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The Impact of Transaction Costs on Turnover, Asset Prices and Volatility: The Cases of Sweden's and Finland's Security Transaction Tax Reductions

ABSTRACT

Drastic changes in transaction tax on securities trading in both Sweden and Finland give us a unique opportunity to study the effects of a purely exogenous change in transaction costs. The impact on turnover can be predicted accurately using a simple model. Lower transaction costs cause significant increases in turnover with an elasticity of approximately –1. We apply an asset-pricing model that is able to predict asset price changes. The transaction cost elasticity in asset prices is –0.20 for Sweden and –0.21 for Finland. Volatility in securities prices is significantly reduced when transaction costs decrease.

Keywords: *Security Transaction Tax, Transaction Cost, Transaction cost elasticity*
JEL classification: G12, G28

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1. INTRODUCTION

There is an ongoing debate on the effect of transaction taxes on financial markets. Several papers recommend the introduction of a security transaction tax [STT] to curb ″excessive″ short-term trading and to thereby reduce ″excess″ volatility in the prices of financial assets. Tobin (1984) recommends a restriction of the growth of the financial sector because it has taken up an increasing share of social resources and suggests a STT as one means of achieving this. Summers and Summers (1988), Stiglitz (1989) and Rubinstein (1992) suggest that STT would decrease volatility in securities markets by discouraging excessive ″speculative″ short-term trading. At one level the empirical evidence to date generally supports the views that recommend a STT. An increase in transaction costs will reduce trading but that it curbs ″excessive″ short-term trading as the advocates of a STT desire, has not been established. Jarrell (1984) studies the effects of the deregulation of the brokerage commissions in the United States in May 1975. He estimates the increase in traded volume caused by the lower transaction costs during 6 years after deregulation of NYSE brokerage commissions and finds a transaction cost elasticity of about –1 , i.e. the percentage response of the turnover rate to a percentage change in transaction costs. Jackson and O'Donnell (1985) study quarterly data from the London Stock Exchange over the period 1964 to 1985. They find the transaction cost, which they define as the transaction tax plus 3/4 % for a round trip transaction, to have a long run elasticity of –1.65. Umlauf (1993) uses daily and weekly data on Swedish equity index returns over the period 1980 to 1987 to compute the price impact of the announcement of the 1% STT introduction in 1983 and the increase to 2% in 1986. Prices declined 2.2% on the announcement 1983 and 0.8% in 1986. He also concludes that as a result of the second increase a significant part of the trading in Swedish shares migrated to London since the tax was only charged on trading in Sweden and international trades were tax exempt if traded overseas.

Traditional finance theory assumes the absence of benefits from trading, namely liquidity, when transaction costs are incorporated. Commonly a model is specified assuming no transaction costs and then these costs are subtracted from cash flows without further refinement of the underlying model. However, financial assets cannot be valued correctly if the costs of providing liquidity, i.e. transaction costs, are incorporated in the model while the benefits of liquidity are excluded. Swan (2003) presents a capital asset pricing model that incorporates transaction costs and the benefits of endogenous trading. Investors explicitly incorporate the benefits of trading securities, either debt or equity or both, in their preference functions. That is, more liquid securities which turn over more frequently with lower transaction costs are more valuable to investors because of easy entry and exit by investors. In this paper we test the endogenous trading model in the context of a study of the effects of STT changes. A change in

STT is an exogenous event with a major impact on transaction costs and is thus an appropriate environment in which to study the effects of such changes on both turnover and asset prices. Lower transaction costs raise security turnover and thus liquidity. The model of Swan (2003) can be used to predict the extent and direction of share price changes in response to this exogenous liquidity event. To add current empirically based information to the discussion on the effects of STT we study the partial and then the complete abolition of the STT in Sweden in 1991 and the abolition of the STT in Finland in 1992. We thus continue the work started by Umlauf (1993) that studied the Swedish STT increases in the 1980s. We also add empirical evidence to the discussion on pricing of liquidity started by Amihud and Mendelson (1986b). Relevant measures of transaction costs and empirical evidence of liquidity effects is also presented by Chalmers and Kadlec (1998). The purpose of this paper is to apply the Swan (2003) model of asset pricing together with a related turnover model to the STT changes in Sweden and Finland. This way we aim to determine the extent and direction of changes in trading volume, volatility and share prices in response to these two exogenous liquidity events.

When we use information available to all market participants up to the day before the change in STT we find that we can predict the impact with considerable accuracy. In Sweden the turnover rate (value of shares traded to market capitalization) is predicted to increase from 18% to 22% following the first reduction in STT and from 22% to 30% following the final abolition of STT. Asset prices are predicted to increase by 7.5% following the first STT reduction and 9.7% as a result of the second reduction. In Finland the turnover rate is predicted to increase from 10% to 15% following the abolition of STT change while prices are predicted to rise by 6.6%. These predicted changes are also observed in the markets with some of the price changes taking place at announcement of the STT change. The turnover increases to the predicted level within 8 months for Finland and 14.5 months for Sweden. In the Swedish case the price impact around the time of the announcements is moderate but it appears to take full effect when equilibrium has been reached 14.5 months after the final STT reduction. We test this assumption to account for other possible explanations for the price increases. When we include data pre and post STT changes the transaction cost elasticity in turnover rate is –1.002 for Sweden and –1.274 for Finland. The transaction cost elasticity in asset prices, i.e. the percentage response of asset prices to a percentage change in transaction costs, is –0.27 before and –0.13 after the STT changes for Sweden and –0.15 before and –0.28 after the STT change for Finland. This means that lower (higher) transaction costs cause significant increases (decreases) in turnover and prices in a proportion given by the elasticity. We also find that the volatility in securities prices as measured by the daily high-low price dispersion is reduced when transaction costs are lowered. The transaction cost elasticity in volatility, i.e. the per-

TABLE 1. Correlation matrix.

