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ABSTRACT

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

The public finance literature demonstrates the equivalence between consumption and labor-income (wage) taxes. We introduce an experimental paradigm in which individuals make real labor-leisure choices and spend their earned income on real goods. We use this paradigm to test whether a labor-income tax and an equivalent consumption tax lead to identical labor-leisure allocations. Despite controlling for subjects' work ability and inherent labor-leisure preferences and disallowing saving, subjects reduce their labor supply significantly more in response to an income tax than to an equivalent consumption tax. We discuss the economic implications of a policy shift to a consumption tax.

JEL Classification: C91, H22, H31

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

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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 simplify the 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 a large body of subsequent literature[1] are premised on the equivalence between a linear wage tax

[1] Extensions of the AS result include Deaton (1979) who 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

and a comprehensive uniform 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.[3]

In this paper, we offer the first test of the equivalence between consumption and wage taxes. To do so, we introduce a new experimental paradigm in which both work and leisure choices earn subjects payments in real goods. This paradigm consists of an incentivized, two-stage individual choice problem that requires subjects to allocate their time between leisure (rewarded with a payment for each unit consumed) and a real-effort task. Their performance at the real-effort task in the first stage earns them income, which they allocate in the second stage between two consumption goods. After gaining experience in this environment, we introduce a tax. In the labor income tax (IT) treatment, a 50-percent flat wage tax is imposed on earned income. In the equivalent consumption tax (CT) treatment, a 100-percent ad-valorem tax is levied on both consumption goods. No savings are permitted in either treatment. 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. In other words, both tax treatments present subjects with the same budget constraint. 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.

Although we have designed these two tax treatments to be theoretically equivalent, we

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.

[3] This theoretical equivalence hinges on the standard assumption of constant returns to scale. In economies exhibiting decreasing-returns-to-scale technologies, Helpman and Sadka (1982) demonstrate that wage taxes are always welfare inferior to consumption taxes.

propose a behavioral hypothesis that suggests individuals will work more and consume less leisure in the CT treatment than in the equivalent IT treatment. Our hypothesis is based on money illusion, that is, individuals' observed tendency to think in nominal rather than real terms. An individual suffering from money illusion will typically display a reluctance to accept a nominal wage cut or to sell a house at a nominal loss.[4] Likewise, we anticipate individuals to respond more adversely to a nominal wage cut (due to a wage tax) than to a reduction in the real wage rate (due to a consumption tax). In our experimental framework, we expect that this differential reaction will translate into individuals choosing to work less under a wage tax than under an equivalent (measured in real purchasing power terms) consumption tax. Put differently, we predict that individuals will underestimate the burden associated with an indirect consumption tax (that erodes real purchasing power via price increases) relative to the corresponding burden associated with a direct wage tax.

Our results corroborate our conjectures and appear consistent with the money illusion explanation. Indeed, individuals in IT reduce their labor supply by 1/3 on average compared to the no-tax treatment, significantly more than the 15% decrease in labor supply in CT. The labor supply elasticities with respect to the net real wage are 0.56 in IT and 0.24 in CT. Furthermore, this differential labor supply response across tax treatments holds over the entire range of labor market abilities and persists over time. This finding bears major implications for tax policy design by establishing a novel perceptual 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

[4] See Shafir et al. (1997) for early survey evidence on money illusion as well as Fehr and Tyran (2001, 2007) for experimental evidence and Brunnermeier and Julliard (2008), Cohen et al. (2005) and Kooreman et al. (2004) for empirical evidence.

