Pricing of Differentially Taxed Securities: Experimental Evidence

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This study employs an experimental laboratory market to examine whether differentially taxed securities are priced to yield equivalent after tax returns. Five experimental markets are conducted in which taxable and nontaxable securities simultaneously are bought and sold by subjects. The profits realized from the taxable securities are subject to a proportional tax. An analysis of the data supports the veracity of the underlying microeconomic theory describing the effect of taxes on security prices.

INTRODUCTION

This research examines the equilibrium prices of two types of securities (taxable and nontaxable) in a laboratory market setting to determine whether their after tax yields are equivalent. Scholes and Wolfson (1992) have articulated a microeconomic theoretical framework based on the notion that in a market containing differentially taxed securities, investor demand for the tax-favored security will drive up its price relative to a fully taxable security, resulting in a lower pretax return for the tax-favored security. In the absence of market frictions, the marginal investor's after tax returns, on a risk-adjusted basis, will be equivalent across the differentially taxed securities.

Prior research has demonstrated that yield spreads between tax-favored and taxable securities differ (Poterba, 1989; Feenberg and Poterba, 1991). The results of Poterba (1989) and Feenberg and Poterba (1991) suggest that while tax-induced yield spreads exist, however, there is reason to question whether markets price securities to yield equivalent risk-adjusted, after tax returns. Specifically, their research results indicate that the relative pricing of comparable tax-exempt and taxable bonds do not fully reflect the marginal investor's tax rate.

The implications of the relative pricing of differentially taxed securities are far-reaching, particularly in understanding the effect of taxes on security market behavior. Prior research examining the effect of taxes on market behavior generally assumes that differentially taxed security prices fully reflect the securities' underlying tax attributes. Due to the complex market environments being studied, the veracity of this assumption generally cannot be demonstrated unequivocally. We are not aware of any published study that has been able to test explicitly the descriptiveness of this assumption due to the influence of confounding market factors. The relative pricing of differentially taxed securities also has implications for understanding the relation between taxes and corporate capital structures and the overall cost of capital. For instance, if the demand for tax-favored securities (e.g., corporate stock on which capital gains are subject to lower marginal rates) reflects the tax benefits of these securities to investors, corporate issuers may have the opportunity to

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minimize their cost of capital by issuing securities that are tax-favored to their investor clientele.

Like Poterba (1989) and Feenberg and Poterba (1991), this study examines the relative pricing of taxable and nontaxable securities. The purpose of this examination is to determine whether markets correctly price differentially taxed securities' tax attributes such that their after tax yields are equivalent. Unlike the other studies, however, we examine this research issue in an experimental setting employing a computer-based double auction program. The primary benefit of using the experimental method is to eliminate the potentially confounding frictions and noise present in naturally occurring markets. An experimental research method allows us to isolate the effect of taxes on security prices without also having to consider the competing effects of security risk, changes in security supply, and the unobservability of differences in investor expectations and marginal tax rates. Thus, our experimental method complements existing field research by providing a simpler setting in which to test and explore this theory.

PREVIOUS LITERATURE

The effect of taxes on security prices and returns has been of long-standing interest to researchers. Miller and Modigliani (1961) recognized that the differential taxation of security returns could lead to pretax security return and price differences resulting in a rejection of their dividend irrelevance proposition. Later, Brennan (1970) provided additional theoretical support for a tax effect by extending the capital asset pricing model to incorporate differentially taxed security returns. Following these theoretical studies, researchers (Black and Scholes, 1974; Litzenberger and Ramaswamy, 1982) have attempted to demonstrate empirically the relation between differential taxation and pretax security returns.[1] These empirical studies assume that capital gains are tax favored relative to dividends and investigate whether the before tax returns of low-dividend-yielding common stock are less than those of high-dividend-yielding common stock. The research results are mixed, leaving unanswered the issue of whether markets fully price securities' tax attributes.

Of direct relevance to our study, Poterba (1989) examined the change in yield spreads between prime grade, tax-exempt bonds and newly issued Treasury securities from 1955 through 1988. Poterba's results provide evidence that yield spreads reflect changes in individual tax rates. Feenberg and Poterba (1991) extend Poterba's (1989) results through 1990 and analyze the tax profile of bondholders. They posit that an after tax efficient market should price differentially taxed securities such that the after tax returns to the marginal investor are equivalent. This returns equivalency condition suggests:

$$(1)\ R_t * (1 - t_m) = R_{nt}$$

where:

R_t and R_{nt} = The pretax returns on risk-adjusted taxable and nontaxable securities; and

[1] Scholes and Wolfson (1992, pp. 366-368) provide a summary and discussion of this stream of research.

t_m = The marginal investor's tax rate.[2]

Feenberg and Poterba measured the difference in yield spreads by computing the annual implicit tax rate for both one year and 20 year maturity bonds.[3] Their results show that from 1980 to 1990 the implicit tax rates on one year maturity bonds ranged downward from 48.5 percent in 1980 to 26.1 percent in 1990. For 20 year maturity bonds, the implicit tax rates ranged downward from 30.8 percent in 1980 to 19.0 percent in 1990.

