

Security Transaction Taxes and Market Quality

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This paper examines changes in market quality variables associated with nine modifications to the New York State Security Transaction Tax (STT) between 1932 and 1981. STTs are found to be directly related to individual stock volatility, bid-ask spreads, and the price impact of trades. Evidence of an inverse relationship is found between STTs and volume. No consistent relationship is evidenced between the level of an STT and the volatility of portfolios. We examine the propensity of traders to switch trading locations to avoid the tax and find no consistent evidence that they will change locations. Overall we conclude that an STT harms market quality.

Securities transaction taxes (STTs) have received renewed interest as a result of the recent economic turmoil. In September 2011 the European Commission put forward a proposal for a tax on all European Union stock, bond, and derivative trades.¹ EU finance ministers are far from agreeing on whether the tax should be implemented.² The current European debate mirrors the historical debate among academic theorists and empiricists. For example, advocates of STTs have argued that the tax can be used to raise significant tax revenue while discouraging destabilizing speculative trading and limiting excess volatility by ‘throw[ing] sand in the wheels’ of financial markets. Opponents of STTs, in contrast, argue that an STT will harm market quality by reducing volume, increasing price volatility and causing inefficient price discovery. They contend that an STT can lead to lower asset prices, an increased cost of capital for businesses, lower returns to savings and widespread tax evasion.

Empirical studies examining the implications of an STT either use a quasi-tax,³ test smaller markets which do not provide a variety of firm sizes, or look at international market competition where a lack of fungibility inhibits the transfer of volume from one exchange to another. Further, there is no existing empirical study of the impact of a U.S. imposed STT on market quality.⁴ Nor is there an empirical study that examines the direct impact of a security transaction tax on equity bid-ask spreads. This paper strives to fill that void by examining nine changes in the level of an STT imposed by New York State from 1932 to 1981. This is the first paper to comprehensively examine the impact of a U.S. imposed STT on various measures of market quality. In addition, unlike previous studies that observe the transfer of volume across country borders, our dataset offers the opportunity to test the hypothesis that an STT in New York State shifts volume from the New York Stock Exchange (NYSE) to U.S. regional exchanges.

While proponents of STTs argue that the imposition or increase in the tax will reduce speculative trading and thus volatility, we find no evidence to support that theory. In contrast, we find evidence suggesting that STTs and individual stock volatilities are directly related. Examining the volatility of portfolios (e.g. an index) we find that although the majority of events exhibit a direct association, most changes lack statistical significance. However, neither individual nor portfolio volatilities exhibit the inverse relationship predicted by proponents of the tax.

¹ The proposal calls for stock and bond trades to be taxed at 0.1% and derivative trades to be taxed at 0.01% of value.

² O'Donnell, John and Daniel Flynn. 2012. "German bid to save transactions tax gets cool response" Reuters, March 31, 2012.

³ A quasi-tax is a fixed financial payment required to trade (e.g. fixed commissions).

⁴ Amihud and Mendelson (1992) argue that a STT of 0.5 percent will increase transaction costs. Employing a model of asset pricing with transaction costs they project that a 0.5 percent STT will increase the average firm cost of capital by 1.3 percent and reduce the average NYSE stock price by 13.8 percent.

Being the first paper to empirically examine the impact an STT has on spreads, we find a direct relationship between STTs and bid-ask spreads. Consistent with previous literature we find that volume moves in the opposite direction of the tax change. Finally, we find a direct relationship between STTs and price impact. We control for market wide changes unrelated to the change in the STT level by conducting panel regressions with fixed effects for each market quality variable. Our results are robust, and taken together we find that an STT harms market quality.

In the following section, we review the regulatory history of U.S. STTs at both the state and federal level. We then review existing theoretical and empirical work in section III. Section IV describes our data and presents our methodology, Section V contains results and is followed by our conclusions in section VI.

II. Regulatory History

The first New York State transfer tax was imposed on June 1, 1905 at the rate of two cents per \$100 of par value on stocks traded, transferred, or delivered in New York State.⁵ The tax was not implemented as a financial stability measure, but a revenue generator and was estimated to produce annual revenues of \$5,000,000 to make up for the state deficit.⁶ The original law contained a graduated tax schedule for stocks with par values below \$100. In 1906, the New York legislature passed an amendment to the law which eliminated the graduated schedule for stocks with par values less than \$100. In January of 1907 that amendment was declared unconstitutional and the graduated schedule was reinstated. Seven years later in response to some companies issuing stock with no par value, the law was amended to place a two cent tax on shares issued without par value.⁷ Suffering under the weight of the Great Depression, New York doubled the STT on March 1, 1932 to four cents per \$100 of par value and four cents per share for stocks without a par value to meet large state deficits. The graduated feature of the tax was effectively maintained for stocks with par values less than \$100 per share. For example, a stock with a par value of \$10 paid an STT of \$0.004 per share.

In an effort to avoid the now doubled STT, firms began reducing their par values. By March of 1933 200 listed firms had reduced their par values to between \$1 and \$10 thereby greatly reducing the impact of the tax.⁸ In response to this trend, New York's governor proposed that the

⁵ Traded refers to the location of the exchange or contra broker. Transferred refers to the location of the transfer agent. Delivered refers to the domiciles of the stock's seller.

⁶ "The Stock Transfer Tax", *New York Times*, March 14, 1905.

⁷ "Stock Transfer Tax Amendment," *Wall Street Journal*, Jun 4, 1913.

⁸ "Brokers Assail Stock Tax Plan," *New York Times*, Mar 26, 1933.

tax be changed to a price basis rather than par value.⁹ Effective June 2, 1933 the tax became \$0.03 *per share* for stocks trading below \$20 a share and \$0.04 *per share* for stocks trading at or above \$20.

In 1945 the schedule was modified for shares selling for less than \$20. In particular, for shares selling for less than \$5, a tax of \$0.01 per share was charged; for shares selling between \$5-10 a tax of \$0.02 per share was charged; for shares selling between \$10-20 a tax of \$0.03 per share was charged; and for shares selling for over \$20 a tax of \$0.04 was charged.¹⁰ This tax schedule remained in effect for 21 years, when on July 1, 1966 the STT was increased by 25%.

Following the 1966 STT increase, the NYSE began lobbying New York State to reduce the tax stating that it put them at a competitive disadvantage relative to out-of-state exchanges. As it had done in the past, the NYSE threatened to move out of New York to avoid the tax. Bowing to pressure from the NYSE, in 1968, an amendment was introduced that gradually reduced the tax imposed on non-residents until it reached a reduction of 50% by July 1, 1973.¹¹ At the time, 12% of US investors were subject to the tax as New York residents.¹² The amendment also capped the maximum tax liability per trade for residents and non-residents placing orders within New York to \$350.

In August 1975, a 25% surcharge was imposed on all stock transactions, which would expire on July 31, 1978. Prior to its expiration, the U.S. Supreme Court found the 1968 amendments to be unconstitutional because they violated the interstate commerce clause by discriminating against interstate sales.¹³ New York taxed sales made on non-New York exchanges more heavily than those sales made on New York exchanges. As a result, following the 25% surcharge expiration on July 31, 1978, a four year phase-out period began. During this period, rebates were issued to residents, non-residents and orders placed through the Intermarket Trading System (ITS).¹⁴ For New York residents, starting October 1, 1979, 100% of the tax was paid and 30% was rebated; beginning October 1, 1980, 60% was rebated; and starting October 1, 1981 100% was rebated. The phase-out period was slightly different for non-residents who continued to pay 50% of the tax through July 31, 1978 and from August 1, 1978 to September

⁹ Ibid.

¹⁰ "Transfer Tax Bill Signed", *New York Times*, April 20, 1945.

¹¹ Between July 1, 1969 to June 30, 1970 non-residents paid 95%; July 1, 1970 to June 30, 1971 non-residents paid 90%; July 1, 1971 to June 30, 1972 non-residents paid 80%; July 1, 1972 to June 30, 1973 non-residents paid 65% and starting on July 1, 1973 and thereafter non-residents paid 50%. See "Stock-Transfer Tax Cut Is Signed," *New York Times*, June 23, 1968.

¹² Ibid.

¹³ U.S. Supreme Court. "Boston Stock Exchange v. State Tax Commission." 429 U.S. 318 (1977). <http://supreme.justia.com/us/429/318/>

¹⁴ The intermarket trading system is an electronic linkage system that links together U.S. equity exchanges and 100% of the tax was rebated on all orders placed through ITS so that the tax would not hinder market competition. As a result, non-residents could avoid the tax entirely by placing orders through ITS.