2005 and Ruffle 2005). 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 competitiveness of the market.[5]

Our paper contributes to a recent fast-growing strand in the public finance literature on the misperception of taxes. 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 (2009) focus on individuals' misperception of the difference between marginal and average tax rates. In a series of tax and redistribution decision-making scenarios, McCaffery and Baron (2006) elicit attitudes toward various fiscal policies and find that subjects prefer hidden to transparent taxes and ignore the longer-term effects of tax policies. Based on a grocery store field experiment and empirical state-level data on alcohol sales, Chetty et al. (2009) show that posting sales-tax-inclusive prices renders the tax more salient and thus reduces consumer demand relative to adding the sales tax at the cash register. Finkelstein (2009) demonstrates that toll rates increase in response to a switch from manual collection (where drivers pay in cash) to a less salient electronic collection system (where drivers are automatically debited).[6]

The organization of the paper is as follows. In the next section we present a simple theoretical framework to illustrate the mechanism underlying our main experimental hypothesis and, to the extent that this hypothesis finds validation, the potential welfare gain from a shift to a consumption tax. In section 3, we detail the experimental design and procedures. Section 4 presents the results. Section 5 concludes.

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

[6] Salience may be the source of the money illusion we hypothesize in our setup. Wage taxes are tantamount to a direct wage cut; whereas price increases due to an equivalent consumption tax are more subtle and may go undetected. In the next section, we invoke the more general notion of misperception to model individuals' under-reaction to the consumption tax.

2 An Illustrative Model of Agents' Misperception

Before turning to the focus of our paper, namely, the experimental test, we present a simple behavioral model designed merely to highlight a role for misperception in individuals' labor-leisure decisions. In particular, this model illustrates our main finding that individuals choose a higher labor supply under a consumption tax than under an equivalent labor income tax. The model also demonstrates the potential welfare gain associated with a shift from a labor income to a consumption tax regime.

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.[7]

The production function employs labor only and exhibits constant returns to scale. We denote by $w > 0$ the individual's hourly productivity (hence the competitive wage rate). We normalize the price of the consumption good to unity, without loss of generality. The individual is faced with the following (perceived) 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 misperception, possibly a result of money illusion (see our discussion in the Introduction). When $\alpha = 1$ the individual is fully rational and perceives the consumption tax and the corresponding budget constraint correctly, in accordance with neo-classical consumer theory. When $\alpha < 1$ the individual underestimates the burden associated with a consumption tax.[8] Based on his perceived budget constraint in (1), the individual

[7] Given the illustrative nature of our model, we assume a quasi-linear specification, which rules out income effects, to render our exposition more tractable. See Diamond (1998) and Salanie (2003) for applications in the optimal income tax literature.

[8] Chetty et al. (2009) employ a similar formulation to study the role of tax salience in consumer purchasing decisions. In our model, tax misperception is exogenously given and is measured along a continuum, whereas

determines his labor supply and earns the commensurate income. Finally, he spends this income on the consumption good, subject (regrettably) to the true budget constraint (as if $\alpha = 1$ in (1)).

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 $\alpha < 1$, for any wage tax there exists a consumption tax that generates strictly higher tax revenues while leaving the individual's utility unchanged.

Proof: See the Appendix.

From the proof of the proposition, we observed that a shift from a wage tax to a theoretically equivalent consumption tax induces an agent who underestimates the burden of a consumption tax ($\alpha < 1$) to work longer. This shift yields higher tax revenues, but, at the same time, reduces the agent's utility. 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.

3 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

Chetty et al. treat individuals' misperception as a costly binary choice between full attention and complete inattention to the sales tax added at the cash register to the posted price.

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.

3.1 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.

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.[9] 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

[9] One $USD equals about 3.5 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 reduce the variance in question difficulty across questions, we excluded integers ending in "0" or "1".

assigned. Subjects are not made aware of the ranking algorithm, their overall ranking or the existence of the other tax 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. 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).[10] (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

[10] 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.

(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.[11]

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 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).[12] 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

[11] 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.

[12] 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.

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.[13] As an additional control and so as to eliminate the tax framing effect observed in Chetty et al. (2009), we presented to subjects the tax-inclusive income and tax-inclusive prices of the consumption goods in each of the respective tax treatments. See the screenshots in Part 3 of the Appendix.