Stockholm

Estimated Variables	T_t	T_{t-1}	C	R_f	V	US r	US t	US v
1. Ln(Turnover Rate $_t$)	1.00							
2. Ln(Turnover Rate $_{t-1}$)	0.65	1.00						
3. Ln(Trans. Costs $_{t-1}$)	-0.51	-0.50	1.00					
4. Ln(Interest Rate $_{t-1}$)	0.06	0.05	0.08	1.00				
5. Ln(Volatility $_{t-1}$)	-0.56	-0.65	0.54	-0.01	1.00			
6. Ln(US Return $_{t-1}$)	0.10	0.09	-0.24	-0.07	-0.08	1.00		
7. Ln (US Traded Val. $_{t-1}$)	0.04	0.06	-0.11	-0.01	-0.05	0.48	1.00	
8. Ln (US Volatility $_{t-1}$)	-0.01	-0.01	0.04	-0.02	0.01	-0.15	0.04	1.00

Helsinki

Estimated Variables	T_t	T_{t-1}	C	R_f	V	US r	US t	US v	FX	SW r
1. Ln(Turnover Rate $_t$)	1.00									
2. Ln(Turnover Rate $_{t-1}$)	0.46	1.00								
3. Ln(Trans. Costs $_{t-1}$)	-0.36	-0.35	1.00							
4. Ln(Interest Rate $_{t-1}$)	-0.19	-0.20	0.26	1.00						
5. Ln(Volatility $_{t-1}$)	0.28	0.51	-0.28	-0.17	1.00					
6. Ln(US Return $_{t-1}$)	-0.03	-0.03	0.04	0.04	-0.03	1.00				
7. Ln (US Traded Val. $_{t-1}$)	0.26	0.28	-0.26	-0.35	0.24	-0.04	1.00			
8. Ln (US Volatility)	-0.03	-0.03	0.03	0.01	-0.01	0.02	0.02	1.00		
9. Ln (Exchange Rate $_{t-1}$)	0.36	0.36	-0.35	-0.41	0.32	-0.06	0.65	-0.08	1.00	
10. Ln (Swedish Return $_{t-1}$)	-0.15	-0.15	0.44	-0.31	-0.15	0.01	-0.15	0.06	-0.45	1.00

The turnover rate is calculated as daily number of shares turned over per market tradeable shares outstanding. The transaction costs are the sum of the relative bid-ask spread, the average brokerage fees and the STT. Interest rate is the annualized one month market rate. Volatility is measured as the daily high-low dispersion in traded prices. US return is the daily change in the Dow Jones industrial average. Us traded value is the total daily value traded on NYSE and US volatility is the daily variation in price. Exchange rate is the Bank of Finland official daily FIM / EURO rate. Swedish Return is the daily market index change on Stockholm stock exchange.

centage response of volatility to a percentage change in transaction costs, is about 0.40. We conclude that the model we present accurately predicts changes in turnover rate, prices, liquidity and volatility induced by alterations in transaction costs such as the STT. We also conclude that the abolished STT is an important reason for the improved security market conditions of the investigated Nordic countries.

The remainder of the paper is organized as follows. Section 2 describes the changes in STT on the investigated markets, describes the applied models and variables used in our empirical tests and the construction of the data set. Section 3 presents the empirical findings. Section 4 provides our interpretation of the results and outlines future research.

2. THE STT REDUCTIONS, MODELS AND THE DATA SAMPLE

2.1 The STT reductions

In Sweden a securities turnover-tax of 1% per roundtrip trade was introduced in 1983 and increased to 2% in 1986. Some concessions were made for smaller trades and trades within the brokerage houses. Trading in Swedish stocks outside Sweden were not taxed. In Sweden the turnover-tax reduction became effective in two steps. On January 1, 1991 the tax of 2% for a round-trip transaction was decreased to 1% per round-trip transaction. and on December 1, 1991 the turnover-tax was completely abolished. In Finland a stamp-duty on securities trading on the stock exchange had been collected since 1942. Except for a brief increase in 1985 it had been 1% per round-trip transaction. On May 1, 1992 the stamp-duty on exchange traded stocks in Finland was abolished. The stamp-duty was collected on over the counter trades until the end of 1992 and is still collected on securities trades outside the stock exchange.

2.2 Estimation of transaction cost elasticity in turnover

To measure the turnover effects and the transaction cost elasticity we apply Equation (1), the basic constant elasticity specification that explains turnover with transaction costs. This model works well in earlier studies and has a strong intuitive appeal. It was first applied in Jackson and O'Donnell (1985).

$$\tau_e = \alpha c_e^{-\beta} \tag{1}$$

In Equation (1) τ_e is the turnover rate, c_e is transaction costs (including tax, brokerage fees, bid-ask spread, market impact costs and opportunity costs) and β is the absolute value of the transaction cost elasticity in turnover.

2.3 Estimation of transaction cost elasticity in prices

To be able to measure the price impacts of changed transaction costs on specific assets or markets we estimate the price elasticity using a liquidity-based capital asset pricing model with endogenous turnover proposed by Swan (2003). This endogenous trading model is described more thoroughly in the Appendix. The model is applied in this study to determine transaction cost elasticity in prices as follows. The return on an equity asset such as a stock with a perpetual dividend, D, can be expressed as the dividend yield, D/p^a. The model recognizes the benefits of the liquidity effects created by a change in transaction cost and is applicable to markets with any level of transaction cost elasticity. Hence the asset price becomes: $p_a = D/(r_f + ep)$, where r_f is the risk-free rate corresponding to Tbills or bonds and the equity premium is denoted ep. Swan (2003) shows that for a risk neutral investor who cares about liquidity/turnover the yield on the stock in excess of the Tbill or bond yield is given by $ep = [1/(1 - \beta)]\{\tau_e c_e - \tau_b c_b\}$, where as before in (1) above β is the absolute value of the transaction cost elasticity, τ_e is the turnover rate for equity, c_e is the transaction cost for equity and τ_b and c_b are the corresponding values for a more liquid security such as Tbills or bonds. The term $\{\tau_e c_e - \tau_b c_b\}$ represents the difference between the transaction costs or "amortized spread" between the relatively illiquid equity stock and Tbills since the product of turnover and unit transaction cost is the total transaction cost. The term $[1/(1 - \beta)]$ reflecting the transaction cost elasticity converts the cost differential into the investor's utility valuation. When the absolute value of the transaction cost elasticity β limits to 1 the equity premium simplifies to $ep = a \ln (c_e/c_b)$ since $\tau_e = \alpha c_e^{-\beta}$. In empirical applications the elasticity tends to be close to but not exactly 1.