30, 1980, paid 62.5%. This coincided with the expiration of the 25% surcharge and left the effective tax paid by non-residents unchanged. Starting October 1, 1980 non-residents were subject to the same tax schedule as residents. Appendix A illustrates effective transfer tax rates for various stock prices and partitioned by whether the investor was a New York resident or not.

New York was not the only taxing authority to levy transfer taxes. On December 1, 1914, the federal government imposed a \$0.02 tax on each \$100 of par value of stock to help pay for the cost of US involvement in World War I. That tax was repealed briefly in September of 1916, but reinstated in December 1917.¹⁵ On June 21, 1932 the tax was changed to \$0.04 per \$100 of par value, unless the stock was trading above \$20 in which case it was \$0.05 *per \$100 of par value*. Stocks without par values were taxed on a per share basis. On September 20, 1941, the tax was increased to \$0.05 (\$0.06) per \$100 of par value for stocks trading at or below (above) \$20 per share. The federal tax was repealed in January 1966.

Massachusetts and Pennsylvania also levied transfer taxes at one time, but their impact was much smaller than the New York tax. By 1939 Massachusetts and Pennsylvania levied a tax of two cents per \$100 of *aggregate par-value* of stock sold or two cents per share in the case of no par-value stock.¹⁶ The fact that New York levied the tax on a per share basis and Massachusetts and Pennsylvania used aggregate par value resulted in a much higher tax paid in New York.^{17,18}

Corporations could reduce the impact of the tax on their shareholders, by managing their par values. To investigate this possibility, we obtain par values for our sample of 236 stocks from the 1932 doubling of the New York tax from the Moody's Manuals for 1934.¹⁹ We find that railroad industry stocks tend to have par values of \$100 (20 out of 27 firms). For the 200 non-railroad industry stocks covered by Moody's, there were only ten with par values of \$100, while 132 listed no par value and 58 had par values between \$1 and \$50. We also examine reported changes in par value around the 1932 New York doubling of their STT. We find that 28 firms (from our sample of 236) changed their par value between 1930 and 1933. Of these 28 we find that 24 changed to a par value that lowered taxes based on par.²⁰ Therefore we conclude that

¹⁵ "Wall St. Sees End of Stock Sales Tax", *New York Times*, July 4, 1916.

¹⁶ Recall that New York switched to taxing on a per share basis much earlier.

¹⁷ For example, assume a trade involving 100 shares of a \$10 par value stock for \$40 a share. The New York tax is \$4 (\$0.04 on each share sold) while the Pennsylvania and Massachusetts tax is \$0.20, since the aggregate par-value of the 100 shares is \$1,000. It can therefore be seen that the New York tax is 20 times greater than the tax in Massachusetts or Pennsylvania. See "Stock-Deal Taxes and Their Effects", *New York Times*, December 10, 1939.

¹⁸ Both the MA and PA transaction taxes remained inconsequential and were repealed in the 1950s.

¹⁹ See *Moody's Manual of Investments and Security Rating Service* volumes for industrial, bank and financial, public utility, and railroad securities.

²⁰ Fifteen increased their par value from zero to a small positive number and nine reduced their par to a smaller number. The remaining four firms reduced their par value to zero.

firms actively changed their par values to avoid STTs for their investors. Thus, STTs that are based on share price cannot be avoided by corporate actions and will have the largest impact on investors. We would then expect the New York STT to have a measurable impact on investor behavior and hence market quality.

One purpose of this study is to examine the change in market share across state lines around transaction tax changes. Since the federal transfer tax could not be avoided inside the United States and states other than New York imposed a minuscule tax, we focus on those tax changes occurring in New York. We are however cognizant of confounding impacts so we are careful to control for changes in federal tax rates around the time of New York tax changes.

III. Literature Review

Theoretical papers have not reached a consensus on the impact of STTs on market quality. Some argue that an STT will improve market quality, while others argue that it will reduce it. Still others state that the effect is ambiguous. Following is a review of the different camps in this ongoing debate.

The earliest proponents of STTs, Keynes (1936) and Tobin (1978), argue that an STT will improve market quality. In particular, Keynes contends that chasing short-term returns, while potentially profitable to some, is a zero-sum game in terms of economic welfare. Since one investor's gain is another's loss and trading utilizes resources, the value-added through trading is negative. As a result, imposing an STT may increase welfare by reducing wasted resources. Second, since trading is speculative by nature, it potentially contributes to financial instability when trades are driven by short-term capital gains and not fundamental information. Keynes argues that an STT will curtail short-term speculation, and thereby reduce wasted resources, market volatility and asset mispricing. Consistent with Keynes, Tobin (1978) proposes a tax on foreign exchange transactions that would make short term currency trading unprofitable. He suggests that a transaction tax would "throw some sand in the wheels of speculation."

Consistent with these arguments, Stiglitz (1989) and Summers and Summers (1989) argue that an STT targets short-term noise traders whose trades contribute to *excess* market volatility. Therefore, an STT is associated with a reduction in volatility.

Stiglitz (1989) further argues that the impact of an STT on market liquidity would be insignificant. He contends that although an STT will lead to thinner markets, the change in

spread will be insignificant since the extra time that market-makers hold securities will not yield a significant change in the inventory risk component of the spread.

In stark contrast to the proponents of an STT, the opponents argue that an STT will have an adverse impact on market quality. In particular, Kupiec (1991) develops a model where an STT is directly related to excess volatility. Similarly, Amihud and Mendelson (2003) conclude that an STT is directly related to volatility since STTs reduce the amount of informed trading, thereby widening the gap between the transaction prices and the security's fundamental value. Lastly, Song and Zhang (2005) argue that although an STT may reduce noise traders, quoted depth will diminish leading to an increase in volatility.

Schwert and Seguin (1993) suggest that there is no evidence of *excess* volatility and since the tax is a burden on all traders, the reduction in trading will not limit the activity of noise traders alone—it will affect liquidity traders and price-stabilizing informed traders as well. Therefore, the impact of the tax on volatility is ambiguous. The authors also argue that an STT would indirectly increase transaction costs through the three components of the bid-ask spread: order processing costs, inventory risk and information asymmetry.²¹ For example, since an STT reduces trading volume, the number of trades available for the market-maker to recover his fixed cost declines, thereby increasing the order processing component of the spread.²²

Amihud and Mendelson (1992) estimate the impact of a hypothetical 0.5% STT on spreads, returns, and stock values for NYSE stocks using turnover data from the late 1980s. They conclude that a 0.5% STT would increase the cost of equity by 1.3% and reduce the price of the average NYSE stock by 13.8%

Just as the theoretical literature is divided on the impact of STTs on market quality, so too is the empirical literature. Apart from Roll (1989), which performs cross-country regressions, the eleven empirical studies examine 28 different STT tax (and quasi-tax) changes in 11 different countries. We summarize the empirical literature in Table 1 and discuss it below. For each paper we list the change in percentage tax (quasi-tax) for each event since there may be a relationship between the size of the change and the impact on volatility. We also list for each paper the measures examined in the paper as well as the finding for each measure. Statistically significant

²¹ The order processing component is part of the fixed cost the market-maker charges for trade execution. The inventory risk component is the market-maker's compensation for holding onto risky assets. The information asymmetry component represents the likelihood that a market-maker is facing an informed trader who has superior knowledge of the asset's fundamental value.

²² An STT will also increase the order processing component directly due to the cost of collecting the tax. Second, because equity market-makers use derivatives to hedge their risky inventory positions, an STT on derivatives increases the cost of hedging their positions. The increase in the market-maker's cost for hedging increases the inventory risk part of the bid-ask spread. Finally, if an STT reduces the amount of noise trading, as proponents suggest, then the possibility of the market-maker facing an informed trader increases, thereby increasing the information asymmetry element of the bid-ask spread.

findings are indicated by an asterisk, otherwise the finding is insignificant. Rather than discussing each paper separately we will focus on the findings for each measure of market quality examined.

A. Volatility

Of the nine papers that empirically examine changes in volatility around changes in STTs, only one (Roll (1989)) finds the inverse relationship predicted by Stiglitz (1989) and Summers and Summers (1989). That relationship is, however not significant. Two of the papers (Baltagi, Li, and Li (2006) and Jones and Seguin (1997)) find a statistically significant direct relationship between volatility and the level of an STT which supports the predictions of Kupiec (1991) and Amihud and Mendelson (2003). The remaining papers either find an insignificant direct relationship (Umlauf (1993) and Hau (2006)) or conclude that they find no relationship.