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.

3.2 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.[14] 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

[13] 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.

[14] 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.

pizza slices. The vouchers were valid for redemption for up to one year.

3.3 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.[15]

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. In choosing three similarly well liked goods we aim, again, to minimize the number of subjects opting for a corner solution and to create sufficient variation across subjects' labor-leisure allocation decisions to provide a persuasive test of the equivalence of the two tax regimes. 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.[16]

[15] The reader may wonder why participants don't simply choose all labor or all leisure according to the decision that maximizes the total monetary value of the vouchers, subject to their labor market ability and the real wage rate. After the experiment, they could then sell or trade excess vouchers and purchase at market price the goods they did not consume during the experiment. The answer is that these vouchers (familiar only to the subjects in these experiments) are likely to trade at a substantial market discount. In addition, the number of bottled drinks, falafel sandwiches or pizza slices potentially earned from either complete labor-market or leisure specialization in this experiment would greatly exceed many subjects' optimal quantity of this good in a year. Even students value a diversified diet. The paucity of observed corner solutions in our experiments validates this reasoning.

[16] 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

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.

Our experiment consists of three parts with the first two parts serving as controls. 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 a within-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.

There is also an important between-subject aspect of the design that merits mention. Exposing all subjects to both tax treatments one after the other risks making transparent their equivalency, thereby unintentionally suggesting to subjects that they are expected to make identical labor-leisure choices. Moreover, order effects are non-existent in a between-subject design and session effects are rendered irrelevant since subjects in each session are equally divided between the two tax treatments.

A number of design choices were made to enhance the external validity of our results. The instructions to participants, for instance, explain the tax on goods and the tax on income precisely as such. In fact, the language of the instructions was purposely chosen to reflect the labor-leisure decisions and the taxation of goods and income outside of the laboratory. To frame our experiment in more neutral terms would subject our results to the critique

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.

that they may not be robust to a more realistic setting. Also, the subject repeated the same labor-leisure choice to allow for learning from the environment and past decisions. Finally, we recruited economics majors only. If economics students underestimate the impact of a reduction in real income through higher prices of consumption goods, as hypothesized, resulting in differential labor supply across the two tax treatments, then all the more so with a less savvy subject pool more susceptible to tax misperception.

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

[insert Table 2 here]

The next three rows display 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 $<$ .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. The difference in these differences of each subject's average response to the two taxes is 24.2 seconds ($s.d.$ = 10.5) and is significant at the 2% level.

Namely, subjects' labor supply is significantly more responsive to the income tax than the consumption tax, as hypothesized. The implied arc elasticities of labor supply with respect to the real net wage are 0.56 in IT and 0.24 in CT. The differential reaction to the two taxes can also 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.[17]

[insert Table 3 here]

Returning to our main result, regressions (1) and (2) of Table 4 report highly significant difference-in-difference estimates, with the subject's own labor market ability ($ability_i$), measured as the number of multiplication questions subject i correctly answered in Part One, as

[17] 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. See Farber (2005) and Fehr and Götte (2007) for critiques of this finding.

a control in (2). The coefficients of -24.2 and -23.9 on the treatment indicator IT reveals that subjects reduce their labor supply by an additional 24 seconds on average in response to the income tax compared to the equivalent consumption tax. The coefficient on $ability_i$ in (2) is small and not significantly different from zero.

[insert Table 4 here]

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). Regressions (3) – (6) in Table 4 report the regression results with subject i's labor supply in round t in seconds as the dependent variable. The random-effects GLS regression results in (2) 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.

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, regression (3) also includes dummies for rounds 2, 4 and 5, none of which is significantly different from zero.[18] In words, the only significant reduction in subjects' labor supply occurs in round 3 when the income or consumption tax is first introduced. Prior to the tax, subjects spend as much time solving multiplication problems in round 2 as in round 1. Subsequent to the tax's introduction (rounds 4 and 5), subjects' labor supply stabilizes.