The elasticity of the asset price with respect to the transaction cost change can be obtained from the endogenous trading model by differentiating the asset pricing relationship to obtain Equation (2).

$$\textit{Price Elasticity } P_E = -\frac{\tau_{e,t} c_{e,t}}{D/p_t^a} = -\frac{\tau_{e,t} c_{e,t}}{r_f + ep_t} \tag{2}$$

Where as before τ_e is the turnover rate, c_e transaction costs (including tax, brokerage fees, bid-ask spread, market impact costs and opportunity costs), D/p^a dividend yield, r_f the risk free interest rate and ep the equity premium (the excess return on equity including dividends compared to the return on bonds). This price elasticity has an intuitive interpretation as the total transaction costs realized through trading (the amortized spread) discounted at the security's cost of capital. The sensitivity of the price to transaction cost changes is thus proportional to the ratio of the value of transacting versus the expected equilibrium return on the security.

2.4 The data sample

The data used in this study include detailed daily data from the Swedish stock exchange (Stockholms Fondbörs)[1] and all on-market trades and a sample of quotes from the Finnish Stock Exchange (Helsingin Arvopaperipörssi)[2]. For Sweden the data consist of the daily number of traded shares, the volume in SEK, the number of trades, the daily high and low and the closing best bid and ask for the 121 stocks traded during the years 1990, 1991 and 1992. The data are centered on the two dates, January 1, 1991 and December 1, 1991, when the turn over tax reduction became effective in two steps. When foreign listed stocks and stocks with missing data are excluded the sample is narrowed down to 80 stocks. In addition, market aggregate data for all shares traded on the main list over the period (at the end of 1992, 118 companies with several share series) is used for analysis of the price impact of the tax change, for liquidity analysis and for market descriptive purposes. For Finland the data consist of all trades for the 30 stocks which were traded during the whole period 1991, 1992 and 1993. The trade data include trading price, volume, buying and selling broker-dealer. The data are centered on May 1, 1992, which is the date the stamp duty reduction became effective in Finland. In addition a sample of all shares traded on the main list (138 at the end of 1993) is used for analysis of the price impact of the tax change, for liquidity analysis and for market descriptive purposes.

The individual stock returns are corrected for dividends, splits and bonus issues and the volume measures are corrected for changes in the number of outstanding stock of the companies. To estimate total market effects we use the all-share stock indexes for Stockholm and Helsinki, adjusted for dividends. To measure the turnover rate we use market capitalization and turnover measures for individual stocks and on a market aggregate basis. We use short and long-term market interest rates to measure changes in the interest rate level and the term structure. We use market return and turnover data from the New York stock exchange to proxy world market developments. We use the preceding days measures of the US stock market return and activity (due to the time difference, New York opens when the Nordic markets are about to close and most of the effects of New York (and Asia) hit the Nordic markets the following day). We use the Dow Jones Industrial average since this is the index that is used by most participants in the Nordic markets to measure US stock returns on a daily basis. We also compare our findings to estimations using the broader CRSP index for the US market. To meas-

1 Since 1998 the Stockholm stock exchange is a subsidiary of the OM Group Ltd which is a public company also holding the majority of the shares in the Swedish Options Brokers, the Swedish options and futures exchange.
2 Since 1998 the Helsinki stock exchange is a privately held limited company Hex Ltd. following a merger with the Finnish Options Brokers the Finnish options and futures exchange.

ure exchange rate impacts we use the exchange rates of the Swedish krona and the Finnish markka towards the European currency ECU, (now EURO). All variables are measured on a daily level.

The primary criterion for inclusion in our sample is that a stock must have a closing bid-ask spread for all days included in the sample. Both the Finnish and Swedish markets characteristically have periods of thinner trade in otherwise liquid stocks. Both markets were quiet during the beginning of the investigated periods and thin trading periods are unavoidable. In the Swedish sample of 80 stocks there is an average of 280 trading days of the 731 days investigated or 38.3%, when the stocks have not been traded. In the Finnish sample of 30 stocks there is an average of 32 trading days of the 500 days or 6.3%, when the stocks have not been traded. This should not be a major problem since all of these stocks have bid ask quotes for all days (except trading halts) and have been traded actively during the later end of the investigated period. In the analysis measures will be taken to adjust for the thinly traded days. Also the thin trading is a natural consequence of high transaction costs and it would be wrong not to include stocks based on this criterion. Most of the days with little or no trading occur before the changes in STT when some of the trading had migrated to other markets and some trades that might have occurred if transaction costs had been lower were not executed. We perform comparative studies based on weekly data to ensure that thin trading does not cause erroneous interpretations of our findings. As a result of these exclusions the analysis on company level will be performed on a sample that represents all larger capitalization companies and several smaller companies in Sweden; a total of 61% of total market capitalization at the end of the investigated period. The sample of companies used for Finland represents 81% of the market capitalization at the end of the investigated period. While the variables in this study make use of intra-day variations (i.e. detailed trade records, bid-ask spread, market impact costs, and so on) all variables are summarized to a single daily observation. As a consequence, for Sweden we end up with 731 trading days over the two years and eleven months period with a total of 58480 observations. For Finland we end up with 500 trading days over the two-year period with a total of 15,000 observations.

3. EMPIRICAL FINDINGS

3.1 Economic environment

The Swedish market was considerably more active after the changes in STT. In the Swedish case there were no other major structural changes in the market around this time. Sweden experienced a currency crisis during the end of 1992 however, causing a peak in interest rates and a fall in share prices. The effectively weaker currency could be one reason for the remarkably stronger share prices in 1993. To the extent we include this volatile period starting about one year after the final STT change we have to be aware of these effects on our findings.

In Finland we can see a substantial increase in turnover when we compare the traded volume during one year before the STT change to traded volume one year after. When we look at a four-month period before and after the STT change the turnover of shares does however decrease slightly. One of the reasons for this is that despite an improved environment for securities trading there were other serious problems in the Finnish economy. During the four months after the STT change a severe drop in price levels occurred as a result of an economic policy which defended a weakening currency with higher interest rates. In this situation capital is expected to flow offshore.