Their results suggest that in 1990 an investor with a marginal tax rate greater than 26.1 (19.0) percent would maximize his or her after tax returns by investing in one year (20 year) tax-exempt bonds rather than comparable taxable bonds. Feenberg and Poterba explain this difference between the one year and 20 year bond implicit tax rates by suggesting that the one year implicit tax rates reflect current tax rates while the 20 year implicit tax rates reflect both current and expected future tax rates.

A critical assumption underlying the theory tested in their study is the returns equivalency condition described in equation (1). Unlike prior research of this issue, Feenberg and Poterba examine Federal Reserve and tax return data to determine the tax rate of the marginal investor clientele.[4] Their data show that since 1982, households have had the largest percentage ownership of tax-exempt bonds. For example, in 1990 households directly (and through fund holdings) owned slightly less than 70 percent of the tax-exempt bonds, whereas the second largest holder (property and casualty insurance companies) owned just 13.7 percent of the outstanding tax-exempt bonds. Of these households, Feenberg and Poterba estimate that from 1987 to 1989 over one-half of the tax-exempt bonds were held by households with adjusted gross income of $100,000 or more and over one-third were held by households with adjusted gross income of $200,000 or more. The predominance of bond holdings by high tax rate households provides credible evidence that such households were the marginal investor clientele during this period.

As shown below, however, the computed implicit tax results raise concerns that either high tax rate households are not the market's marginal investor clientele or that the market failed to fully price the bonds' tax attributes. If high tax rate individuals were the market's marginal investor clientele, the relative pricing of taxable and tax-exempt bonds should result in implicit tax rates equal to the maximum statutory rate. Though the implicit tax rate on one year maturity tax-exempt bonds is generally within three to six percentage points of the statutory rate, the implicit tax rate on the 20 year maturity tax exempt bonds is roughly one-half of the maximum statutory tax rate. Without a

[2] The marginal investor is defined as the investor clientele that establishes the equilibrium price of the traded securities. Thus, it is the marginal investors' tax rate (t_m) that will drive the after tax return equivalency condition described in equation (1).

[3] The implicit tax rate, t_m, computed by Poterba (1989) and Feenberg and Poterba (1991) is equal to 1 - (R_{nt} + R_t) and represents the tax rate at which the marginal investor would be indifferent to investing in the tax-favored or nontax-favored security.

[4] A persistent weakness of prior research in this area is the extreme difficulty of accurately determining the marginal investors' tax rate. Prior studies that have examined this issue include Elton and Gruber (1970), Kalay (1982), Black and Scholes (1974), and Litzenberger and Ramaswamy (1979).

conclusive explanation for these mixed results, it is difficult to conclude whether markets are after tax efficient.

Year	Implicit Tax Rates		Maximum Statutory Tax Rate
	One year maturity	20 year maturity	
1987	33.4%	19.0%	38.5%
1988	31.5	15.5	28.0
1989	29.0	17.9	33.0
1990	26.1	19.0	33.0

Source: Feenberg and Poterba (1991)

Among the alternative explanations for these curious results are that investors fail to make adequate valuation allowances for differentially taxed securities (Bittker, 1980) and that security price comparisons are confounded by differences in risk across the securities (Fama, 1977). Prior studies, including Poterba and Feenberg and Poterba, are unable to rule out these explanations due to the variety of confounding frictions and noise inherent in price data from organized markets. In addition to the difficulties of adjusting market returns for differences in securities' risk, it also is difficult to ascertain the marginal investor's tax rate. Market participants often include corporations, trusts, pension funds, and individuals, all of whom are subject to varying income tax rates and income recognition rules. In addition, each of these participants may face uncertainty with regard to future tax rates which would affect the equilibrium pricing of differentially taxed securities.

ECONOMIC ENVIRONMENT AND HYPOTHESIS

Prior empirical studies of the effect of taxes on security returns and prices have used stock market or individual tax return data. While these data should provide a high degree of external validity, the lack of empirical consensus in their findings and the existence of rival explanations suggest that these studies lack sufficient internal validity.

The goal of an internally valid experimental design is to provide conditions in which the systematic variation from a manipulated effect can be maximized while simultaneously minimizing the error variance attributable to noise in the environment. Internally valid results are best achieved in a controlled laboratory setting.

In recent years, experimental economics (specifically experimental laboratory markets) has been used widely in economics research.[5] This method provides researchers both a high degree of internal validity and an alternative means to test economic theory. Furthermore, this method is useful because it provides economic theory its best chance to perform. If a theory is not descriptive in this simplified environment, it is doubtful how descriptive the theory is in a more complex environment such as the New York Stock Exchange.

[5] See Davis and Swenson (1988) for a discussion of the usefulness of using this method in tax policy research.

The goal of a laboratory market is to create a well-defined microeconomy. Smith (1982) characterizes a microeconomy as consisting of an economic environment and an institutional setting. An economic environment consists of agents (1, ... , N) and commodities (1, ... , K). Each agent possesses a utility function (u^i), a technological endowment (T^i), and a commodity endowment (w^i). Thus, the ith agent can be characterized by the vector $e^i = (u^i, T^i, w^i)$ defined on the K dimensional commodity space. The economic environment is then defined to be the collection, $e = (e^1, \ldots, e^n)$, of these triples.

