part is identical to that of the second part. That is, you are given three minutes during which time you must decide how much of the three minutes to devote to answering multiplication questions in exchange for points and how much of the three minutes to preserve in exchange for bottled soft drinks. Each correctly answered question earns you two points redeemable for falafel sandwiches and pizza slices, as explained below. For every 15 seconds you choose to preserve on the clock you earn one bottled soft drink. Below is an example of a screenshot from the time-allocation stage of the experiment. Please take a look at this now.

Point-Allocation Stage

Like the point-allocation stage of the second part of the experiment, you will now be asked to allocate the points you earned from the first time-allocation stage (at a rate of 2 points per correctly answered question) between half falafel sandwiches and pizza slices. However, there is now a tax on the prices of these two goods such that the price of each good including the tax is double the price paid in the second part. In other words, each point can be exchanged for either half a falafel sandwich or one pizza slice. You must spend all of your earned points on any combination you like of falafel sandwiches and pizza slices. Note that the bottled soft drinks you earned in the first stage are not subject to the tax and cannot be exchanged for falafel sandwiches or pizza slices. Below is an example of a screenshot from the point-allocation stage of the experiment. Please take a look at this now.

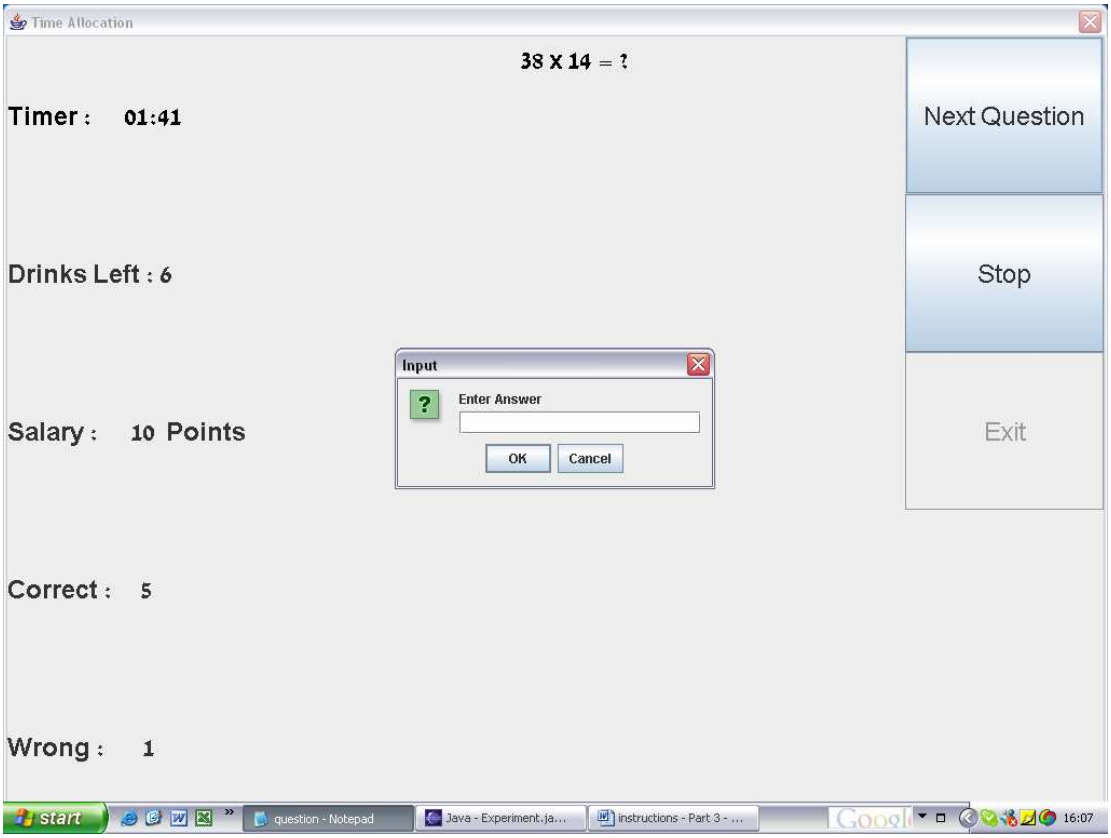
After you have decided how to allocate your earned points between half falafel sandwiches and pizza slices, press the "Confirm Choice" button, followed by the "Proceed to the Next Round" button. The time-allocation and point-allocation stages will be repeated twice more.