During the autumn of 1992 the Finnish markka was devalued and floated which led to a substantial decrease in the exchange rate after the currency crisis settled. This in turn resulted in an increase in the prices and volumes on the stock exchange, due both to the adjustment of the exchange to the lower currency and to the improved outlook for the exporting sector, a vital part of the Finnish economy. Also by the beginning of 1993 the restrictions on foreign investments in Finnish securities were lifted. This started a trend towards a situation in which close to one half of the most important Finnish companies are owned by investors outside of Finland and this has increased the price level as well as liquidity and trading volume. In our analysis we attempt to correct for these other environmental changes to isolate the impact of the stamp duty change.

A trend of increased turnover of shares appears to be evident in the world market for securities during the last decade. The increase in turnover appears to have started in the US with the deregulation of the securities market industry in 1975 and, during the late 1980s in most other markets with increases in activity coinciding with market de-regulations and upheavals of market restrictions. In our study we are investigating one of the possible reasons for this increase in turnover; the improved liquidity associated with lower costs of transacting. If there is a trend of increased turnover, however, this could have an impact on our findings. We estimate comparative results correcting for any trends over time in turnover.

3.2 Predicted effects

Before we examine the actual impacts of the STT changes we apply our models to predict the expected effects. We start with a prediction since the actual realized effects can be estimated for relatively short time spans only and the results have to be seen as indicative when applied to other time periods and markets. The prediction procedure can be divided into four steps.

First we determine the effect of the STT change on total transaction costs including brokerage fees and bid ask spreads. When we know the percentage change in STT and when we assume that the change in overall transaction costs have a proportional effect on brokerage fees and bid ask spreads, we can calculate expected change in total transaction costs. In Sweden the first STT change of 50% was 23% of average total transaction costs. The second STT change was 30% of total transaction costs. The abolishment of STT in Finland accounted for 20% of average total transaction costs. We assume that the brokerage fees and bid-ask spread levels change at least with the same proportion as total transaction costs. This assumption is based on earlier empirical findings but a model for this effect could be developed.

Secondly, we then expect the total effects on transaction costs including expected changes in brokerage fees and bid ask spreads are 36% and 56% for the Swedish STT changes respectively and 37% for Finland.

Thirdly, we estimate the transaction cost elasticity in turnover applying Equation (3) to daily market data available up to the day before the STT change, see Tables 2, 3 and 4. Equation (3) is an empirical application of Equation (1) similar to the Equations applied by Jackson and O'Donnel (1985). In addition to transaction cost changes we expect the turnover to be impacted by variations in volatility, interest rate, foreign stock markets and characteristics of individual companies. To account for these factors we estimate a pooled cross-sectional equation with different intercepts for each company (one of the individual stock dummies is dropped in the regression). In addition Equation (3) is an auto-distributive log model including the lagged dependent variable as one of the independent variables to pick up the long run transaction cost elasticity in the turnover rate.

$$\begin{aligned}&\ln(\textit{Turnover rate}_{t}) = \alpha_1 + \beta_1 \ln(\textit{Turnover rate}_{(t-1)}) + \beta_2 \ln(\textit{Transaction costs}_{(t-1)}) +\\&\beta_3 \ln(\textit{Price volatility}_{(t-1)}) + \beta_4 \ln(\textit{Interest rate}_{(t-1)}) + \beta_5 \ln(\textit{US market index}_{t}) +\\&\beta_6 \ln(\textit{US market volume}_{t}) + \beta_7\, \textit{Individual stock dummy}_{1}. + \ldots +\\&\beta_j\, \textit{Individual stock dummy}_{j}.\end{aligned} \tag{3}$$

Finally we estimate the transaction cost elasticity in prices applying Equation (2) to aggregated data for the year before the STT change, see Table 6. For Sweden the turnover elasticity estimates are –0.908 and –0.906 while the price elasticity estimates are –0.211 and 0.175. For Finland the turnover elasticity estimate is –1.388 and the price elasticity estimate is –0.177.

We then use the estimates above to calculate the impacts on the current volume, turnover rate and market capitalization to predict the turnover and price level after the STT changes. The effects are calculated with Equation (4) and (5) as follows.

$$\begin{aligned}&\textit{Predicted change in volume} = \textit{Current volume} \times \textit{Trans. cost elasticity}_{turnover} \times\\&\textit{Change in Trans. costs}_{STT,BRK,BAS}\end{aligned} \tag{4}$$

TABLE 2. Effects on turnover rate and transaction cost elasticity.

– Individual stocks Sweden.

Stockholm	**1.1.90 to 31.12.90**	**1.1.90 to 30.11.91**	**1.1.90 to 30.11.92**
Independent Variables			
Ln(Turnover Rate $_{t.1}$)	0.18912	0.17149	0.23270
	(25.49)	(32.21)	(57.25)
Ln(Trans Costs $_{t.1}$)	-0.73625	-0.7505	-0.768758
	(-16.59)	(-26.32)	(-39.15)
Ln(Interest Rate $_{t.1}$)	1.1974	0.85433	1.1135
	(5.27)	(4.93)	(22.07)
Ln(Volatility $_{t.1}$)	-0.11660	-0.11582	-0.14595
	(-7.77)	(-10.77)	(-16.26)
Ln(DJIA $_{t.1}$)	-1.2741	0.5276	1.5924
	(-2.98)	(1.47)	(11.31)
Ln (US Traded Value $_{t.1}$)	-0.13648	0.09951	-0.13327
	(-1.66)	(1.65)	(-2.55)
Trans. Cost Elasticity	-0.9080	-0.9058	-1.0019
N	19520	38080	58000
R^2adjusted	0.5452	0.5625	0.5658

The relationship of turnover rate (number of shares traded / shares outstanding) to transaction costs and a set of macroeconomic variables. The data set consists of 80 representative stocks for Sweden over the time periods 1.1.90 to 30.11.92. The coefficients are estimated from time series regressions of the following logarithmic form (auto distributed lag model):

$$ln(Turnover\ rate_{t}) = \alpha_1 + \beta_1\ ln(Turnover\ rate_{(t-1)}) + \beta_2\ ln(Transaction\ costs_{(t-1)}) + \beta_3\ ln(Price\ volatility_{(t-1)}) + \beta_4\ ln(Interest\ rate_{(t-1)}) + \beta_5\ ln(US\ market\ index_{t}) + \beta_6\ ln(US\ market\ volume_{t}) + \beta_7\ Individual\ stock\ dummy_{1}. +...+ \beta_j\ Individual\ stock\ dummy_{j}. \quad (3)$$

The estimated transaction cost elasticity is reported under Trans. Cost Elasticity. T statistics are reported beneath the coefficients in parenthesis. (The coefficients for the individual stock dummies are not reported).The main interest is the coefficient for the transaction cost variable and the long term transaction cost elasticity obtained by dividing the transaction cost coefficient by 1–the dependent of the lagged dependent variable turnover rate.