In this study, the economic environment consists of six agents (three sellers and three buyers) and three commodities (cash, a wholly taxable security, and a nontaxable security). The securities do not have any intrinsic value but represent buyer claims to receive one of two equiprobable redemption values of either 100 or 700 francs at the end of the trading period.[6] Thus, the fully taxable and tax-exempt securities have the same pretax expected return distribution.[7]

An agent's technological endowment is the knowledge he/she brings to the environment. This knowledge is represented by each agent's expectation of the securities' end-of-period redemption value. In addition, agents are provided an initial wealth endowment at the beginning of each period. Sellers are endowed with five units each of the two types of securities, and buyers are endowed with initial working capital denominated in francs. Agents are assumed to be expected utility maximizers whose utility for the risky assets and/or cash is a function of their risk preferences and the exogenously determined explicit tax rate.

Smith defines an institution as the means by which agents communicate and exchange commodities for the purpose of modifying their endowments to maximize their own utility. An institution must contain a language (M) consisting of messages (m) that are sent by agents, a set of allocation rules (h(m)) which defines the final commodity allocation as a function of the messages sent, a set of cost imputation rules (c(m)) which defines the payment to be made by each agent as a function of the messages sent, and a set of adjustment process rules (G) which consists of market starting, transition and stopping rules. Thus, the ith agent's property rights are defined by $I^i = (M^i, h^i(m), c^i(m), G^i(*))$. A microeconomic institution is defined by the collection of these property rights.

This study's laboratory market requires agents' messages to take the form of bids (offers) from buyers (sellers) of individual securities. Acceptable messages are determined by the adjustment process rules. These rules specify that only buyers may place bids and sellers make offers for a single unit of the securities. Furthermore, a convergence rule requires that successive bids (offers) prior to an acceptance may not be less (more) than preceding bids (offers).

The allocation rules are a function of the messages sent between buyers and sellers of securities. These rules require that once a bid/offer agreement is achieved, the buyer is required to transfer cash to the seller in exchange for a single unit of the risky asset. The

[6] The experimental currency and redemption values are denominated in francs that are convertible into dollars at a known conversion ratio. The use of a grossed-up experimental currency in experiments is a common practice designed to avoid keyboarding errors associated with inputting dollars and cents.

[7] One pretax redemption value applicable to both types of securities is randomly determined at the end of each trading period.

seller recognizes either profit or loss by reducing the sale proceeds from the securities sold by an exogenously determined unit cost based on an upward sloping cost schedule. The unit cost is identical for both security types and is shown in Figures 1A and 1B.[8] Unsold securities have no value to the seller.[9]

Buyers recognized either profit or loss by reducing the actual redemption value of the securities held by the price paid. An additional cost to the buyers is a fixed-rate management fee or tax imposed on any profit realized from the taxable securities.[10] Buyers' are informed that profits from the purchase of taxable securities are subject to a 30 percent proportional tax rate, while profits realized from the purchase of nontaxable securities are not taxed. Furthermore, losses realized from either type of security are not subject to a tax, i.e., no tax refunds are given, nor could the loss be offset against profits in subsequent or preceding periods. Buyers retain no claim to unused working capital at the end of the period. Assuming the buyers' risk preferences are homogeneous, the aggregate demand function for each security type, as shown in Figure 1A, is perfectly horizontal and is a function of expected after tax profit.

In a competitive market equilibrium, the marginal, after tax economic profits earned by buyers on both security types is expected to be zero.[11] Given that the securities are risky, this zero profit condition is predicated on the assumption that buyers are risk neutral. The expected price of the taxable security (with no loss offset) is derived by solving the following equation for P:

$$(1)\ .5\ [(700 - P)\ (1 - .3)] + .5\ (100 - P) = 0$$

This equation yields an expected competitive equilibrium price of 347 francs for the taxable security. The expected price of the nontaxable security is 400 francs and is derived from the following equation:

$$(2)\ .5\ (700 - P) + .5\ (100 - P) = 0$$

Figure 1 illustrates the predicted market equilibrium and leads to the following hypothesis stated in the alternative form.

> **Hypothesis:** The equilibrium prices of the taxable and nontaxable securities will be 347 and 400 francs, respectively.

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[8] Although the cost schedule is identical for both securities, it is applied separately by security type. For example, the third nontaxable security sold has a cost basis of 290 irrespective of the number of taxable securities sold before that point.

[9] This is analogous to an initial public offering or new issue of a corporate security.

[10] The word *tax* was not used during the experiment to avoid introducing a real world term that could induce role-playing. The reader is referred to Plott (1982) for an expanded discussion of proper attributes of subject instructions.

[11] This statement reflects the fact that there is no benchmark return present in this experimental environment. Buyers have no alternative investment opportunity.