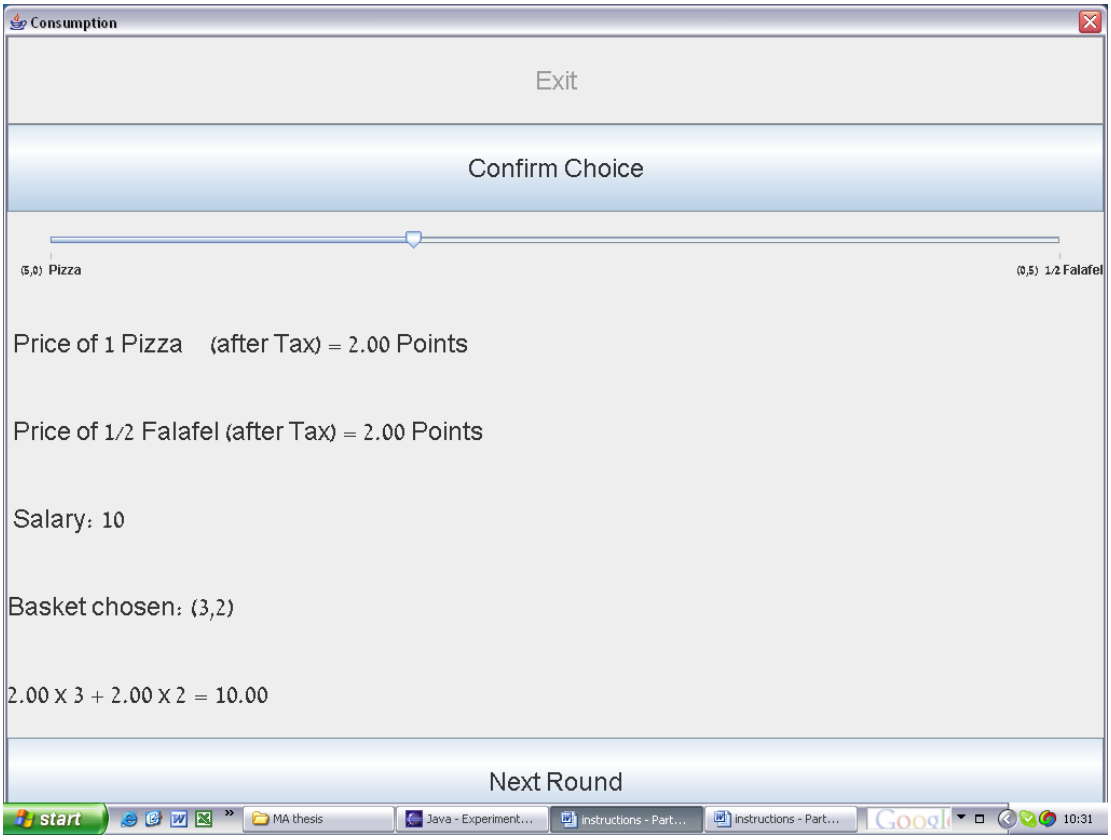
Payment

At the end of the experiment, you will be paid the money you earned from correctly solving multiplication questions in Part One. You will also be paid the number of vouchers for bottled soft drinks, half falafel sandwiches and pizza slices that you earned from one randomly chosen round of Part Two. Finally, you will receive additional vouchers for bottled soft drinks, half falafel sandwiches and pizza slices according to your earnings from one randomly chosen round among the three in which you participated in this Part Three of the experiment. The falafel vouchers may be redeemed at Falafel El Hanegev in Mercaz Oren. The pizza vouchers may be redeemed at American Pizza also in Mercaz Oren. The soft drink vouchers may be redeemed at either Falafel El Hanegev or American Pizza in Mercaz Oren. All vouchers are valid for up to one year.

This completes the instructions for this part of the experiment. If you have any questions, please raise your hand and a monitor will come to assist you.

Below are two examples of screenshots from Part Three, the first from the time-allocation stage and the second from the point-allocation stage.