B. Volume

Each of the five studies that examine the relationship between volume and an STT find evidence of an inverse relationship. Baltagi, Li, and Li (2006) find a statistically significant relationship while the remaining papers (Hu (1998), Liu (2007) Sahu (2008) and Jarrell (1984)) report an insignificant inverse relationship.²³ These papers support the theoretical predictions of an inverse relationship argued by Schwert and Seguin (1993). A complementary measure related to volume used in the literature is market share. For example, Campbell and Froot (1994) point out that in many cases domestic investors can avoid STTs by trading in another country. Consistent with Campbell and Froot, Umlauf (1993), finds that an increase in a securities transaction tax is associated with a decline in market share in the domestic country. Existing studies may not be able to capture the true level of volume transferred between exchanges due to currency risk concerns as well as the lack of fungibility existing across borders.

C. Bid-Ask Spreads

Prior to this study there has been a lack of empirical evidence of the impact of an STT on bid-ask spreads. The literature on the impact of stock transaction taxes on spreads largely relies on the indirect effect of trading volume on liquidity.

²³ Jarrell (1984) does not conduct tests of significance.

Bloomfield, O'Hara and Saar (2009) examine the relationship between spreads and STTs in a laboratory setting in the context of different types of traders. They examine three scenarios for the impact of an STT on the components of bid-ask spread. If noise traders are less active because of the STT, the inventory risk component of the spread may decrease; the adverse selection cost may increase; or it may remain unchanged. If noise traders trade less, then prices will be less volatile and the inventory risk component of the bid-ask spread will decline, thereby increasing liquidity. However, if noise traders trade less, increasing the probability of informed trading, then the adverse selection costs could increase, resulting in an increase in spreads. Finally, given a decline in noise trading from an STT, informed traders may trade less aggressively on their information, keeping adverse selection costs unchanged. Bloomfield, O'Hara and Saar use the total price impact as a proxy for spreads and find no significant effect on spreads or price impact.

The empirical literature does not reach a consensus. By empirically examining nine changes in the level of an STT in the same market with market share not being clouded by fungibility, this paper adds to the empirical literature on STTs.

IV. Data and Methodology

We obtain dates for changes in the level of security transaction taxes at the state and federal level from the New York Times and Wall Street Journal. As stated earlier, in addition to the federal stock transfer tax instituted in 1914, the states of New York, Massachusetts, and Pennsylvania all enacted STTs during the last century. As previously shown, the Massachusetts and Pennsylvania taxes were minuscule so they are ignored. Since one goal of this paper is to examine whether traders move their trading to avoid taxes, we do not examine the nationwide federal tax. We then focus on changes in the New York STT from its imposition in 1905 through its elimination in 1981. The dates and tax rates are contained in Appendix A. There are eleven tax changes that impact both residents and non-residents. The October 1, 1968 tax change placed a cap of \$350 on the tax paid for one transaction. The cap impacted trades of over 7,000 shares for prices above \$20 and trades of over 28,000 shares for prices less than \$5. Since this was limited to larger trades we would not expect a market wide change in market quality and thus do not examine that change.

We use daily closing prices and volume to estimate the impact of an STT on volatility, percentage effective bid-ask spreads and price impact. Daily closing prices and volume for the NYSE and American Stock Exchange (AMEX) are obtained from the Center for Research in

Security Prices (CRSP). The CRSP databases do not contain prices prior to 1925; therefore due to data limitations we are not able to examine the imposition of the New York STT in 1905. We then limit our study to the nine remaining tax changes that impact both residents and non-residents.

Consistent with Jones and Seguin (1997), we define sample stocks as all those continuously traded on the two New York stock exchanges - the NYSE and AMEX from one year before to one year after each tax change. There are four exceptions to this rule due to the proximity of confounding events. The March 1932 New York increase occurs just three months before the June 1932 doubling of the federal STT. As stated earlier, corporations managed the STT paid by their investors by changing their par values. We hypothesize that changing the New York STT to a per share basis (June 1933) will have a larger impact on market quality than doubling the amount taxed on par value at both the New York (March 1932) and Federal (June 1932) level. To test this hypothesis we use the twelve months before the March 1932 New York event and the eleven months June 1932 through May 1933 as the post period. For the July 1966 New York state tax increase, six months pre and post are used to avoid a confounding influence related to the January 1966 elimination of the federal security transaction tax. Similarly, fixed commissions (a quasi-transaction tax) were abolished three months prior to the August 1975 STT increase. Therefore, the 1975 event uses three months pre and post. Finally, the August 1, 1978 tax change coincides with the introduction of the Intermarket Trading System. A pilot program of 11 stocks traded on the NYSE and Philadelphia Stock Exchange began in April 1978. Between August and November 1978 the program was expanded to include all inter-listed stocks on multiple regional exchanges. The 1978 tax change gives orders placed through ITS (and destined for the NYSE) a 100% rebate. To avoid confounding influences of the ITS start up period, we define the post period for the 1978 tax change as December 1978 through June 1979.

In their study of the elimination of fixed commissions, Jones and Seguin (1997) employ NASDAQ stocks as a control sample. Until, June 1, 1982 NASDAQ market makers were not required to report their trades. Although CRSP contains data on NASDAQ starting in 1972, stocks prices are the mid-point of the closing bid and ask and not actual trade prices. Returns derived from these prices are then based on spread midpoints and not closing prices. Therefore, NASDAQ stocks would not be an adequate control sample for NYSE and AMEX stocks for which closing prices are available (but not bids and offers). We thus focus on NYSE and AMEX stocks.

Table 2 reports cross-sectional means of stock prices, market values and standard deviation of daily returns for each STT change. We observe that the average price is fairly stable over the entire sample period. We also note that volatility exhibits a temporal monotonic decline.

The market quality measure that has garnered the most attention in theoretical and empirical papers is volatility. Of the nine papers listed in Table 1 that examine volatility, four examine individual stock volatility and five examine the volatility of an index or portfolio. To be comparable with previous papers, we measure volatility for individual stocks as well as for portfolios. Since we are interested in the behavior of noise traders following changes in STTs, we estimate individual stock volatilities to capture the full impact of their behavior. Forming portfolios may diversify away the impact of noise traders on volatility. However, Jones and Seguin (1997) argue that the portfolio approach is superior to examining single stocks since most investors hold portfolios. We therefore also estimate portfolio volatilities. Our portfolios consist of all NYSE and AMEX stocks, so they are equivalent to an index.

We employ the following methodology to analyze portfolio volatilities. For each day t over the estimation period we calculate the equally weighted return for portfolio p , R_{pt} . To estimate σ_{pre} and σ_{post} we follow Johnson and Kotz (1970) (as well as Jones and Seguin (1997)) and estimate the standard deviation of each portfolio p by multiplying the mean absolute value of returns by $\sqrt{\pi/2}$, where π is the mathematical constant.²⁴

To obtain an estimate of the change in portfolio volatility following a tax change, we regress the standard deviation of each portfolio on a dummy variable $I_{Post,t}$ which takes the value 1 if the day is after the tax change, otherwise zero or,

$$(1) \quad \sqrt{\frac{\pi}{2}} |R_{p,t}| = \beta_{p0} + \beta_{p1} I_{post,t} + \varepsilon_{p,t},$$

where β_{p0} then represents an estimate of the pre-event volatility and β_{p1} represents the change in volatility from the pre-event. Newey-West standard errors with five lags are reported for the volatility change β_{p1} .²⁵

The next market quality measure we examine is spread width. This measure has not been previously examined in the extant literature. However, bid and ask data are not available for US stocks prior to the 1990s. Recently Holden (2009) has developed a low frequency proxy for effective spread width that Goyenko, Holden, and Trzcinka (2009) show provides good estimates

²⁴ See Johnson and Kotz (1970).