Figure 1A—Illustration of Market Supply and Demand Schedules

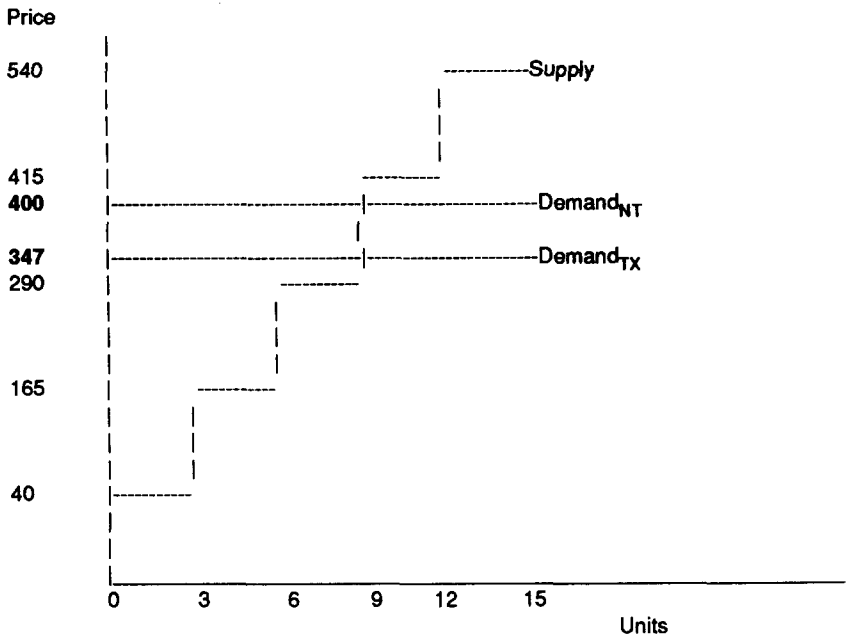


Figure 1B—Summary of Market Parameters

Buyers' Redemption Values (in francs)

High (p = .50)	Low (p = .50)
700 francs	100 francs

The expected and actual before tax redemption values were identical for the taxable and nontaxable securities
Buyers' tax rate: 30 percent
Buyers' currency conversion rate: 225 francs: $1

Sellers' Unit Cost Schedule

Unit Number	Cost Basis
1	40 francs
2	165
3	290
4	415
5	540

The unit cost schedule is identical for the taxable and nontaxable securities
Sellers' currency conversion rate: 525 francs: $1

SEQUENCE OF EXPERIMENTAL EVENTS

The data used in this study are generated from five separate experiments. In addition, two pretest experiments are conducted. Six subjects participated in each experiment. The experimental subjects are student volunteers enrolled in upper division and graduate-level accounting and business courses at a major state university. These students are used because they have completed courses in accounting, finance, and statistics. A flow chart of the sequence of events for each experiment is shown below.

Figure 2—Sequence of Experimental Events

Introduction and Training
- Subjects complete risk preference questionnaires
- Questionnaires reviewed and subjects assigned to terminals
- Make introductions and review instructions and materials
- Review trading procedures and rules
- Execute and record sample transactions
- Conduct practice trading sessions

Conducting the Experimental Market Trading Periods
- Announce high-low redemption values
- Open markets for the four-minute trading periods
- Close markets and randomly determine redemption values
- Subjects complete profit sheets for the period
- Monitor audits subjects' profit sheets

Completion of Market Trading Sessions
- Profit sheets are collected
- Subjects complete postexperiment questionnaires
- Subject earnings are verified and converted to cash
- Subject submit questionnaires and receive cash earnings
- End of experiment

Potential subjects first complete a risk preference questionnaire developed by Kachelmeier (1989). The instrument elicits certainty equivalents for 24 separate lotteries. Individual responses are reviewed and evaluated, and predominantly risk-neutral subjects are selected to participate in the experiment. This method does not ensure that subjects will perform in a risk-neutral manner, but it does provide a simple, low cost, nonobtrusive means of categorizing subjects by risk preferences.[12]

Each subject is assigned to a computer terminal.[13] Subjects read a set of instructions that subsequently are reviewed by the monitor. After answering subject questions, the market training session begins. The markets are designed as computerized, double auctions and conducted using the Multiple Unit Double Auction Program.[14] This program

[12] The use and validity of certainty equivalent solicitation instruments is based upon the seminal research of Becker, DeGroot, and Marschak (1964). The instrument used in this experiment is a modification to the one used by Harrison (1986) and recently used by Beck, Davis, and Jung (1991).

[13] To ensure privacy and confidentiality, each terminal is separated from the others by cardboard partitions that prevent subjects from seeing other subjects' computer screens or materials. Additionally, subjects are asked not to communicate with each other during the session.

[14] Experiments are conducted using the networked Multiple Unit Double Auction Program developed at California Institute of Technology and Southern University of Louisiana (Johnson, Lee, and Plott, 1988).

permits near-instantaneous buying and selling of multiple security types and displays current and past bid/ask information as well as each subject's cash and security balances.

The subjects first are directed through approximately 40 transactions by the monitor to become familiar with how the terminal function keys and software operate. After achieving a basic understanding of the procedures necessary to make trades, a number of four minute practice trading periods are conducted. The purpose of the practice periods is to increase subject understanding of the market trading process and subject computer proficiency. Subjects are not paid for the profits earned in these periods.[15]

Each of the five experiments consisted of seven, four minute live trading periods. At the beginning of each trading period, each buyer is endowed with a trading currency denominated in francs, and each seller is endowed with five units each of two types of securities. Prior to opening the markets, the monitor announces the possible redemption values of 700 francs and 100 francs to the subjects. When the markets open, subjects are free to trade either or both security types at will. At the end of the four minute period, the markets automatically close.