The coefficients on IT, CT and the round dummies remain unchanged when the subject's own ability at the labor task is included in regression (4). The $ability_i$ variable is not

[18] This same finding holds if we interact the round 4 and round 5 dummies separately with each of the tax treatments.

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 counteracting 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 ($p < .01$).[19]

[insert Table 4 here]

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 a random-effects, double-censored Tobit regression in (6). 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 fact that a disproportionate number of these observations (26/45) appear in the no-tax rounds (despite having only 2/5 tax-free rounds) attests to subjects' labor supply sensitivity. 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.[20] Still, the intention to consume all leisure is revealed in 21 instances in which the subject stopped the clock between 1 and 6

[19] We also tried interacting $ability_i$ separating with IT and CT. The coefficients on both interaction terms are close to, and not significantly different from, zero.

[20] 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).

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 being in CT with no single attempt to consume all leisure in the no-tax treatment. Put another way, all instances of voluntary unemployment take place after taxes are introduced, with over 80% of them in the income tax treatment. A χ^2-test of proportions shows that these differences are highly significant ($p < .0001$, $df = 2$).

In Tobit regression (6), the dependent variable $labor\ supply'_{it}$ is adjusted to take on the value of 0 for all values 0 to 6 seconds and equals $labor\ supply_{it}$ for all other values. As in the GLS regressions, the marginal effects on IT and CT reported in (6) continue to differ significantly from zero and from one other at the 1% level. Again, neither $ability_i$ nor any of the round dummies is significantly different from zero.[21]

The inability of subjects' labor market productivity to explain the variation in their labor market allocation decision is surprising. Higher ability individuals are, by definition, more productive in a given amount of time. If, across the spectrum of abilities, subjects' average time devoted to the labor market is similar, then we would expect labor market earnings to rise with ability. To examine this possibility, we regress $ability_i$ as well as the tax treatment indicators and round dummies on subject i's net real labor market earnings (henceforth abbreviated as "net earnings") in round t.[22]

The highly significant coefficient of 0.66 on $ability_i$ in (7) indicates that each additional question a subject is capable of solving when he devotes the entire three minutes to the labor

[21] The Tobit regression is estimated using Gauss-Hermite quadrature with 12 points of evaluation (Stata's default). As a robustness check, we re-estimate (6) based on both 8 and 16 quadrature points. None of the coefficients changes by more than 0.001%.

[22] In each of the two no-tax rounds, a subject's net earnings simply equal his gross earnings (two points times the number of correctly answered multiplication questions), whereas net earnings are half of gross earnings for the three tax-inclusive rounds in both IT and CT.

task earns the subject 0.66 more points in net labor market income. In (8), we allow for ability to explain differentially a subject's net earnings in the tax and no-tax treatments. Indeed, each additional unit of ability translates into 0.85 additional points of income per round in the no-tax treatment compared to 0.46 points per round in the tax treatments.

Since abilities are similarly distributed across tax treatments, our main finding that subjects reduce their labor supply by a larger amount in IT than in CT should translate into more sharply reduced labor market earnings with the introduction of the tax in IT than in CT. The 16.4-point drop in net labor income in IT is in fact significantly larger than the 14.8-point decrease in net labor income in CT ($p = .038$). The IT and CT estimates are robust to the alternative specification of $ability_i$ in (8) and continue to differ significantly from one another ($p = .045$).

5 Conclusions

Two often-raised arguments in favor of a shift to a consumption tax are its administrative advantages compared to 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 (see McCaffery 2002). Our paper uncovers evidence for an additional, perceptual advantage: post-paid consumption taxes encourage higher labor supply than equivalent pre-paid wage taxes. This result 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. These findings violate the equivalence between these labor-income and consumption taxes upon which the optimal tax literature is premised and offer the potential for a welfare-improving government response, as our simple theoretical model demonstrates.