TABLE 3. Effects on turnover rate and transaction cost elasticity.

– Individual stocks Finland.

Helsinki	**1.5.91 to 30.4.92**	**1.5.91 to 30.4.93**
Independent Variables		
Ln(Turnover Rate $_{t-1}$)	0.14481	0.20054
	(11.36)	(22.45)
Ln(Transaction Costs $_{t-1}$)	-1.1871	-1.0183
	(-13.91)	(-20.42)
Ln(Interest Rate $_{t-1}$)	-0.0007	-0.4687
	(-0.0040)	(-3.822)
Ln(Volatility $_{t-1}$)	0.00416	0.01428
	(0.8933)	(4.527)
Ln(DJIA $_{t.1}$)	2.8790	-0.28038
	(2.97)	(-0.53)
Ln (US Traded Value $_{t-1}$)	1.2235	0.89099
	(7.54)	(8.63)
Ln (Exchange Rate $_{t-1}$)	1.5064	2.9983
	(1.33)	(8.38)
Ln (Swedish GenIndex $_{t-1}$)	0.28476	-1.1040
	(0.34)	(-5.67)
Trans. Cost Elasticity	-1.388	-1.274
N	7350	14850
R^2adjusted	0.2548	0.3474

The relationship of turnover rate (number of shares traded / shares outstanding) to transaction costs and a set of macroeconomic variables. The data set consists of 30 representative stocks for Finland over the time period 1.5.91 to 30.4.93. The coefficients are estimated from time-series regressions of the following logarithmic form with a two additional variables β_5 *ln(Exchange rate$_{(t-1)}$) + β_6 ln(Swedish market return$_{(t-1)}$)* added to equation (3):

$$\ln(\text{Turnover rate}_t) = \alpha_1 + \beta_1 \ln(\text{Turnover rate}_{(t-1)}) + \beta_2 \ln(\text{Transaction costs}_{(t-1)}) + \beta_3 \ln(\text{Price volatility}_{(t-1)}) + \beta_4 \ln(\text{Interest rate}_{(t-1)}) + \beta_5 \ln(\text{Exchange rate}_{(t-1)}) + \beta_6 \ln(\text{Swedish market return}_{(t-1)}) + \beta_7 \ln(\text{US market return}_t) + \beta_8 \ln(\text{US market volume}_t) + \beta_9 \text{ Individual stock dummy}_1. + \ldots + \beta_j \text{ Individual stock dummy}_j.$$

The estimated transaction cost elasticity is reported under Trans. Cost Elasticity. T statistics are reported beneath the coefficients in parenthesis. (Individual stock dummies are not reported).

TABLE 4. Effects on turnover rate and transaction cost elasticity – Grouped by size.

Dep. Variable	**Independent Variables**						
Ln(Turnover rate)	**Ln (Trans. Costs) (t-1)**	**Ln(Volatility) (t-1)**	**Ln(Int. rate) (t-1)**	**Ln(US Volume) (t-1)**	**Trans. Cost Elasticity**	**N**	**$R^2_{adj.}$**
Stockholm **1.1.90 – 30.11.92**							
1 high MCap	-0.8420	-0.11691	0.37407	0.25976	-2.46	11600	0.620
2	-1.2519	-0.15497	0.80560	0.19204	-2.88	11600	0.637
3	-1.1850	-0.23828	1.1347	0.36511	-2.07	11600	0.349
4	-0.9116	-0.34933	0.89945	0.43514	-1.30	11600	0.209
5 low MCap	-0.3236	-0.30205	0.65698	0.09712	-0.50	11600	0.167
Helsinki **1.5.91- 30.4.93**							
1 high MCap	-0.3833	0.91978	-0.31053	0.75388	-0.69	2970	0.306
2	-1.1809	0.00690	-0.87871	0.85016	-1.58	2970	0.274
3	-1.3867	0.00796	-0.23560	0.96086	-1.74	2970	0.339
4	-2.0859	0.02397	0.09148	0.98195	-2.83	2970	0.393
5 low MCap	-0.7513	0.00059	-0.33872	0.83732	-1.08	2970	0.190

The relationship of turnover rate (number of shares traded / shares outstanding) to transaction costs and a set of macroeconomic variables. The sample is divided into groups with group 1 composed of the highest capitalization stocks and group 5 of the lowest capitalization stocks. The coefficients are estimated from time series regressions of the following logarithmic form:

$$\ln(\text{Turnover rate}_t) = \alpha_1 + \beta_1 \ln(\text{Turnover rate}_{(t-1)}) + \beta_2 \ln(\text{Transaction costs}_{(t-1)}) + \beta_3 \ln(\text{Price volatility}_{(t-1)}) + \beta_4 \ln(\text{Interest rate}_{(t-1)}) + \beta_5 \ln(\text{Exchange rate}_{(t-1)}) + \beta_6 \ln(\text{Swedish market return}_{(t-1)}) + \beta_7 \ln(\text{US market return}_t) + \beta_8 \ln(\text{US market volume}_t) + \beta_9 \text{ Individual stock dummy}_1 + \ldots + \beta_j \text{ Individual stock dummy}_j.$$