Participant _____

Instructions for Participant

Part 3 – Tax on Correctly Answered Questions

Time-Allocation Stage

Like the time-allocation part of the second part, you are given three minutes during which time you must decide how much of the three minutes to devote to answering multiplication questions in exchange for points and how much of the three minutes to preserve in exchange for bottled soft drinks. However, there is now a tax on the points you earn. Each correctly answered question earns you two points. But with the tax on the points you will keep half of the total points you earn. In other words, your net income is 1 point for each correctly answered question. These points are redeemable for falafel sandwiches and pizza slices, as explained below. You must spend all of your earned points on any combination you like of falafel sandwiches and pizza slices. For every 15 seconds you choose to preserve on the clock you earn one bottled soft drink. Note that the bottled soft drinks you earn are not subject to the tax.

Point Allocation

The point-allocation part of the third stage is identical to that of the second part. That is, you will now be asked to allocate the points you earned from the first time-allocation part (at a rate of 2 points per correctly answered question) between half falafel sandwiches and pizza slices. Each point can be exchanged for either two half falafel sandwiches or two pizza slices. You must spend all of your earned points on any combination you like of half falafel sandwiches and pizza slices. Note that the bottled soft drinks you earned in the first part cannot be exchanged for falafel sandwiches or pizza slices.

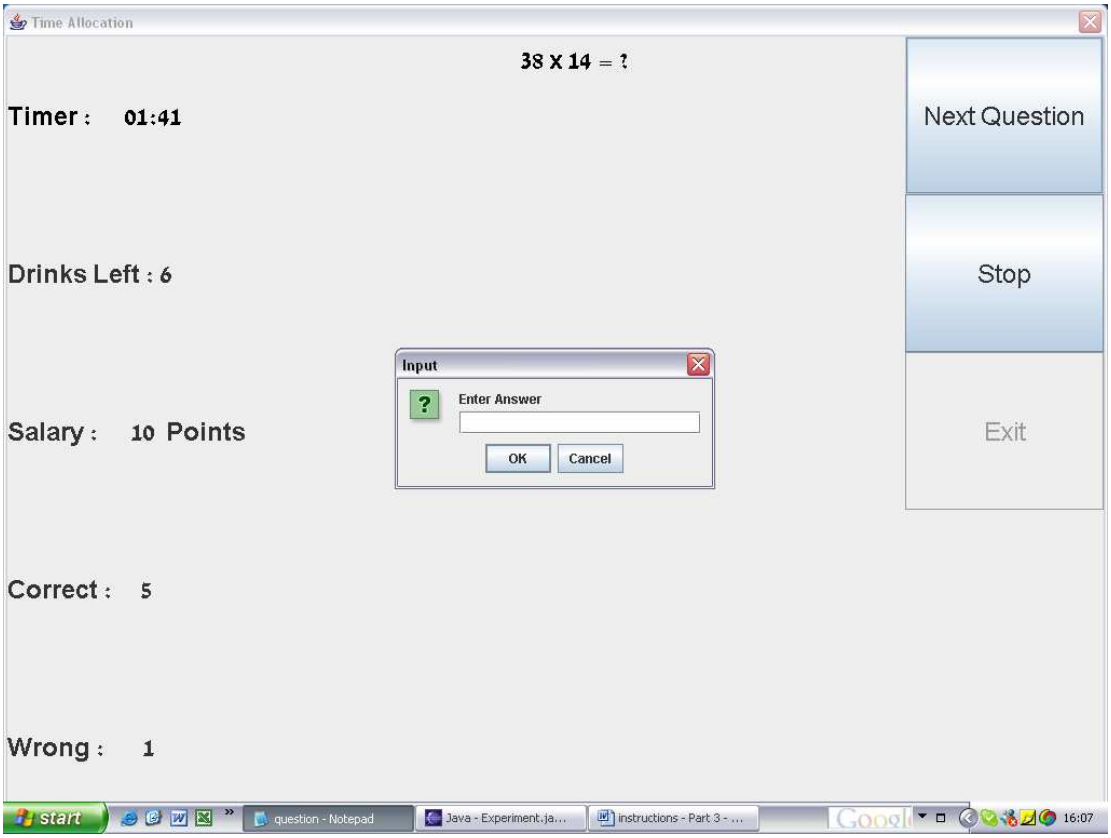
After you have decided how to allocate your earned points between half falafel sandwiches and pizza slices, press the "Confirm Choice" button, followed by the "Proceed to the Next Round" button. The time-allocation and point-allocation stages will be repeated twice more.