²⁵ Since data on returns based on closing prices for NASDAQ stocks nor spread midpoint data for NYSE and AMEX stocks is not available for the period of our study, we cannot perform the control sample tests that Jones and Seguin (1997) with any degree of confidence.

of actual effective spread. In Holden, V_t is the fundamental stock value at the end of day t and develops as

$$(2) \quad V_t = V_{t-1} + \frac{1}{2}\lambda S_{t-1}Q_{t-1} + \varepsilon_t$$

where S_{t-1} is the effective spread, λ is the portion of the half-spread resulting from adverse selection Q_{t-1} is the trade indicator that specifies a buy/sell/no trade transaction and ε_t is the public information shock. The price change process is then

$$(3) \quad \Delta P_t = \frac{1}{2}S_t Q_t - (1 - \lambda) \frac{1}{2}S_{t-1}Q_{t-1} + e_t$$

Where e_t is normally distributed with \bar{e} mean and σ_t standard deviation. To estimate the Holden model a likelihood function is first estimated by maximum likelihood (ML) and the parameter estimates are then used to compute the effective spread.

To understand the Holden methodology, assume that on three consecutive trading days, there are three observable prices (P_t, P_{t+1}, P_{t+2}) which correspond to a price cluster triplet and a half spread triplet $(C_t, C_{t+1}, C_{t+2}), (H_t, H_{t+1}, H_{t+2})$ respectively. The half spreads are unique to each price cluster and are determined from each cluster. For example, an odd eighth price such as \$20 1/8 is assigned to price cluster $C_t = 1$ and has a single possible spread, $S_t = \$1/8$. From this spread there are only two possible half spreads $H_t \in \{\$1/16, \$-1/16\}$. P_{t+1} and P_{t+2} correspond to half spreads H_{t+1} and H_{t+2} in the same way.

Next, the likelihood function is constructed and can be estimated using ML for each price triplet as

$$(4) \quad \Pr(P_t, P_{t+1}, P_{t+2} | \mu, \widehat{\gamma}_1, \widehat{\gamma}_2, \dots, \widehat{\gamma}_{j-1}, \bar{e}, \sigma_t, \lambda) \\ = \sum_{(H_t, H_{t+1}, H_{t+2}) \in H} \{ \Pr(C_t) \Pr(C_{t+1}) \Pr(C_{t+2}) \Pr(H_t | C_t) \Pr(H_{t+1} | C_{t+1}) \Pr(H_{t+2} | C_{t+2}) n(P_{t+1} - H_{t+1} - (P_t - (1 - \lambda)H_t)) n(P_{t+2} - H_{t+2} - (P_{t+1} - (1 - \lambda)H_{t+1})) \}$$

where μ is the probability of a trading day, $\widehat{\gamma}_1, \widehat{\gamma}_2, \dots, \widehat{\gamma}_{j-1}$ are the spread probabilities except for the largest spread, \bar{e} is the mean of the error term, σ_t is the standard deviation of the error term, λ is the percentage of the spread attributed to the adverse selection component, $n(\cdot)$ is the normal density with mean \bar{e} and standard deviation σ_t , and $\Pr(C_t)$ and $\Pr(H_t | C_t)$ are the probability of a price cluster and conditional probability of a half spread given a price cluster, which are calculated based on the price grid.

Taking the log of the above likelihood function gives the general likelihood function, which sums all the log likelihoods of all price triplets over the time period

$$(5) \quad \sum_{t=1}^{T-2} \text{Ln} (\text{Pr}(P_t, P_{t+1}, P_{t+2} | \mu, \hat{\gamma}_1, \hat{\gamma}_2, \dots, \hat{\gamma}_{j-1}, \bar{e}, \sigma_t, \lambda))$$

where T represents the number of days in the time period.

Once the likelihood function is estimated the effective spread is calculated as

$$(6) \quad \text{Holden} = \frac{\sum_{j=1}^J \hat{\gamma}_j s_j}{\bar{P}},$$

where \bar{P} is the mean of the closing prices, $\hat{\gamma}_j$ is the estimated spread probabilities which sum to one and s_j is the possible spread. Following Holden (2009) we use the frequency with which closing prices occur in particular price clusters, to estimate the corresponding spread probabilities.

Two other market quality variables of interest are volume and market share for exchanges in and out of New York around each tax change. Traders can switch their trading to an exchange outside of New York to avoid the New York STT if that opportunity exists. However, for the majority of our sample period, shares were traded in physical form so it was necessary for brokers and transfer agents to be close to each other to transfer actual securities. As a result, it was more difficult for investors to avoid the tax. In addition, while many NYSE stocks were traded on regional exchanges outside of New York, American Stock Exchange stocks were not. Therefore, we limit this part of the study to NYSE stocks. If traders do indeed switch to non-NYSE venues to avoid the tax then we should see a reduction in the NYSE's market share and volume following tax increases and an increase following tax reductions. To obtain the needed data, we hand collect monthly volume figures from the Bank and Quotation Record for each regional exchange as well as the NYSE. Market share is estimated as the total trading volume for each exchange in month t divided by the total sum of volume on all exchanges. That is,

$$(7) \quad \text{marketshare}_{x,t} = \frac{\text{volume}_{x,t}}{\sum_{x=1}^n \text{volume}_{x,t}},$$

where x represents the total volume on exchange x in month t . To calculate impacts we average market share for each exchange over either the pre or post period.

The final market quality measure we examine is price impact. If an STT reduces volume then we would expect trades to have larger price impact, *ceteris paribus*. Again, due to data limitations during the period of our study we rely on low-frequency proxies for price impact. We rely on the Amihud (2002) price impact measure which has been shown by Goyenko, Holden

and Trzcinka (2009) to be a good proxy for price impact. Specifically, Amihud's illiquidity proxy is measured as

$$(8) \quad Amihud = \frac{|r_{i,t}|}{\$Volume_{i,t}},$$

where $r_{i,t}$ and $\$Volume_{i,t}$ are the stock return and dollar volume for stock i on day t , respectively. This ratio can be interpreted as the daily price impact of order flow because it measures absolute price change per dollar of daily trading volume.

In the next section we discuss the results of tests to measure changes in our market quality measures around STT changes.

V. Results

The first market quality measure we examine is volatility. Recall that proponents of an STT argue that the imposition or increase in the tax will reduce speculation and hence volatility. Therefore they predict an inverse relationship between an STT and volatility. However, only one (Roll (1989)) of the nine empirical papers cited in Table 1 that examine volatility finds evidence of an inverse relationship as predicted by proponents of the tax.²⁶ Seven papers find no statistically significant relationship, while Jones and Seguin (1997) find a statistically significant direct relationship between the tax and volatility.

To be comparable with the majority of previous papers that examine the relationship between STTs and volatility we first examine the volatility of daily return for individual stocks. The results are contained in Panel A of Table 3. Panel A reports the date and nature of each change in the first column. The next column lists the percentage point change in the STT for a \$5 stock. The next three columns list the average pre, post and change in volatility. Examining the change in volatility relative to the change in the level of the STT, we find that for eight of the nine STT changes stocks evidenced a change in volatility in the same direction as the STT change. Six of the eight changes that exhibit a direct relationship with STT level are statistically significant at acceptable levels.

However, the observed changes may be due to market wide changes in volatility unrelated to the change in STT. Therefore we perform a one-way fixed effects model for our unbalanced panel of the form:

$$(9) \quad Y_{it} = \varphi_t + \beta \%STT_{it} + \theta X_{it} + \varepsilon_{it}$$

²⁶ Only nine of the ten papers examine volatility. Liu (2007) does not.

where Y_{it} is the standard deviation of returns for stock i at period t (*pre or post*). φ_t is the time fixed effect. To estimate %*STT* we first determine the applicable STT and then calculate $\%STT_{it} = \frac{STT_i}{AvgPrice_i}$, where STT_i is the tax per share for stock i that depends on the *AvgPrice* in that period. X_{it} represents control variables: *AvgPrice*, *AvgDailyVolume*, and the Holden percentage effective spread proxy. We include eight events (1933, 1945, 1966, 1975, 1978, 1979, 1980 and 1981). We exclude the 1932 event, which is based on par values and therefore we cannot calculate the %*STT*. We then assume that the %*STT* is equal to zero for all stocks prior to 1933 (when the per share tax was first imposed) and post 1981 (when the tax was repealed).

The parameter estimates are contained in Panel B of Table 3. The variable of interest is %*STT*. Examining that parameter estimate we find that it is positive and statistically significant after including time fixed effects. This provides additional evidence which suggests that STTs are directly related to volatility.