Much of the policy reform debate in the U.S. favors a pre-paid consumption tax such as

the individual cash-flow tax (that could take the form of a traditional Section 408 Individual Retirement Account), which is essentially a wage tax, over a post-paid consumption tax (such as VAT) as a candidate to replace income tax. Our evidence, to the contrary, 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.

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Appendix

Proof of Proposition: 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:

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

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 definition, 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 labor supply strictly increases with respect to the net-of-tax wage rate and the individual's misperception of the consumption tax ($\alpha < 1$); 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 from the strict concavity of the utility function 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 $\ell^{''}$, 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 ($c^{''}$, $\ell^{''}$) 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}. □

Table 1 - Ability-sorting algorithm

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

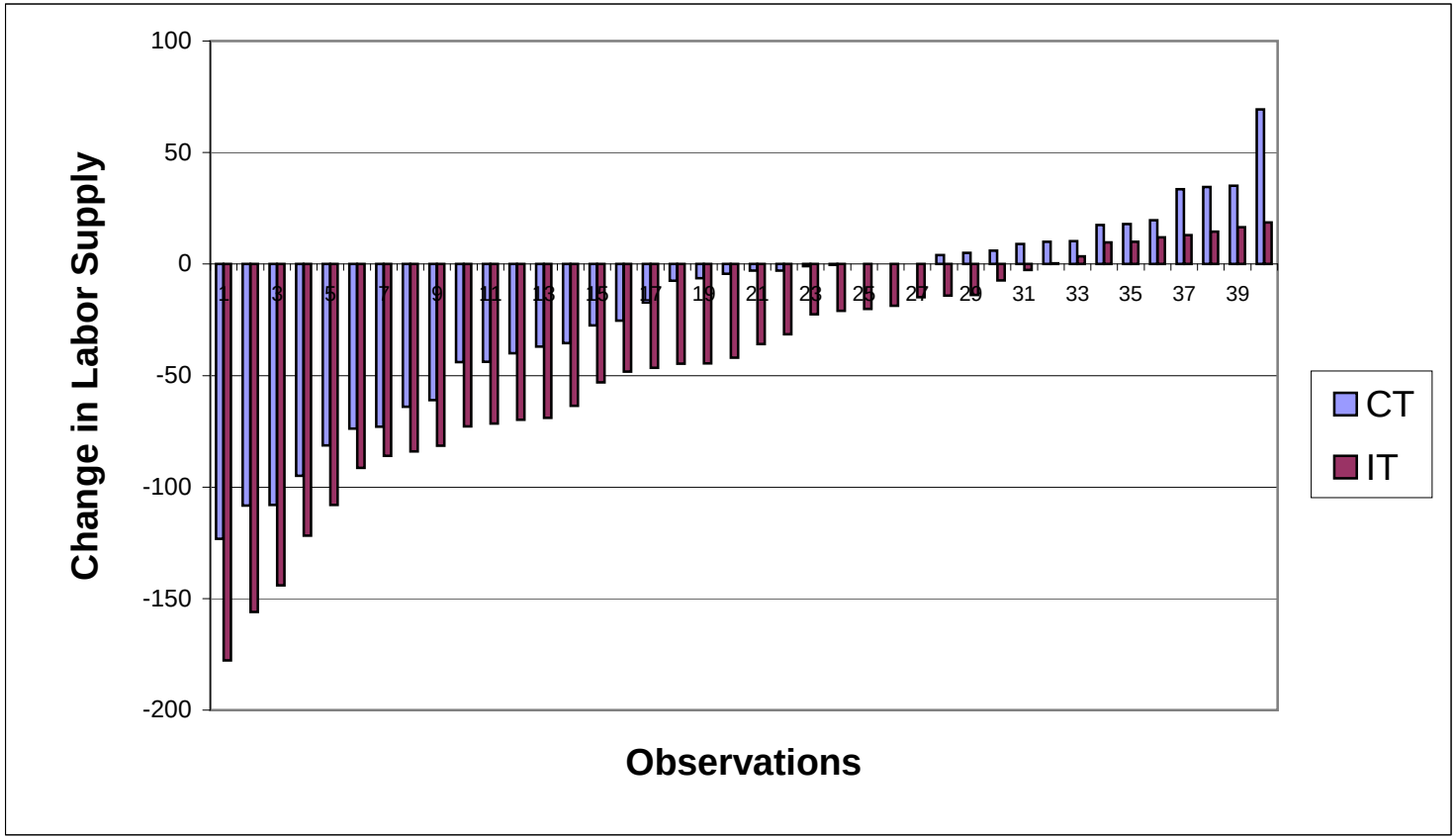
To balance the two tax treatments in terms of labor market productivity, subjects in a session are assigned to either the consumption tax treatment (*CT*) or income tax treatment (*IT*) according to the displayed ability-ranking algorithm.