Payment

At the end of the experiment, you will be paid the money you earned from correctly solving multiplication questions in Part One. You will also be paid the number of vouchers for bottled soft drinks, half falafel sandwiches and pizza slices that you earned from one randomly chosen round of Part Two. Finally, you will receive additional vouchers for bottled soft drinks, half falafel sandwiches and pizza slices according to your earnings from one randomly chosen round among the three in which you participated in this Part Three of the experiment. The falafel vouchers may be redeemed at Falafel El Hanegev in Mercaz Oren. The pizza vouchers may be redeemed at American Pizza also in Mercaz Oren. The soft drink vouchers may be redeemed at either Falafel El Hanegev or American Pizza in Mercaz Oren. All vouchers are valid for up to one year.

This completes the instructions for this part of the experiment. If you have any questions, please raise your hand and a monitor will come to assist you.

Below are two examples of screenshots from Part Three, the first from the time-allocation stage and the second from the point-allocation stage.



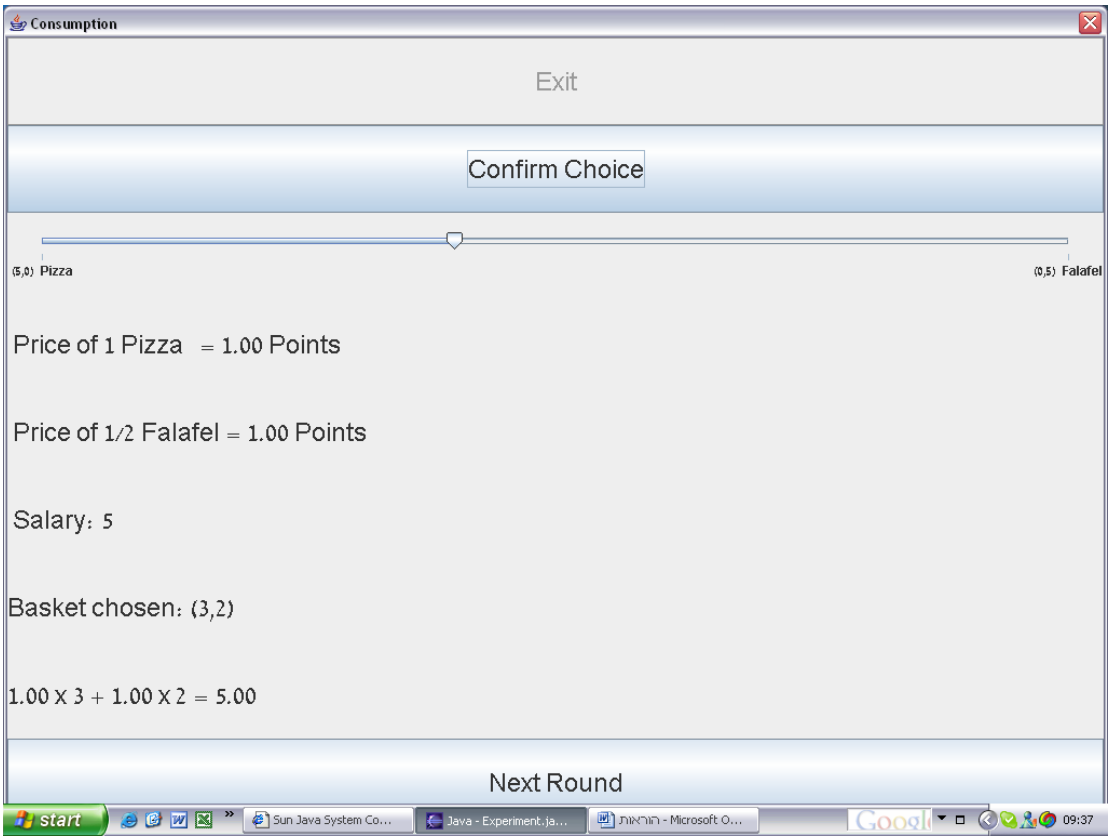


Table 1 - Ability-sorting algorithm

Treatment	
CT	*IT*
1	2
4	3
5	6
8	7
9	10
12	11
13	14
16	15
…	…

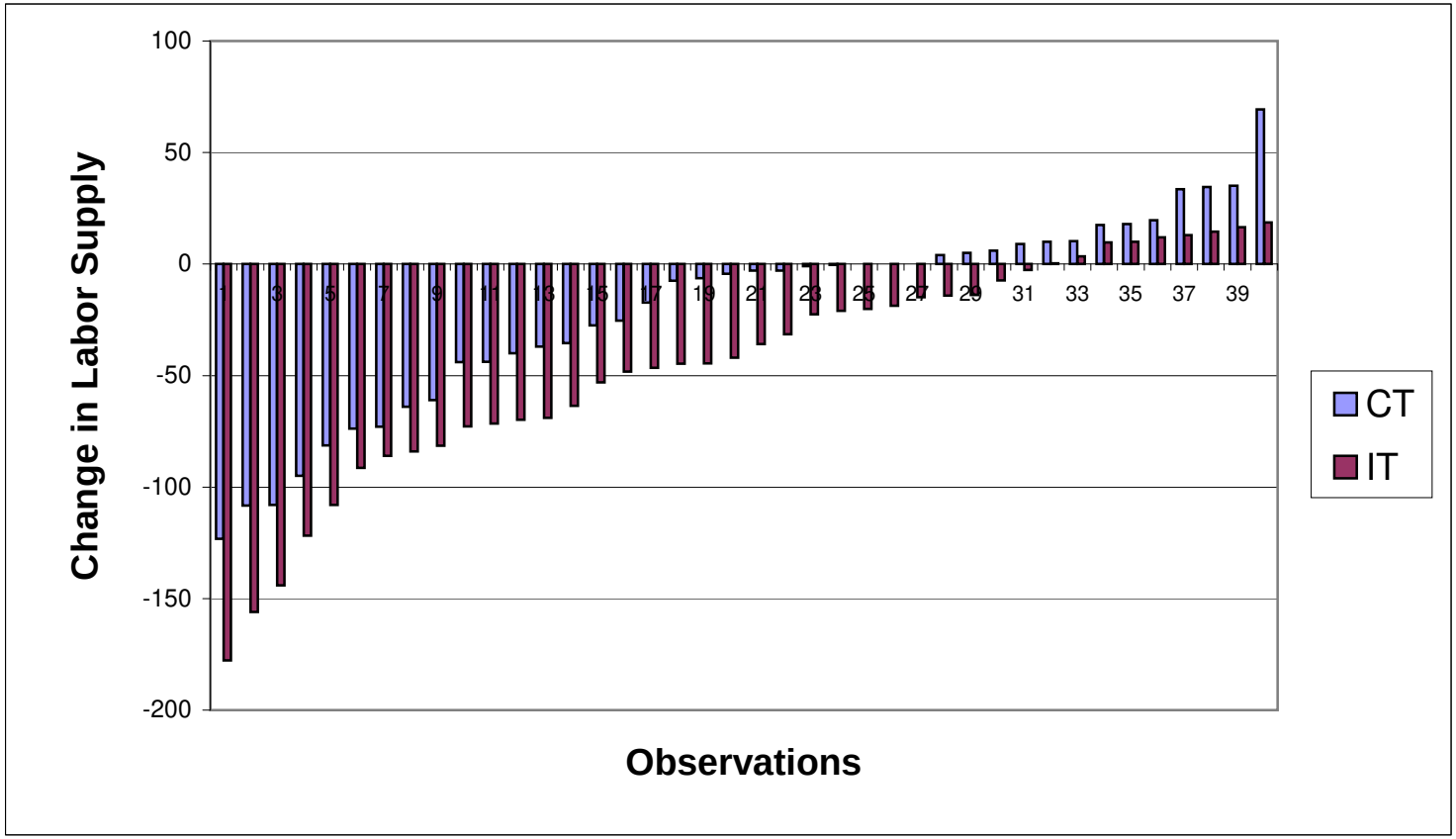
To balance the two tax treatments in terms of labor market productivity, subjects in a session are assigned to either the consumption tax treatment (*CT*) or income tax treatment (*IT*) according to the displayed ability-ranking algorithm.