Our next step is to use the methodology of Jones and Seguin to examine the relationship between portfolio volatility changes and the level of STTs. The results of the regressions detailed earlier are found in Table 3 Panel C. The parameter estimate of interest is β_{pl} which measures the change in volatility following the change in the STT. Examining the parameter estimates in column four reveals that in five instances volatility appeared to change in the direction of the tax change (1932, 1933, 1966, 1980, and 1981) while the level of volatility appears to move in the opposite direction of the tax change for four of the events (1945, 1975, 1978, and 1979). Although the majority of the estimates are consistent with a direct relationship between STT and portfolio volatility, only four of the nine estimates are statistically significant at acceptable levels. Therefore, we conclude that there appears to be no consistent relationship between portfolio volatility and the level of an STT.

The next market quality measure we examine is spread width. This measure has not been previously examined in the extant literature. Since bid and ask data is not available for US stocks prior to the 1990s, we employ the Holden low frequency measure described in Holden (2009). We first examine univariate changes in spread width surrounding our STT events. The pre-event, post-event, and change in spread are listed in Panel A of Table 4. Examining the average change in spread and comparing it to the change in STT reveals that in all cases spread width changed in the direction of the STT. In all but one case, the change is statistically significant at acceptable levels.

As with individual stock volatility, to test for market wide changes in volatility we perform a one-way fixed effects model for our NYSE and AMEX unbalanced panel of the form:

$$(10) \quad Y_{it} = \varphi_t + \beta \%STT_{it} + \theta X_{it} + \varepsilon_{it}$$

where Y_{it} is the Holden effective spread measure for stock i at period t (*pre or post*). φ_t is the time fixed effect. To estimate $\%STT$ we first determine the applicable STT and then calculate $\%STT_{it} = \frac{STT_i}{AvgPrice_i}$, where STT_i is the tax per share for stock i that depends on the *AvgPrice* in the period. X_{it} represents control variables: *AvgPrice*, *AvgDailyVolume*, and the standard deviation of return. The parameter estimates are contained in Panel B of Table 4.

As before, the variable of interest is $\%STT$. Examining that parameter estimate we find that it is positive and statistically significant. This provides additional evidence consistent with the univariate statistics which suggests that STTs are directly related to effective bid-ask spread width.

Given the inverse relationship between spread width and volume documented in previous literature, and given that we find spreads to have a significant direct relationship with changes in STT levels, we would also expect volume to have an inverse relationship. Of the five papers listed in Table 1 that examine volume, all five find an inverse relationship between an STT and volume, but only one is statistically significant. Accordingly, we next examine volume. We must remember though that the STT changes we examine only impact New York State exchanges, corporations, and residents. Therefore we expect the impact of changes in the level of the New York STT to mostly impact New York exchanges. We must also remember that in some circumstances non-New York investors could avoid the tax by trading on exchanges outside of NY. Changes in STTs may induce those that can to switch trading to another exchange. Umlauf (1993) documents that the increase in Swedish transaction taxes in 1986 is associated with a dramatic shift in trading from Stockholm to London.

We therefore examine both market share and volume for the NYSE and regional exchanges in Table 5. Listed is the average market share and monthly share volume for each exchange before and after each New York STT change. During the time period of our study (1932-1981) an increasing portion of regional stock exchange volume was in NYSE listed stocks.²⁷ Therefore, we expect that regional stock exchange market share would increase (decrease) when New York State increases (decreases) the level of the STT. However, because the New York State tax was applied as long as part of the transaction took place within the state (i.e. if the location of the exchange, contra broker or transfer agent is in New York or if the stock seller is domiciled in New York) and most brokers and transfer agents were located in New York, it may have been

²⁷ See Weaver (2008) for a discussion of the changing role of regional stock exchanges in the 20th Century.

difficult for investors to shift their trading and avoid the STT. Examining the market share numbers contained in columns 2 through 4 of Table 5, we find that for five of the nine STT changes (1933, 1945, 1966, 1975, and 1978) the sign of NYSE market share change was opposite that of the STT sign change, and in four cases it was of the same sign. Therefore, our results are mixed.

Some investors may not switch to (from) a regional exchange if there is an increase (decrease) in the New York STT. Some may just not trade certain stocks. Therefore, we also look at volume since it captures volume switched to other exchanges as well as decisions to not trade at all. Examining NYSE volume in the last three columns of Table 5 reveals that, in eight of the nine STT changes, volume moved in the opposite direction of the tax change. Six of those eight cases are statistically significant at acceptable levels. Therefore we conclude that, consistent with previous empirical papers, STTs and volume are inversely related.

Since trading volume acts as a shock absorber for price impacts, we would also expect that changes in STT levels would affect measures of price impact. We examine that possibility by considering the Amihud measure. An increase in the Amihud measure indicates a decrease in liquidity in that a given volume will have a larger price impact. A direct relationship between the Amihud measure and changes in the STT would suggest that STTs harm market quality, while an inverse relationship would suggest that it improves it. Table 6 provides univariate changes in the Amihud measure surrounding STT level changes. Examining the univariate changes in the Amihud measure after the STT changed reveals that for seven of the nine STT changes the Amihud measure changed in the direction of the tax change and that all seven cases are statistically significant at acceptable levels. This suggests that STTs adversely impact market quality.

Panel B contains parameter estimates of a one-way fixed effects model similar to that performed for individual stock volatilities and effective spreads for our NYSE and AMEX unbalanced panel. The parameter estimate for $\%STT$ is positive and statistically significant providing additional support for the notion that STTs are directly related to the Amihud measure.

VI. Conclusion

Security transaction taxes have been the subject of debate for decades among academics that develop models of the relationship between STTs and market quality, empiricists who examine the relationships for existing taxes, and governments seeking to raise revenue without harming economic growth. In spite of the length of the debate, no consensus has yet been reached. We

add to the debate by examining the impact on market quality of nine changes to the New York State STT between the first significant change to it in 1932 and its repeal in 1981.

We find that increasing an STT is accompanied by an increase in average stock volatility and transaction costs for investors, a reduction in volume, and higher price impact for trades. We find no consistent relationship that suggests that investors will switch trading to non taxing venues to avoid the tax, but do find that corporations will manage par values in the direction of minimizing taxes if they are based on par value. Finally, we find no consistent relationship between STTs and portfolio volatilities.

Our findings largely come down on the side of opponents of the tax who suggest that an STT will harm market quality. Since spreads have been shown to be directly related to a firm's cost of capital, imposing an STT may hinder economic growth by reducing the present value of projected profits.

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Appendix A

TABLE A.1—CHANGES IN THE NEW YORK STATE SECURITY TRANSACTION TAX

Date	P<\$5	\$5<P<\$10	\$10<P<\$20	\$20<P	Change to State STT
Panel A: Effective tax rate on per share basis for residents placing orders in New York					
June 1, 1905	\$0.02 on \$100 par value of stock transferred in New York State on round lots				Began
March 1, 1932	\$0.04 on \$100 par value of stock transferred in New York State on round lots.				Doubled
June 2, 1933		\$0.030		\$0.040	Changed to per share basis
July 1, 1945	\$0.010	\$0.020	\$0.030	\$0.040	Reduced for stocks less than \$10
July 1, 1966	\$0.013	\$0.025	\$0.038	\$0.050	25% increase
Oct 1, 1968	\$0.013	\$0.025	\$0.038	\$0.050	Capped at \$350
Aug. 1, 1975	\$0.016	\$0.031	\$0.047	\$0.063	25% surcharge
Aug. 1, 1978	\$0.013	\$0.025	\$0.038	\$0.050	25% surcharge expires
Oct 1, 1979	\$0.009	\$0.002	\$0.026	\$0.035	After 30% rebate
Oct. 1, 1980	\$0.005	\$0.010	\$0.015	\$0.020	After 60% rebate
Oct 1, 1981	\$0.000	\$0.000	\$0.000	\$0.000	After 100% rebate
Panel B: Effective tax rate on per share basis for non-residents placing orders in NY					
June 1, 1905	\$0.020 on \$100 par value of stock transferred in New York State on round lots.				Imposed
March 1, 1932	\$0.040 on \$100 par value of stock transferred in New York State on round lots.				Doubled
June 2, 1933	\$0.030	\$0.040	Changed to per share basis		
July 1, 1945	\$0.010	\$0.020	\$0.030	\$0.040	Reduced for stocks less than \$10
July 1, 1966	\$0.013	\$0.025	\$0.038	\$0.050	25% increase
Oct 1, 1968	\$0.013	\$0.025	\$0.038	\$0.050	Capped \$350
July 1, 1969	\$0.012	\$0.024	\$0.036	\$0.048	Paid 95%
July 1, 1970	\$0.011	\$0.023	\$0.034	\$0.045	Paid 90%
July 1, 1971	\$0.010	\$0.020	\$0.030	\$0.040	Paid 80%
July 1, 1972	\$0.008	\$0.016	\$0.024	\$0.033	Paid 65%
July 1, 1973	\$0.006	\$0.013	\$0.019	\$0.025	Paid 50%
Aug 1, 1975	\$0.008	\$0.016	\$0.023	\$0.031	25% surcharge
April 17, 1978	(\$0.000)	(\$0.000)	(\$0.000)	(\$0.000)	(rates for ITS orders)
Aug 1, 1978	\$0.008 (\$0.000)	\$0.012 (\$0.000)	\$0.023 (\$0.000)	\$0.031 (\$0.000)	non-residents pay 62.5% coincide w. surcharge expiration
Oct. 1, 1979	\$0.006 (\$0.0)	\$0.001 (\$0.0)	\$0.023 (\$0.0)	\$0.022 (\$0.0)	non-residents pay 62.5%
Oct. 1, 1980	\$0.005 (\$0.000)	\$0.010 (\$0.000)	\$0.015 (\$0.000)	\$0.020 (\$0.000)	After 60% rebate
Oct. 1, 1981	\$0.000	\$0.000	\$0.000	\$0.000	After 100% rebate