The realized state determines whether the redemption value of the securities held by buyers at the end of the trading period is 700 or 100 francs. The realized state is determined by a coin flip at the end of each trading period.[16] After determining the redemption value of the securities, the subjects are able to account for their profits or losses on their profit sheets. Their individual transactions and profit and loss computations are verified by the monitor. Once all the subjects have completed their accounting, the buyers and sellers are re-endowed with either securities or francs and the markets prepare for opening. At the end of the seventh market period, all subjects have their total earnings verified and converted into cash, complete a post-experiment questionnaire, and are dismissed. The subject franc-to-dollar conversion rates are established based on the results of two pretests and are designed to ensure adequate subject compensation. The currency conversion rates for buyers and sellers are included in Figure 1.

RESULTS

NECESSARY EXPERIMENTAL PRECEPTS

Before determining whether the data generated in the experiment support or reject the research hypothesis, we report the results of tests of whether the necessary precepts to create a valid microeconomy are established. Smith (1982) and Wilde (1981) state that a well-defined microeconomy is ensured if the reward structure satisfies the nonsatiation, saliency, dominance, and privacy precepts. Nonsatiation requires that subjects always prefer more to fewer dollar earnings. The saliency precept requires that subjects understand the relation between their actions and their earnings. Dominance is achieved if the payments made to the subjects are sufficiently large to dominate all other nonmonetary

[15] In the training periods the possible redemption values of both the taxable and nontaxable securities are 300 and 50 francs, and the management fee used is 15 percent. The training market parameters differ from the actual market parameters to avoid biasing subject responses in the actual market session.

[16] The post-experiment questionnaire asks subjects to indicate on a five point Likert scale whether they agree with a statement that the outcomes of the coin flips are random. Given a range of 1 (strongly agree) to 5 (strongly disagree), the mean response is 1.58.

arguments in their utility functions. The final precept, privacy, requires that subjects be unaware of the earnings of other subjects in the experiment.

This experiment uses subject responses to various questions and statements contained in the post-experiment questionnaire to determine whether these precepts are satisfied. The questionnaire statements and subject responses are summarized in Table 1. Subjects are asked to indicate on a five point Likert scale their agreement with each statement on the questionnaire. The coded value of the subject responses ranges from 1 (strongly agree) to 5 (strongly disagree).

Table 1—Adequacy of Experimental Constructs and Manipulations From Postexperimental Questionnaire Data

Statements	Mean Response*
Dominance Precept	
Compensation received was adequate	1.76
Compensation outweighed opportunity costs	2.00
Possible to earn substantial earnings	2.23
Hourly wage of most recent job	$7.16
Nonsatiation Precept	
Maintained a serious attitude	1.50
Saliency Precept	
Understood direct relationship between experimental profits and cash compensation	1.16
Privacy Precept	
Had no knowledge of other subject's earnings	1.77
Was aware of subject conversations	4.60
Adequacy of Subject Training	
Adequate preparation received in training session	1.50
Able to make trades and understand messages	1.43
Still learning procedures during market sessions	3.90
Understood how to compute and record profits	1.23
Strength of Tax Manipulation	
Management fee influenced bids	1.80

*Other than the hourly wage response, all responses indicate mean Likert scale values where the scale ranged from 1 (strongly agree) to 5 (strongly disagree). Tax manipulation responses are only applicable to buyer subjects. All other means are for all subjects

As shown in Table 1, the subject responses indicate a high degree of experimental realism and success in establishing these precepts. Subjects agree that the compensation received is adequate and exceeds their opportunity cost.[17] In addition, subjects indicate that they maintained a serious attitude, understood the direct relation between experimental profits and cash compensation, and had no knowledge of other subjects' earnings.

In addition to generating data to test the four experimental precepts, the post-experiment questionnaire also is used to measure the adequacy of subject training and the influence of taxes on buyer choice behavior. These results are summarized in Table 1. Overall, subjects respond that the training session did an adequate job of preparing them to perform in the markets and to record their performance. In addition, subjects in the buyer group indicate a sensitivity to the management fee or tax effect.

[17] For the one and one-half hour experiment, buyer and seller average earnings are $12.07 and $13.89 respectively.

Only the buyer group is subject to any exogenously imposed risk in this experiment. The expected prices generated from our hypothesis assume buyers are risk-neutral. Buyers' responses to the price judgment risk questionnaire are used to estimate the following regression equation:

$$(3)\ CE_i = a_i + \beta_{i1}(EV) + \beta_{i2}(EV)^2 + E$$

where:

CE_i = The ith buyer's certainty equivalent for the lottery; and
EV = The expected value of the lottery.

To assess whether the buyers are risk-neutral, the β_2 coefficient is tested to determine whether it is significantly different from zero. Based on our analyses, 13 of the 15 buyers are classified as risk neutral while the remaining two buyers are classified as risk averse.[18] In addition, the average fit of the regression is 86.8 percent.