The control variables $\beta_5 \ln(\text{Exchange rate}_{(t-1)}) + \beta_6 \ln(\text{Swedish market return}_{(t-1)})$ are not included for Sweden. The estimated transaction cost elasticity is reported under Trans. Cost Elasticity. The coefficients for lagged turnover rate and lagged transaction costs that are used to compute the long run transaction cost elasticity are significant on the 1% level in all regressions. (The coefficients for some control variables are not reported).

$$\text{Predicted change in market capitalization} = \text{Current capitalization} \times \text{Trans. cost elasticity}_{price} \times \text{Change in Trans. costs}_{STT,BRK,BAS} \quad (5)$$

When the turnover and price reactions are estimated using data available the day before the change in STT and Equations (4) and (5) we can observe a substantial increase in turnover and a significant increase in prices. For Sweden we predict turnover to increase by 30% with the first STT reduction and another 54% with the second reduction. The respective increases in the turnover rate are from 18% to 23% in the first reduction and a change to 35% in the second reduction of STT. For Finland we predict yearly turnover to increase by 51% and the turnover rate to increase from 10% to 14% as a result of the STT change. When we apply Equation (2) to the data available at the time of the STT change, the predicted price changes for Sweden are 17.3% summed over both STT changes and 6.6% for Finland. The forfeited tax revenue amounts to approximately 2% of the increase in market capitalization for Sweden and 1.6% of the increase in market capitalization Finland. When we compare these predictions to actual changes in turnover and prices reported in sections 3.3 and 3.4, we find the estimations remarkably accurate (see Table 6). These results are encouraging for the use of our presented estimation technique on other markets. The effects of the changes in transaction costs appear to have a stronger impact on the level of brokerage fees than on the level of the bid ask spread when the estimates are compared to the real outcomes. A more exact model for the total change in transaction costs would improve the accuracy of the predictions.

In all our estimations we consistently use the preceding day's closing values as input when we estimate the effects on today's market activity. We are thus taking the position of an investor at the beginning of the day using information available at that moment to make his or her trading decisions. This approach does not affect the significance of the individual coefficients from our regressions, in fact it somewhat improves the t-values. The approach of using lagged values has a negative impact on the R squared measure of the explanatory power of the model. If we use the same day's values as independent variables the adjusted R squares are in the range of 75% for Sweden and 47% for Finland, (not reported here). When we use lagged independent variables the adjusted R squares are 56% for Sweden and 36% for Finland, (see Tables 2 and 3). The F values are still highly significant and the t-values for the transaction cost coefficients are 39 for Sweden and 20 for Finland.

3.3 Observed effects on turnover rate and transaction cost elasticity

To evaluate the realized effects, Equation (3) is estimated for the samples of 80 Swedish stocks and 30 Finnish stocks. Here we estimate the model using data for the period leading up to the STT changes and data for one year before and one year after the changes. This way we measure the actual impact of an exogenous change in transaction costs and are able to assess the dynamics of the elasticity in transaction cost and asset prices. We are still using lagged values as input variables. The results are presented in Tables 2 and 3.

The coefficients for the transaction cost are significantly negative on both markets. Rising transaction costs thus have a negative impact on the turnover rate of shares while lower transaction costs have a positive impact on the turnover rate. The long-run transaction cost elasticity settles at slightly higher than or close to one (negative). It is –1.0019 (t-value –39.15) for Sweden and –1.274 (t-value –20.42) for Finland, (see Tables 2 and 3). We also estimate the significance of dummy variables for the STT change, currency crisis followed by the devaluation of the local currency and free foreign ownership of shares. Our results indicate that a significant part of the increase in turnover rate seems to have been caused by the stamp duty change. The devaluation of the currency has a strong impact while free foreign ownership has a moderate impact on turnover rate. We also achieve consistent results using market aggregate data and all shares indexes as price measures. These findings show that for markets in which individual stock data are not available the estimations can be done using market aggregate data to achieve similar results. The transaction cost elasticity in turnover for the total market over the period 1987 to 1998 is estimated to be –1.03 (t-value 21.7 and R^2 0.77) for Sweden, and –1.12 (t-value 10.5 and R^2 0.67) for Finland (not reported).

We divide the samples from both markets into groups ranked by capitalization to measure if the sensitivity to changes in transaction costs is larger or smaller in higher capitalization stocks. To the extent that larger capitalization stocks can be considered to be more liquid, we would expect a higher sensitivity since the STT is a larger fraction of the transaction costs, and thus the total change in transaction costs due to the tax cut should be larger. In Table 4 we present the size portfolio results**.** In the Swedish market during the investigated period the absolute largest capitalization stocks are less sensitive to transaction costs than the large to medium sized companies. Overall the transaction cost elasticity in turnover rate decreases with capitalization as expected. In the Finnish market the highest capitalization stocks are less sensitive to the changes in transaction costs than the medium sized companies. The transaction cost elasticity in turnover rate is the lowest for small capitalization companies in Finland as well. Overall we conclude that higher capitalization is associated with higher transaction cost elasticity in the turnover rate. Our findings also indicate that higher trading activity and lower bid-ask spread is associated with higher transaction cost elasticity in turnover rate. These observations are important as they show that each security has a different transaction cost elasticity and that the elasticity for the whole market cannot be imposed on a single stock or a single group of stocks.

To correct for possible trends in the volume and turnover rate over time we estimate the above Equations using the residuals against time to de-trend the series. The adjustment for a possible time trend in the volume and the turnover rate does not change the findings to any significant degree. The estimated coefficients for the transaction elasticity are slightly lower when de-trended turnover measures are used (not reported). The estimated coefficients are sufficiently robust. The Durbin-Watson statistic is close to two and the Durbin's h-statistic has a mean close to zero and a standard deviation close to one, which indicates low autocorrelation in the data used to estimate the auto-distributed lag model (13). A set of tests for heteroskedasticity in the error term show some signs of heteroskedasticity. When we apply White's (1980) heteroskedastic-consistent covariance matrix the estimated coefficients are still significant with a slight decrease in t-values (not reported). When first differences for short-term interest rate and exchange rate are used instead of levels, the coefficients are still similar and significant. The transaction cost elasticity increases however since these transformed money market measures have a weaker explanatory power in the model (not reported).