Notes: This appendix summarizes changes in the New York State Security Transaction Tax from its imposition in 1905 to its elimination in 1981. Beginning in 1932 the tax was charged on a per share basis. At various points during the reign of the tax, state residents were taxed differently than non-residents. For these reasons we list the effective tax for New York State residents (Panel A) and non-residents (Panel B) separately. We also list the effective tax per share for stocks of different prices as listed in tax legislation. In both Panels, P is the security price and the last column indicates the general direction of the tax rate.

TABLE 1—SUMMARY OF RESULTS OF PREVIOUS EMPIRICAL PAPERS

Panel A. Changes in STT					
Paper	Country	Year(s)	Change From	Change to	Measures Examined and Finding
Umlauf (1993)	Sweden	1984	0.0%	1.0%	Volatility - Direct Price Levels - Inverse Market Share - Inverse
		1986	1.0%	2.0%	
Baltagi, Li and Li (2006)	China	1997	0.3%	0.5%	Volume - Inverse* Volatility - Direct*
		Hong Kong	1991	0.6%	
	1992		0.5%	0.4%	
	1993		0.4%	0.3%	
	Japan	1977	0.3%	0.45%	
		1980	0.45%	0.55%	
1978		0.0%	0.5%		
Hu (1998)	Korea	1979	0.5%	0.25%	Price Levels - Inverse* Volatility - No relationship Volume - Inverse for small stocks. No relationship for large stocks.
		1987	0.25%	0.5%	
		1990	0.5%	0.2%	
	Taiwan	1994	0.2%	0.35%	
		1978	0.15%	0.3%	
		1985	0.3%	0.0%	
Liu (2007)	Japan	1986	0.0%	0.3%	Price Levels - Inverse* Volume - Inverse
		1993	0.3%	0.6%	
		1989	0.55%	0.3%	
Roll (1989)	23 countries	January 1987 to March 1989			Cross-country regressions Volatility - Inverse
		1963	2%	1%	
Saporta and Kan (1997)	UK	1974	1%	2%	Price Levels - Inverse Volatility - No relationship
		1984	2%	1%	
		1986	1%	0.5%	
Sahu (2008)	India	2004	0.0	0.15%	Volume - Inverse Volatility - No relationship Price Levels - No relationship
		1998	0.0	0.3%	
Phylaktis and Aristidou (2007)	Athens Stock Exchange	1999	0.3%	0.6%	Volatility - no impact in "normal" economic conditions, but direct relationship during bull markets
		2000	0.6%	0.3%	
Panel B. Changes in Quasi-STT					
Jarrell (1984)	USA	1975	Deregulation of fixed commissions Up to 1%		Volume - Inverse
Jones and Seguin (1997)	USA	1975	Deregulation of fixed commissions Up to 1%		Volatility - Direct*
Hau (2006)	France	2004	Increases in transaction costs		Volatility - Direct

Notes: This table summarizes the results of empirical papers that examine the relationship between Security Transaction Taxes (STT) and the quality of equity markets. All but one of the papers examines changes in the STT or quasi STT. For each paper we list the country examined, the STT change year, and the change. The last Column lists the market quality measures considered and the reported relationship with the STT change. If the relationship is found to be statistically significant, it is indicated by an asterisk (*). Panel A lists those papers that examine STTs while Panel B lists those papers that examine quasi STTs.

TABLE 2—SUMMARY STATISTICS

Event	% Change in STT	# of firms	Price	Market value	σ
March 1932 STT doubled	0.02%	236	19.6	102.0	0.053
June 1933 changed to per share	0.58%	238	26.0	126.6	0.052
July 1945 reduced for stocks less than \$10	-0.40%	526	32.7	79.6	0.039
July 1966: 25% increase	0.10%	1,704	28.3	286.8	0.031
August 1975: 25% increase	0.13%	1,912	17.4	326.9	0.028
August 1978: 25% decrease	-0.16%	1,646	22.2	489.0	0.021
October 1979: 30% rebate	-0.14%	1,742	22.6	518.4	0.021
October 1980: 60% rebate	-0.20%	1,802	24.0	583.0	0.022
October 1981: 100% rebate	-0.40%	1,702	19.9	546.3	0.025

Notes: This table lists summary statistics for NYSE and AMEX stocks following nine changes in the New York State Stock Transfer Tax over the period 1932 to 1981 (when the tax was abolished). Sample stocks are all those continuously traded on one of the two exchanges - one year pre- and post- each tax change. There are four exceptions to this due to the proximity of confounding events: March 1932 eleven months pre and twelve post; July 1966 six months pre and post; August 1975 three months pre and post; and August 1978 twelve months pre and 6 months post (starting in December 1978). For each event we list the percentage change in the security transaction tax for a stock with a market price and par value of \$5. Descriptive statistics given for both samples include the cross-sectional average price per share on the day prior to each event, the average market value (millions) on the day prior to each event, and the average individual stock standard deviation for the trading period prior to each event.

Table 3 - Volatility

Panel A. Univariate Statistics - Individual Firms				
Date and Event	% Change in STT	Volatility- pre	Volatility- post	Δ Volatility <i>t</i> -statistic
March 1932 STT doubled	0.02%	0.053	0.057	0.004 5.2***
June 1933 changed to per share	0.58%	0.052	0.058	0.006 8.95***
July 1945 reduced for stocks less than \$10	-0.40%	0.039	0.041	0.002 3.57***
July 1966: 25% increase	0.10%	0.031	0.038	0.007 9.64***
August 1975: 25% increase	0.13%	0.028	0.031	0.002 8.16***
August 1978: 25% decrease	-0.16%	0.021	0.021	-0.0002 -1.59
October 1979: 30% rebate	-0.14%	0.021	0.022	-0.0001 -1.77
October 1980: 60% rebate	-0.20%	0.022	0.025	-0.003 9.47***
October 1981: 100% rebate	-0.40%	0.025	0.025	-0.0002 -2.16*
Panel B. Panel Regression- Individual Firms				
%STT	AvgPrice	AvgDailyVolume (E-8)	% Effective Bid- Ask Spread	Adjusted R ²
0.031	-0.0002	6.00	0.19	0.09
19.27***	-15.03***	25.23***	27.00***	

Table 3 continued on next page

Table 3—Volatility
(continued)

C. Portfolio volatilities

Date and Event	% Change in STT	β_{p0} (pre- event)	β_{p1} (change) <i>t</i> -statistic
March 1932 STT doubled	0.02%	0.033	0.006 1.98*
June 1933 changed to per share	0.58%	0.060	0.009 2.77***
July 1945 reduced for stocks less than \$10	-0.40%	0.010	0.002 2.76***
July 1966: 25% increase	0.10%	0.009	0.001 0.78
August 1975: 25% increase	0.13%	0.010	-0.003 -3.03***
August 1978: 25% decrease	-0.16%	0.011	0.002 1.49
October 1979: 30% rebate	-0.14%	0.012	0.002 1.40
October 1980: 60% rebate	-0.20%	0.010	-0.001 -1.29
October 1981: 100% rebate	-0.40%	0.011	-0.001 1.21