PRICE DATA

Security price summary statistics for both the taxable and nontaxable securities are tabulated in Table 2 and are presented in Figures 3A and 3B. Though the two security

Table 2—Security Price Summary Statistics (in francs)

		All Observations			Last 20 Observations		
	No. of Obs.	Median	Mean	Std. Dev.	Median	Mean	Std. Dev.
Period 1							
Taxable	39	375	351[a]	76	383	368[a]	53
Nontaxable	53	390	361	80	420	383[a]	58
Period 2							
Taxable	43	340	340[a]	67	345	349[a]	54
Nontaxable	50	375	369	61	400	395[a]	53
Period 3							
Taxable	46	345	338[a]	45	323	345[a]	42
Nontaxable	46	350	357	49	375	369	44
Period 4							
Taxable	41	327	323	48	326	321	50
Nontaxable	42	353	347	50	330	332	47
Period 5							
Taxable	43	350	337[a]	41	357	345[a]	40
Nontaxable	51	365	364	42	395	387[a]	39
Period 6							
Taxable	43	355	345[a]	33	355	355[a]	22
Nontaxable	52	396	385	30	400	404[a]	21
Period 7							
Taxable	45	365	357[a]	35	367	361	29
Nontaxable	50	400	381	35	378	396[a]	22

[a]These mean prices are not significantly different from the predicted prices of 347 for the taxable security and 400 for the nontaxable security at $p < .05$

[18] An additional test is performed that tests the joint hypothesis that $a = \beta_2 = 0$ and $\beta_1 = 1$. The test yields similar results to those previously described.

Both of the subjects categorized as risk-averse were in the third experimental session. To determine whether this biased the subsequent test of the hypothesis, results are analyzed employing the data from all five sessions and all the data excluding the third session. The results using all the data except those from the third session are not significantly different from the results using all the data. Therefore, the subsequent analysis includes the data from all five experimental sessions.

Figure 3A—Security Price Plots and Interquartile Ranges

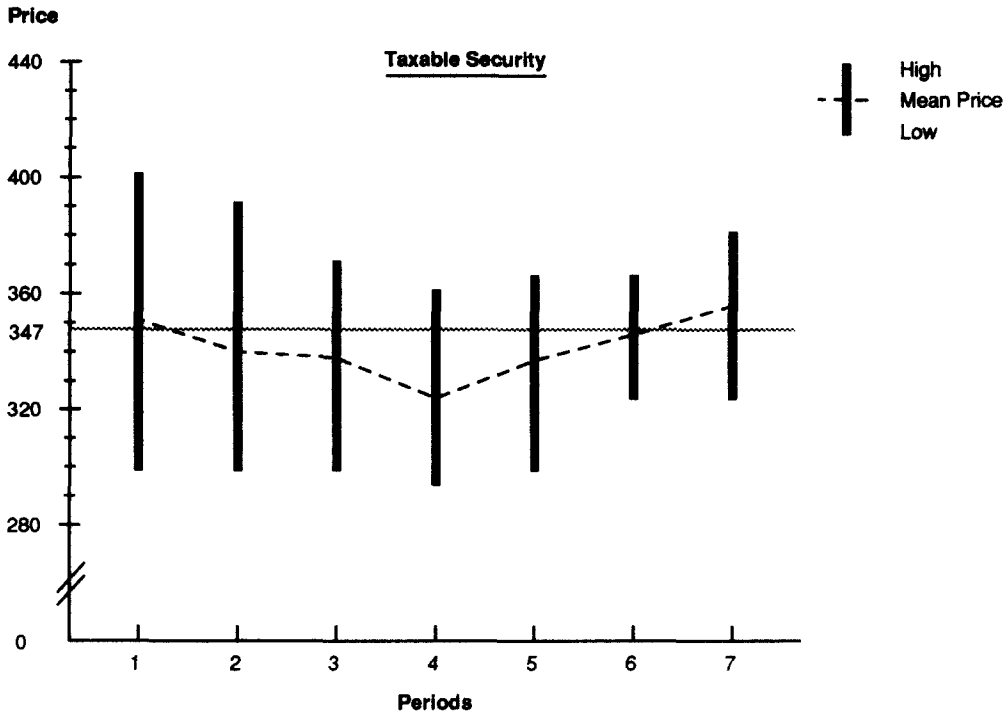
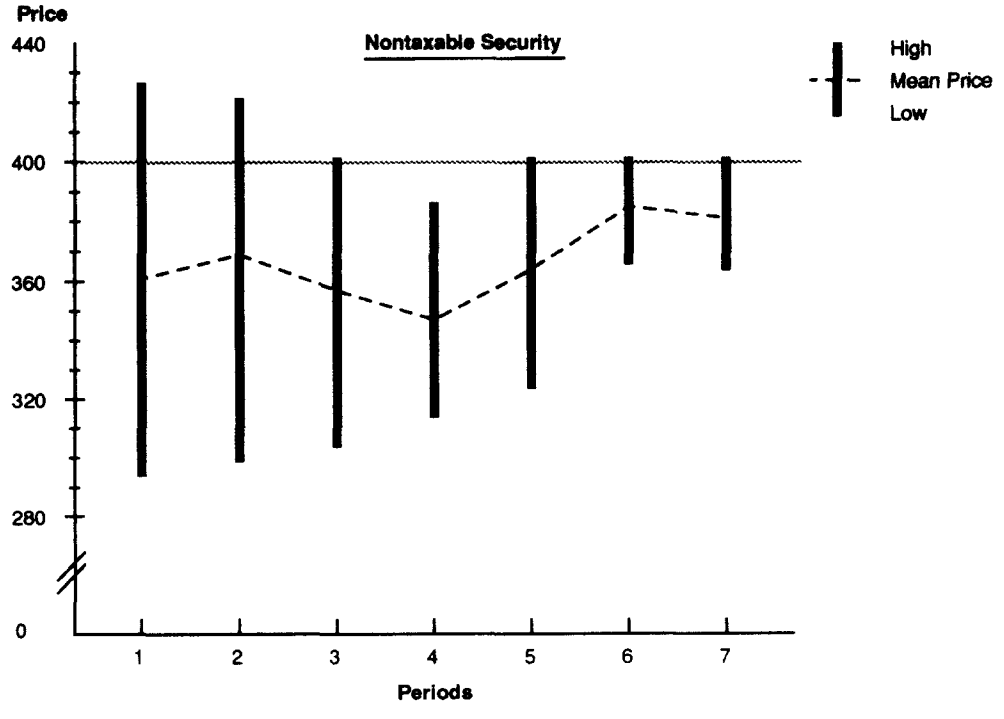