3.4 Observed price effects

The predicted price effects of the decreasing transaction costs, 17.3% for Sweden and 6.6% for Finland (from section 3.2), are fairly moderate in comparison to the predicted effects on turnover rate. If they were to occur their effect on total market capitalization is still substantial in proportion to the decrease in revenue for the receivers of transaction costs.

Since the elimination of the STT taxes in Sweden and Finland were the results of lengthy political debate, the decisions did not come entirely as a surprise. Still however the decisions can not fully have been incorporated in the prices. The Swedish decision was a part of a larger tax reform and the proposal to the parliament was announced much earlier for both changes. The proposal to change the 2% STT in place since 1986 to 1% (two-sided) was presented March 29 1990, while the change was introduced January 1, 1991. The second change was proposed on October 18, 1991, while the change was introduced on the December 1 the same year. In the Swedish cases, we are looking at the price reactions, both around the date of the proposal and on the introduction date. In Finland the decision was made and implemented fairly quickly with less public discussion than in Sweden. The tax in Finland had been unchanged since 1948 except for a temporary increase during 1985 and 1986. The Finnish decision was made on Tuesday night on April 28, 1992 and the change came in force on the May 1 with trading commencing on May 4. The price reaction thus should have occurred from April 29 onwards. The consolidated numbers including earlier STT changes are presented in Table 6. The average changes in the price level is measured as the change in the last trade (continuously compounded daily returns) on the date when the proposals to change the STT law were presented and on the date when they were introduced separately.

In Sweden the price impact of the two announcements is 0.38% and 2.47% for the 121 most liquid stocks and –0.46% and 2.56% for the market index[3]. The reaction to the second proposal to abolish the STT completely is stronger than the reaction to the initial reduction. The price development was negative during the introduction dates in Sweden. The introduction of the STT change was no surprise, since the decision was finalized much earlier. In Finland the price effect including the announcement and the introduction was 6.2% for the 30

3 Stockholms General Index is a capital weighed index of all stocks on the Swedish Stock Exchange.

TABLE 5. Estimation of transaction cost elasticity in prices.

All Shares Stockholm	Sweden 1990			Sweden 1991			Sweden 1992		
	t	*c*	*D/p*	*t*	*c*	*D/p*	*t*	*c*	*D/p*
Input	0.178	0.04285	0.0279	0.225	0.02795	0.0330	0.351	0.01593	0.0414
PE = t * c / D/p	0.2730			0.1905			0.1352		
including			*g*			*g*			*g*
dividend growth rate:			0.01			0.02			0.03
PE = t * c / (D/p) + g	0.2703			0.1868			0.1313		
Average estimated Price Elasticity:				0.1961					
All Shares Helsinki	Finland 1991						Finland 1993		
	t	*c*	*D/p*				*t*	*c*	*D/p*
Input	0.1024	0.04838	0.0337				0.1483	0.0307	0.0159
PE = t * c / D/p	0.1472						0.2870		
including			*g*						*g*
dividend growth rate:			0.01						0.03
PE = t * c / (D/p) + g	0.1458						0.2786		
Average estimated Price Elasticity:				0.2122					

Using Equation (2) and the mean capital weighed yearly turnover rate during the preceding year, mean capital weighed total transaction costs (bid-ask spread, brokerage fees and STT) and mean dividend yield we estimate the transaction cost elasticity in prices for Sweden and Finland. We estimate the price elasticity before the STT changes and after. The average estimated price elasticity is also reported. *t* denotes turnover rate, *c* total transaction costs (Bid-Ask spread + Brokerage Fees + STT) and *D/p* the yearly dividend per price in the beginning of the year.

most liquid stocks and 5.51% for the market index[4] in Finland. The Finnish case is more clear-cut since the tax had been in place for a long time and it was cut to improve the functioning of the market. Also the announcement and introduction occurred over a few days which makes the study of the price effects more reliable. See Table 6 for an overview of the STT changes and the price effects.

3.5 Test of the impact on prices

The effects of the STT changes might not be fully incorporated into prices until the improvement in liquidity has been fully adjusted for in the terms of market activity. That is why we also estimate price change to the point when the turnover of shares has reached the estimated level. For Sweden, the estimated level of turnover is reached fourteen and a half months after the second change in STT. For Finland, the estimated level of turnover is reached just under eight months after the change in STT. The market capitalization for the whole Swedish market at the point when the estimated yearly volume is reached the increase is 13.9% compared to the level before the change in STT. This is however 0.5% less than the return on the interest rate market of 14.4% during the same period. For Finland the increase in market capitalization for the whole market is 8.6% compared to the level before the change in STT. This is 0.8% less than the return on the interest rate market of 8.89% for the same period. The extremely high interest rate level during this period should be replaced with a long term average when we look at the long-term effects. The investors could have discounted some of the lower interest rate levels to come when they determined the prices for common stock. (The short term market interest rates have stabilized around 4% on both markets during 1997–2000). When we look at the raw changes in market capitalization during the period after the STT changes they are close to the estimated price increases when we consider that both markets have several disturbing events during or close to the investigated periods. Note that the change in STT in Sweden was two times larger than the change in Finland and that it appears to take twice the time for the Swedish market to adjust to the lower transaction costs. The observations in this section are only stated as an example of our hypothesis of a relationship between turnover activity and asset prices and have no statistical validity.

We attempt a test of the validity of our proposal that the price changes over the period when the turnover is adjusting to new transaction cost levels can (at least partly) be attributed to the changes in transaction costs. First we estimate how much of the price changes during the first month after the STT change for our sample of companies from Sweden and Finland can be explained by changes in transaction costs. Secondly we estimate how much of the

4 The Hex Index is a capital weighed index of all stocks on the Helsinki Stock Exchange.

TABLE 6. STT change introductions and consolidated price effects.