Table 3 continued on next page

Table 3 (continued)

Notes: This table measures changes in volatility following nine changes in the New York State Stock Transfer Tax over the period 1932 to 1981 (when the tax was abolished). Sample stocks are all those continuously traded on one of the two exchanges - one year pre- and post- each tax change. There are four exceptions to this due to the proximity of confounding events: March 1932 eleven months pre and twelve post; July 1966 six months pre and post; August 1975 three months pre and post; and August 1978 twelve months pre and 6 months post (starting in December 1978). For each event we list the percentage change in the security transaction tax for a stock with a market price of \$5. Table A contains univariate statistics based on the average of individual standard deviations of return. Panel B contains parameter estimates for the following one-way fixed effects model.

$$Y_{it} = \varphi_t + \beta \%STT_{it} + \theta X_{it} + \varepsilon_{it}$$

where Y_{it} is the standard deviation of returns for stock i at period t (*pre or post*) and φ_t is the time fixed effect. To estimate $\%STT$ we first determine the applicable STT and then calculate $\%STT_{it} = \frac{STT_i}{AvgPrice_i}$, where STT_i is the tax per share for stock i that depends on the *AvgPrice in the period*. X_{it} represents control variables: *AvgPrice*, *AvgDailyVolume*, and the Holden percentage effective spread proxy. We include eight events (1933, 1945, 1966, 1975, 1978, 1979, 1980 and 1981) and exclude the 1932 event, which is based on the par values and therefore we cannot calculate the $\%STT$. We assume that the $\%STT$ is equal to zero for all stocks prior to 1933 and post 1981. Panel C provides results for the volatility of a portfolio rather than individual stocks. Here we define volatility as the standard deviation of daily returns for the period before (σ_{pre}) and the period after (σ_{post}) and specify the change in volatility as $\Delta\sigma = \sigma_{post} - \sigma_{pre}$. The standard deviation of portfolio p is defined as $\sqrt{\pi/2} |R_{pt}|$, where R_{pt} is the daily equally weighted portfolio and π is the mathematical constant 3.14. In Panel C we regress the standard deviation of each portfolio on a dummy variable which takes the value 0 pre-event and 1 post-event, yields changes in volatility. We thus use the following time-series regression to estimate volatility pre- and post-event

$$\sqrt{\pi/2} |R_{pt}| = \beta_{p0} + \beta_{pt} I_{post,t} + \varepsilon_{pt}$$

where R_{pt} is the daily equally weighted portfolio and $I_{post,t}$ is a dummy variable which takes the value 1 for the post-event period and 0 for the time period prior to the event. Newey-West standard errors are reported in parentheses below each parameter.

***, **, * Denote significant at the 0.01, 0.05 and the 0.10 level respectively.

Table 4—Effective Bid-Ask Spread Width

Panel A. Univariate Results				
Event	% Change in STT	Spread-pre	Spread-post	Δ Spread <i>t</i> statistic
March 1932 STT doubled	0.02%	1.63%	3.01%	1.38 4.9***
June 1933 changed to per share	0.58%	1.75	3.48	1.73 6.2***
July 1945 reduced for stocks less than \$10	-0.40%	1.16	0.85	-0.31 -2.30**
July 1966: 25% increase	0.10%	1.19	1.49	0.3 2.00**
August 1975: 25% increase	0.13%	2.20	2.31	0.1 1.70*
August 1978: 25% decrease	-0.16%	1.49	1.42	-0.07 -2.50***
October 1979: 30% rebate	-0.14%	1.29	1.26	-0.03 -0.17
October 1980: 60% rebate	-0.20%	1.26	1.09	-0.16 -2.50***
October 1981: 100% rebate	-0.40%	1.11	1.33	-0.22 -4.30***

Panel B. Panel Regression				
%STT	AvgPrice	AvgDailyVolume (E-9)	σ	Adjusted R ²
0.006	-0.0004	-4.00	0.00006	0.08
12.86***	-3.48***	-16.70***	10.05***	

Notes: This table measures changes in bid-ask spread width following nine changes in the New York State Stock Transfer Tax over the period 1932 to 1981. Sample stocks are all those continuously traded on one of the two exchanges - one year pre- and post- each tax change. There are four exceptions to this due to the proximity of confounding events: March 1932 eleven months pre and twelve post; July 1966 six months pre and post; August 1975 three months pre and post; and August 1978 twelve months pre and 6 months post (starting in December 1978). For each event we list the percentage change in the security transaction tax for a stock with a market price of \$5. We define spread as the low frequency measure described in Holden (2009). Panel A lists the results of univariate tests for changes in spread, while Panel B contains parameter estimates for the following one-way fixed effects model.

$$Y_{it} = \varphi_t + \beta \%STT_{it} + \theta X_{it} + \varepsilon_{it}$$

where Y_{it} is the Holden percentage effective spread proxy for stock i at period t (*pre or post*). φ_t is the time fixed effect. To estimate $\%STT$ we first determine the applicable STT and then calculate $\%STT_{it} = \frac{STT_i}{AvgPrice_i}$, where STT_i is the tax per share for stock i that depends on the *AvgPrice in the period*. X_{it} represents control variables: *AvgPrice*, *AvgDailyVolume*, and the standard deviation of returns. We include eight events (1933, 1945, 1966, 1975, 1978, 1979, 1980 and 1981) and exclude the 1932 event, which is based on the par values and therefore we cannot calculate the $\%STT$. We assume that the $\%STT$ is equal to zero for all stocks prior to 1933 and post 1981. The parameter estimate is followed by the Newey-West autocorrelation consistent t-statistic. R-squares are also reported for each event.

***, **, * Denote significant at the 0.01, 0.05 and the 0.10 level respectively.

TABLE 5—MARKET SHARE AND VOLUME

Panel A - March 1, 1932 STT doubled 0.02% increase in STT						
Exchange	Market share			Volume		
	Pre-event	Post-event	t-stat	Pre-event	Post-event	<i>t-statistic</i>
NYSE	88.5%	92.2%	3.2**	44,684,316	57,546,326	1.6
Chicago	4.9%	2.2%	-6.6***	2,500,417	952,625	-4.4***
Philly	1.6%	1.2%	-1.83	811,830	508,993	-2.4**
L.A.	0.8%	0.5%	-2.56**	399,172	215,719	-3.05***
Boston	1.4%	1.5%	0.5	673,552	623,022	-0.40
Baltimore	0.1%	0.1%	-0.38	40,580	33,528	-0.83
Pittsburgh	0.3%	0.4%	1.35	128,954	140,868	0.3
Cleveland	0.1%	0.1%	0.3	39,981	32,532	-1.20
San Fran.	1.8%	1.3%	-1.67	879,002	551,673	-2.22**
Detroit	0.6%	0.5%	-1.16	299,416	209,207	-1.70
Panel B - June 2, 1933 changed to per share 0.58% increase in STT						
NYSE	92.6%	89.5%	-2.3**	53,527,339	36,310,664	-1.77
Chicago	1.9%	2.5%	1.1	833,667	1,193,333	1.54
Philly	1.2%	2.8%	1.29	474,950	1,560,784	1.41
L.A.	0.5%	0.5%	-0.31	201,480	298,840	1.98*
Boston	1.4%	1.3%	-0.40	559,110	556,060	-0.2
Baltimore	0.1%	0.1%	-1.25	34,673	77,721	2.02*
Pittsburgh	0.3%	0.5%	1.28	126,294	219,166	2.1*
Cleveland	0.9%	0.2%	-2.34**	33,594	94,990	3.51***
San Fran.	1.2%	1.9%	1.64	493,948	929,328	2.97***
Detroit	0.5%	0.6%	0.36	340,508	285,598	-0.64**

Table 5 continued on next page

Table 5 (continued)