Figure 3B—Security Price Plots and Interquartile Ranges



types (taxable and nontaxable) are being traded simultaneously, their means and interquartile ranges are graphed separately to facilitate comparison. Before a test of the research hypothesis can be performed, it is necessary to determine in which period a market equilibrium occurs. The interocular evidence presented in Figures 3A and 3B and a review of the security price means, medians, and standard deviations suggest that the markets achieved a fair degree of price stability by period five. The absence of a market equilibrium in the earlier periods is largely attributable to the producer (or, in this case, seller) surplus inherent in the market design that was not bid away in these periods. Additionally, the beginning market periods may reflect subject learning effects. Because the theory being tested assumes a market equilibrium condition, our analysis is limited to the data generated in periods five through seven.

To test our research hypothesis, t-statistics are computed for each security type by period to determine whether the predicted taxable and nontaxable security price differ significantly from the actual security price distribution. As shown in Table 2, the taxable security's predicted price do not differ significantly from the actual mean taxable security price during periods five through seven. During these three periods, however, the nontaxable security's predicted price is significantly higher than actual mean nontaxable price.[19] These data indicate that the market consistently underpriced the nontaxable security's tax attribute contrary to our hypothesized result. Interestingly, this result is consistent with Poterba's and Feenberg and Poterba's findings of implicit tax rates lower than the maximum, statutory tax rate. This result suggests their lower than expected implicit tax rates could have occurred from the relative underpricing of the tax-exempt securities.

Though the market data show the nontaxable security's actual mean price is lower than the predicted price, it is likely that those trades occurring at the margin more fully reflect the market value of the nontaxable security's tax attribute. As shown in Figure 1, 3A, and 3B there is substantial seller surplus that gradually is bid away by the buyers as the markets progress. Due to the stair-step unit cost supply schedule used by the sellers, those trades occurring toward the end of a market period will be free of this seller surplus and provide better evidence of how the markets price the two security types at the margin.

This marginal trading activity is examined by looking at each security type's last 20 trades for periods five through seven. Security price summary statistics for each security type's last 20 trades in each period are tabulated in Table 2 and are presented graphically in Figures 4A and 4B. As is evident by comparing security price standard deviations and interquartile ranges, there is considerably less dispersion surrounding the last 20 observations' mean prices and much less evidence of seller surplus in periods five through seven.

Similar to our prior analysis, t-statistics are computed for each security type by period to determine whether the predicted taxable and nontaxable security prices differs significantly from the last 20 trades' actual security price distributions. Table 2 shows that only once, in period seven, did a predicted security price (the taxable security) significantly differ from the actual security price distribution. During periods five through seven, the mean taxable and nontaxable security prices are generally within 3 percent of the predicted prices. Because the last 20 trades in each period better reflect the decisions made in

[19] The mean nontaxable security price is significantly lower than the predicted price in all seven market periods including periods five through seven.