Table 2 - Descriptive Statistics by Tax Treatment

Treatment	*IT*		*CT*	
Variable	Mean (Std. Dev.)	Observations	Mean (Std. Dev.)	Observations
ability	5.87 (2.60)	40	5.60 (2.56)	40
pre-tax labor supply	141.6 (27.6)	80	130.0 (36.2)	80
after-tax labor supply	98.7 (57.3)	120	109.1 (49.4)	120
Δ labor supply	-44.5 (7.9)	40	-20.3 (7.0)	40
pre-tax units of leisure	2.24 (1.79)	80	2.95 (2.32)	80
after-tax units of leisure	4.99 (3.67)	120	4.36 (3.26)	120
Δ units of leisure	2.75	40	1.41	40

Averages by tax and pre-tax treatment (standard deviations below in parentheses). Labor supply is measured in seconds, units of leisure in numbers of bottled drinks.

Figure 1 - Labor Supply Response to Tax by Subject and Treatment



The subject's average time devoted to the work task in the three rounds of the tax treatment minus the two-round average from the pre-tax treatment is displayed for each subject by tax treatment. Observations are arranged in ascending order along the horizontal axis.

Table 3 - Descriptive Statistics by Response to Tax

variable \ grouping	Lower After-Tax Labor Supply	Higher After-Tax Labor Supply
ability	5.69 (2.63)	5.86 (2.46)
pre-tax LS	139.2 (33.6)	126.3 (27.8)
after-tax LS	90.0 (54.3)	143.1 (24.8)
Δ LS	-49.2	16.8
pre-tax leisure	2.37 (2.14)	3.21 (1.88)
after-tax leisure	5.60 (3.50)	2.08 (1.61)
Δ leisure	3.23	-1.13
pre-tax consumption	9.92 (4.80)	8.90 (3.76)
after-tax consumption	3.56 (2.69)	5.68 (2.31)
Δ consumption	-6.36	-3.22
male	46 (78.0%)	14 (66.7%)
subjects	59	21

Means (std. deviations) by those who lowered and those who raised their labor supply in response to introduction of the tax (*CT* and *IT* pooled).

Table 4 - OLS regressions on Change in After-Tax Labor Supply

variable	(1)	(2)
	coefficient (std. error)	coefficient (std. error)
IT	-24.2** (10.5)	-23.9** (10.6)
$ability_i$	---	-1.2 (1.7)
constant	-20.3 (7.0)	-13.8 (11.2)
Number of Obs.	80	80
adjusted R^2	0.05	0.04

The dependent variable is subject *i* 's change in average worktime from the no-tax to the tax treatment.
*** p-value less than .01 ** p-value less than .05 * p-value less than .10

Subject *i* 's average change in labor supply in response to the tax is regressed on the type of tax faced (*IT* equals one for income tax) and the subject's labor market productivity (in (2)). Heteroskedasticity-consistent standard errors in parentheses.

Table 5 - Random-effects OLS and Random-effects double-censored Tobit panel regressions

method	OLS	OLS	OLS	OLS	Tobit	Tobit
variable \ equation	(3)	(4)	(5)	(6)	(7)	(8)
IT	-38.9*** (6.0)	-39.0*** (6.0)	-36.5*** (7.0)	-41.1*** (6.2)	-37.2*** (6.2)	-42.4*** (6.3)
CT	-20.7*** (6.0)	-20.7*** (6.0)	-18.3*** (6.9)	-25.5*** (6.2)	-19.8*** (6.1)	-26.1*** (6.4)
$ability_i$	---	0.90 (1.59)	---	0.68 (1.72)	1.15 (1.37)	0.40 (1.71)
$ability_i * notax$	---	---	1.22 (1.66)	---	---	---
$ability_i * tax$	---	---	0.57 (1.67)	---	---	---
constant	135.2 (5.2)	130.1 (10.5)	128.2 (10.9)	132.5 (11.3)	---	---
Number of Obs.	400	400	400	240	400	240
ρ	.505	.508	.510	.482	.532	.490
R^2 / Log L	.11	.11	.11	.10	-1817	-1106

*** p-value less than .01 ** p-value less than .05 * p-value less than .10
The dependent variable is subject *i*'s worktime in round *t*.

Random-effects OLS coefficients and marginal effects from random-effects, double-censored Tobit regressions with treatment dummy variables (IT and CT) and the subject's own labor productivity ($subject_i$) as the regressors. Regressions (3), (4), (5) and (7) make use of the 2 pre-tax rounds and all 3 after-tax rounds, and include round dummy variables. Regressions (6) and (8) exclude the first round of data of each treatment.

Figure 2 – Efficiency gain from a shift to a Consumption Tax