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 (49.7)	40	-20.3 (44.1)	40
Δ labor supply in *IT* — Δ labor supply in *CT*	-24.2** (10.5)			
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 - Diff-in-diff, random-effects GLS and random-effects double-censored Tobit panel regressions

method	diff-in-diff	diff-in-diff	GLS	GLS	GLS	Tobit	GLS	GLS
dependent variable	Δ ave. labor supply$_i$	Δ ave. labor supply$_i$	labor supply$_{it}$	labor supply$_{it}$	labor supply$_{it}$	labor supply$_{it}$	net earnings$_{it}$	net earnings$_{it}$
variable \ equation	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
IT	-24.2** -10.5	-23.9** (10.6)	-38.9*** (6.0)	-39.0*** (6.0)	-36.5*** (7.0)	-37.6*** (6.2)	-16.4*** (0.9)	-15.0*** (1.0)
CT	---	---	-20.7*** (6.0)	-20.7*** (6.0)	-18.3*** (6.9)	-19.4*** (6.2)	-14.8*** (0.9)	-13.4*** (1.0)
ability $_i$	---	-1.17 (1.68)	---	0.90 (1.59)	---	0.51 (1.60)	0.66*** (0.17)	---
ability $_i$ * *notax*	---	---	---	---	1.22 (1.67)	---	---	0.85*** (0.18)
ability $_i$ * *tax*	---	---	---	---	0.57 (1.67)	---	---	0.46*** (0.18)
round 2	---	---	1.2 (5.2)	1.2 (5.2)	1.2 (5.2)	2.3 (5.2)	-0.30 (0.75)	-0.30 (0.75)
round 4	---	---	-5.4 (5.2)	-5.4 (5.2)	-4.0 (5.5)	-6.8 (5.2)	0.26 (0.75)	1.09 (0.80)
round 5	---	---	1.0 (5.2)	1.0 (5.2)	2.3 (5.5)	0.0 (5.2)	0.59 (0.75)	1.41* (0.80)
constant	-20.3 (7.0)	-13.8 (11.2)	135.2 (5.2)	130.1 (10.5)	128.2 (10.9)	---	15.7 (1.1)	14.6 (1.2)
Number of Obs.	80	80	400	400	400	400	400	400
ρ	---	---	.505	.508	.510	.532	.300	.296
R^2 / Log L	.06	.06	.11	.11	.11	-1817	.64	.65

*** p-value less than .01 ** p-value less than .05 * p-value less than .10

Difference-in-difference, random-effects GLS estimates and marginal effects from random-effects, double-censored Tobit regressions with treatment indicators (*IT* , *CT*), the subject's own labor productivity (*ability* $_i$) and round dummies as the regressors. Heteroskedasticity-robust standard errors in parentheses. The dependent variable is subject *i* 's average change in labor supply between the tax and no-tax treatment (1)-(2), subject *i* 's labor supply in round *t* ((3)-(6)), and subject *i* 's net earnings in round *t* ((7)-(8)).

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