Figure 4A—Security Prices & Interquartile Ranges for 20 Observations

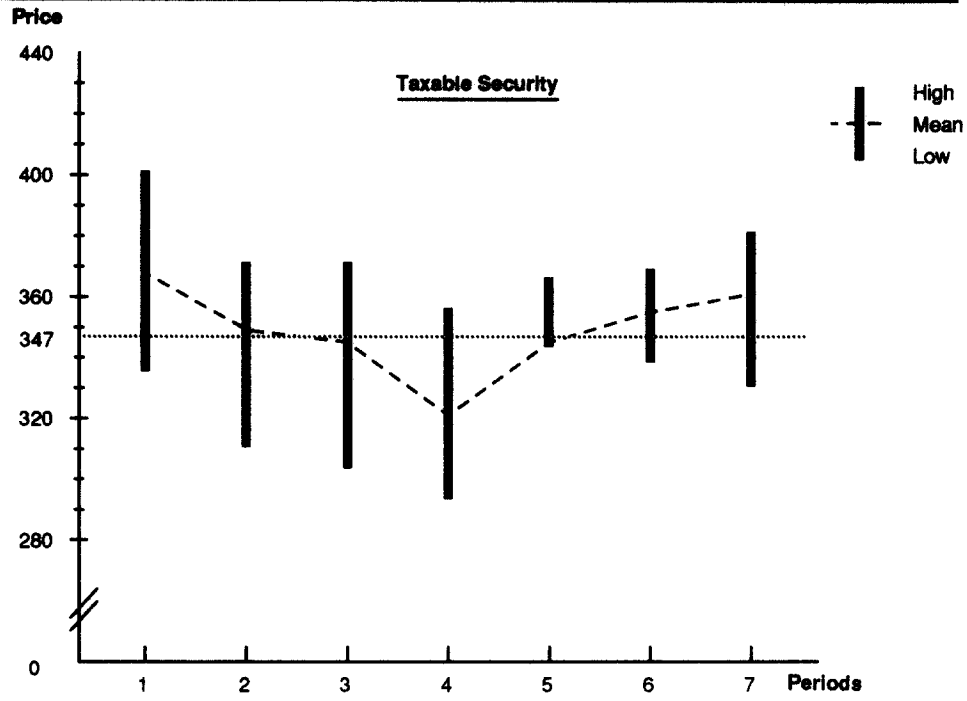
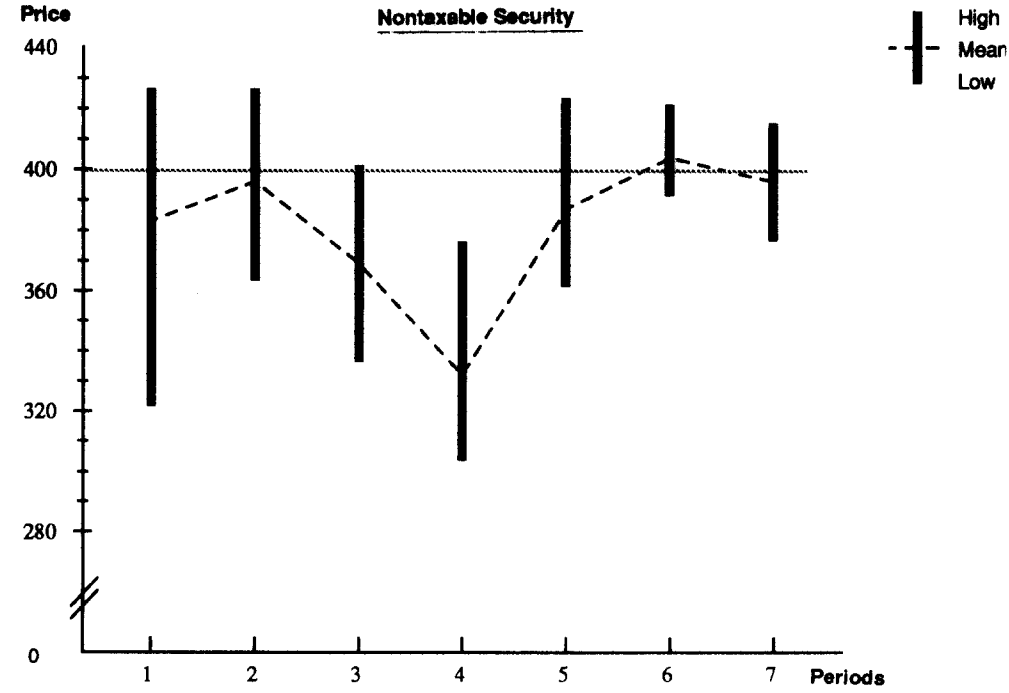


Figure 4B—Security Prices & Interquartile Ranges for 20 Observations



the absence of a seller surplus, this evidence provides the strongest support for our research hypothesis.

SUMMARY AND CONCLUSION

This study investigates the pricing of two differentially taxed securities in a single market environment. The data generated from five experimental sessions support the hypothesis that the taxable and nontaxable securities are priced to yield equivalent after tax returns in a competitive equilibrium. Unlike Poterba (1989) or Feenberg and Poterba (1991), this study is able to establish a single marginal investor tax rate and eliminate the noise and various confounds that exist in prior studies.

Although considerable theoretical and intuitive support exists for the after tax, risk-adjusted returns equivalency assumption underlying numerous prior empirical studies, this study represents an initial market test of this assumption's veracity. The ability to control the market environment and subject preferences allows us to operationalize constructs that cannot be measured accurately in an actual stock market setting. These results have implications for our understanding of prior research in this area and furthers our understanding of how taxes affect security market behavior.

The nature of experimental markets limits the generalizability of the results, however. While the ability to define and control the market environment contributes to a high degree of internal validity, it simultaneously weakens the external validity. If this economic theory is not descriptive in a best shot experimental setting, however, it is doubtful how descriptive it is in more complex market settings.

Although this study supports the fundamental theory concerning the influence of taxes on price behavior, several theoretical extensions remain to be examined. Future studies could begin to introduce into this controlled setting some of the market frictions found in naturally occurring markets (e.g., uncertainty regarding future tax rates). In addition, the economic environment created in this experiment could be extended further by assigning investors different marginal tax rates. Finally, the security risk-adjusted requirement could be relaxed by allowing each security's redemption value to be determined separately. This would permit additional tests of mean-variance efficient portfolio theory.

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