Exchange	Market Share			Volume		
	Pre-event	Post-event	t-stat	Pre-event	Post-event	t-statistic
Panel C. 1945 reduced for stocks less than \$10 0.40% decrease for a \$5 stock						
NYSE	89.9%	91.7%	6.85***	31,357,139	39,191,840	15.60***
Chicago	2.4%	2.2%	-1.65	833,666	935,333	1.90
Philly	1.3%	0.9%	-4.06***	479,070	391,742	-2.88**
L.A.	1.5%	1.3%	-1.83	530,851	568,162	0.90
Boston	1.5%	1.0%	-5.6***	530,478	425,707	-3.33***
Baltimore	0.1%	0.1%	1.12	24,778	36,422	7.80***
Pittsburgh	0.2%	0.2%	-6.8***	84,681	77,843	-0.04
Cleveland	0.1%	0.1%	1.75	46,095	44,436	-0.38
San Fran.	1.6%	1.4%	1.64	569,306	588,901	1.07
Detroit	1.2%	1.0%	-2.47**	425,291	451,383	1.27
Panel D. July 1966: 25% increase in STT 0.10% increase for a \$5 stock						
NYSE	90.2%	88.8%	-3.50***	173,174,234	143,574,934	-1.97*
Midwest	3.9%	4.1%	0.97	7,533,833	6,705,833	-1.00
Philly	1.2%	1.6%	3.51***	2,223,535	2,529,249	2.08*
Pacific	3.9%	4.6%	2.32**	7,508,775	7,313,173	-0.44
Boston	0.6%	0.7%	2.47**	1,091,162	1,137,909	0.76
Pittsburgh	0.1%	0.1%	-0.92	110,783	85,183	-1.58
Detroit	0.2%	0.2%	0.69	338,685	299,694	-0.78
Panel E. August 1975: 25% increase in STT 0.13% increase for a \$5 stock						
NYSE	89.0%	87.9%	-8.95***	448,721,396	307,361,199	-4.33***
Midwest	4.4%	4.8%	3.32**	22,025,000	16,655,000	-4.33***
Philly	1.7%	2.0%	3.82***	8,613,179	6,831,777	-2.05*
Pacific	4.0%	4.4%	2.86**	20,017,213	15,522,371	-1.75
Boston	1.0%	1.0%	-0.65	4,959,876	3,333,667	-3.65***
Panel F. August 1978: 25% decrease in STT 0.16% decrease for a \$5 stock						
NYSE	88.4%	89.1%	1.54	492,256,231	596,529,544	1.98*
Midwest	4.8%	3.9%	-5.34***	26,265,233	28,028,860	1.0
Philly	2.2%	2.6%	1.84	12,515,964	18,835,620	5.77***
Pacific	3.9%	3.7%	-1.17	22,498,255	27,350,599	2.27**
Boston	0.7%	0.7%	-0.44	4,337,420	5,289,851	2.16*

Table 5 continued on next page

Table 5 (continued)

Exchange	Market Share		t-stat	Volume		<i>t-statistic</i>
	Pre-event	Post-event		Pre-event	Post-event	
Panel G. October 1979: 30% rebate a 0.14% decrease for a \$5 stock						
NYSE	89.0%	88.5%	-2.00*	651,084,936	877,307,085	4.7***
Midwest	3.9%	4.4%	2.99**	28,811,167	43,749,917	6.8***
Philly	2.6%	2.9%	1.93*	19,110,916	28,063,150	6.7***
Pacific	3.8%	3.6%	-1.25	27,603,845	35,440,801	3.1**
Boston	0.7%	0.7%	-0.81	5,070,833	6,652,500	3.35***
Panel H. October 1980: 60% rebate a 0.20% decrease for a \$5 stock						
NYSE	88.5%	88.2%	-1.07	877,307,085	996,396,401	1.8
Midwest	4.4%	4.9%	2.79**	43,749,917	55,343,917	3.4***
Philly	2.9%	2.8%	-0.31	28,063,150	31,858,280	3.6***
Pacific	3.6%	3.4%	-1.50	35,440,801	38,225,695	1.02
Boston	0.7%	0.6%	-1.46	6,652,500	7,192,333	0.92
Panel I. October 1981: 100% rebate a 0.40% decrease for a \$5 stock						
NYSE	88.2%	87.4%	-4.14***	996,396,401	1,149,472,970	2.06*
Midwest	4.9%	5.7%	6.04***	55,343,917	75,550,417	4.24***
Philly	2.8%	2.8%	0.11	31,858,280	37,151,226	2.67**
Pacific	3.4%	3.5%	0.96	38,225,695	46,700,845	2.2
Boston	0.6%	0.6%	-3.41***	7,192,333	7,445,000	0.5

Notes: This table measures changes in market share and volume for US stock markets following nine changes in the New York State Stock Transfer Tax over the period 1932 to 1981 (when the tax was abolished). Volume is defined as the average monthly volume over the period. Market share for exchange *j* for month *t* is then defined as

$$marketshare_{x,t} = \frac{volume_{x,t}}{\sum_{x=1}^n volume_{x,t}},$$

Exchanges examined are the NYSE and the regional exchanges in existence at the time of the STT change. Sample stocks are all those continuously traded on one of the two exchanges - one year pre- and post- each tax change. There are four exceptions to this due to the proximity of confounding events: March 1932 eleven months pre and twelve post; July 1966 six months pre and post; August 1975 three months pre and post; and August 1978 twelve months pre and 6 months post (starting in December 1978). For each event we list the percentage change in the security transaction tax for a stock with a market price of \$5. Listed are the pre and post event market share and volume per exchange as well as the t-statistic for the post-pre difference.

***, **, * Denote significant at the 0.01, 0.05 and the 0.10 level respectively.

TABLE 6—AMIHUDD ILLIQUIDITY MEASURE

Panel A. Univariate Changes				
Event	% Change in STT	Amihud _{pre}	Amihud _{post}	Δ Amihud <i>t</i> -statistic
March 1932 STT doubled	0.02%	2.6E-10	4.9E-10	2.3E -107.9***
June 1933 changed to per share	0.58%	2.8E-10	4.7E-10	1.9E-10 6.97***
July 1945 reduced for stocks less than \$10	-0.40%	4.1E-10	4.4E-10	3.5E-9 1.18
July 1966: 25% increase	0.10%	1.0E-10	1.4E-10	4.2E-9 3.18***
August 1975: 25% increase	0.13%	1.0E-10	7.4E-9	-2.7E-9 -2.22**
August 1978: 25% decrease	-0.16%	3.3E-11	2.6E-10	-7.3E-10 -1.99**
October 1979: 30% rebate	-0.14%	3.2E-11	2.7E-11	-4.4E-10 -1.74*
October 1980: 60% rebate	-0.20%	2.7E-11	2.0E-11	-7.2E-10 -3.75***
October 1981: 100% rebate	-0.40%	2.1E-11	1.6E-11	-4.3E-10 -3.25***

Panel B. Panel Regression

%STT	AvgPrice (E-9)	AvgDailyVolume (E-10)	σ	Adjusted R ²
0.00005	9.3	-1.00	0.0007	0.04
9.31***	15.11***	-9.17***	16.00***	

Notes: This table measures changes the Amihud illiquidity measure following nine changes in the New York State Stock Transfer Tax over the period 1932 to 1981 (when the tax was abolished). Sample stocks are all those continuously traded on one of the two exchanges - one year pre- and post- each tax change. There are four exceptions to this due to the proximity of confounding events: March 1932 eleven months pre and twelve post; July 1966 six months pre and post; August 1975 three months pre and post; and August 1978 twelve months pre and 6 months post (starting in December 1978).. For each event we list the percentage change in the security transaction tax for a stock with a market price of \$5. The illiquidity measure, *Amihud*, is defined as

$$\text{Amihud} = \frac{|r_{i,t}|}{\$Volume_{i,t}}$$

Where $r_{i,t}$ and $\$Volume_{i,t}$ are the stock return and dollar volume for stock i on day t , respectively. Panel A lists the results of univariate tests for changes in the measure. Panel B contains parameter estimates for the following one-way fixed effects model.

$$Y_{it} = \varphi_t + \beta \%STT_{it} + \theta X_{it} + \varepsilon_{it}$$

where Y_{it} is the Amihud measure for stock i at period t (*pre or post*). φ_t is the time fixed effect. To estimate $\%STT$ we first determine the applicable STT and then calculate $\%STT_{it} = \frac{STT_i}{AvgPrice_i}$, where STT_i is the tax per share for stock i that depends on the *AvgPrice in the period*. X_{it} represents control variables: *AvgPrice*, *AvgDailyVolume*, and the standard deviation of returns. We include eight events (1933, 1945, 1966, 1975, 1978, 1979, 1980 and 1981) and exclude the 1932 event, which is based on the par values and therefore we cannot calculate the $\%STT$. We assume that the $\%STT$ is equal to zero for all stocks prior to 1933 and post 1981.

***, **, * Denote significant at the 0.01, 0.05 and the 0.10 level respectively.