Sweden		Announced 24/10/83	Announced 11/3/86	Announced 29/3/90	Introduced 1/1/91	Announced 18/10/91	Introduced 1/12/91	Estimated Turnover
Transaction tax rate		1%	2%	(1%)	1%	(0%)	0%	Reached
Price Effect I)								
- 121 Liquid Stocks		...	...	0.38%	-0.18%	2.47%	-1.30%	...
- All Shares Index		-2.2%	-0.8%	-0.46%	-1.64%	2.52%	-0.93%	13.89%
Est. Return End. Trad.		...	...	7.54%	...	9.73%	...	17.27%
Exp. Return Int. II)		...	...	-0.13%	...	-0.57%	...	...
Tax Revenue Year	BSEK	...	...	...	7.54	...	9.73	...
Capitalization Chng	BSEK	...	...	...	15.0	...	72.9	...

Finland		In tax law 25/03/48	Introduced 1/01/85	Announced 19/12/86	Introduced 1/01/87	Announced 29/04/92	Introduced 1/05/92	Estimated Turnover
Transaction tax rate		1.0%	1.4%	(1.0%)	1.0%	(0%)	0.0%	Reached
Price Effect III)								
- 30 Liquid Stocks		...	...	...	...	2.23%	3.93%	5.23%
- All Shares Index		...	...	...	...	1.69%	3.81%	5.10%
Est. Return End. Trad.		...	...	...	...	...	...	6.56%
Exp. Return Int. II)		...	...	...	...	0.61%	0.80%	…
Tax Revenue Year	BFIM	...	...	...	...	...	0.062	...
Capitalization Chng	BFIM	...	...	...	...	...	5.17	...

Notes:
I) The price effects of the 1984 and 1986 changes for the announcement day only, source: Umlauf (1993). The price effects for the 1991 changes is analyzed in more detail and describes the effect over several days.
II) The expected return based on the daily reactions in the all share index to changes in interest level and the US market during 10 days prior and 10 days post not including the days when the price reaction is measured
III) The price effect for the Finnish data is reported for the days of announcement and introduction only for 1986-87, and in more detail for the 1992 change.
:::Predictions and estimated tax revenue changes are reported only for the recent abolishments of STT.

The table is an overview of the price changes (unadjusted for interest rate return) in our samples and in the market index at the announcement days and the introduction days of the recent reductions in STT in Sweden and Finland. The changes in the market index when earlier STT adjustments were announced is also included. Under Est. Return End. Trad. we report the price change that is estimated by the Endogenous Trading model based on our estimations of transaction cost elasticity. Under Exp. Return Int we report the short term market reactions that would be expected if the market only follow the daily interest rate and international stock market changes. The expected reactions are estimated with and OLS regression of the short term reactions to these market variables during ten days prior and ten days post the STT change not including the days of the STT change. Under Tax Revenue Year we report the yearly tax revenue that is forfeited by the tax cut. Under capitalization change we report the gross change in market capitalization during the period when the market turnover rate has adjusted to the predicted level, (14.5 months for Sweden and 8 months for Finland).

price changes over the period when the turnover is adjusting to new transaction cost levels can be explained by changes in transaction costs. This period is 14.5 months for Sweden and 8 months for Finland. We apply Equation (3) from section 3.2 to estimate the relation between the excess return and the change in transaction cost. We include as control variables for size and liquidity the average market capitalization and the turnover rate during the predicted adjustment period t–1 to t, respectively. Other control variables measuring the market environment during the period cannot be included in this estimation due to a low number of data points. This is why we estimate a simple version of Equation (3) in Equation (6) below.

$$Excess\ return = \alpha_1 + \beta_1\ ((c_t - c_{t-1}) / c_{t-1}) + \beta_2\ Mean\ Market\ Cap + \beta_3\ \tau_t \quad (6)$$

The findings for Sweden are presented in Table 7. For the Swedish sample of 80 stocks the relative change in transaction costs to the excess return is significant both for the one month period and for the 14.5 month periods after the STT change. When the change in turnover rate or alternatively the total turnover rate during the period after the STT change is added to the equation this factor explains excess returns better than the change in transaction costs for the shorter period, (see Table 7). The estimations on the Swedish data indicate that the lower transaction costs cause higher turnover rates and an expected increase in prices due to a lower demand for compensation for illiquidity. The adjusted R squares are between 4.7% for the first month after the STT change and between 6% and 8% for the longer adjustment period. For the sample of 30 Finnish companies none of the variables are significant, (not reported).

We conclude that the price effects are in line with expectations for a STT effect, with positive reactions during the days of announcement of a decrease in STT and negative price reactions to increases in STT. The magnitudes of the price effects are also in line with our estimated price changes for both markets supporting the applicability of the presented models. When the returns in excess of the risk free market interest are considered, the returns are much lower than the predicted returns and the similarities between predicted and raw price changes have to be considered as a stroke of luck.

3.6 Observed liquidity effects and the impact of other structural changes

The sample of 80 Swedish and the 30 Finnish stocks during the STT change periods are analyzed using Equations (7) and (8). The findings are reported in Table 8.

$$ln(Number\ of\ trades_{\ t}) = \beta_1\ ln(Number\ of\ trades_{(t-1)}) + \beta_2\ ln(Trade\ size_{\ t}) + \beta_3\ ln(Brokerage + BidAsk\ Spread_{\ (t-1)}) + \beta_4\ STT\ change\ dummy\ 1_{\ t} + \beta_5\ STT\ change\ dummy\ 2_{\ t} \quad (7)$$

TABLE 7. Test of the price effects.

	Regr. 1 **Sweden** **1st month**	Regr. 2 **Sweden** **14.5 months**	Regr. 3 **Sweden** **1st month**	Regr. 4 **Sweden** **14.5 months**
Dependent Variable Excess Return $(P_t / P_{t-1}) / P_{t-1}$ $-(IR/365*(t-(t-1))$				
Independent Variables				
Intercept	-0.10263 (-3.64)	-0.31487 (-2.74)	-0.09263 (-3.13)	-0.28464 (-2.25)
Change in Trans. Costs $((c_t - c_{t-1}) / c_{t-1}$	-0.28268 (-2.22)*	-1.3171 (-2.84)**	-0.17539 (-1.17)	-1.1625 (-2.01)*
Mean Market Cap $_{t->t-1}$			0.27 E-11 (1.21)	0.25 E –11 (0.29)
Change in Turnover Rate *)			-0.00071 (-0.73)	-0.00094 (-0.56)
Total Turnover Rate $\tau_{t->t-1}$ *)			-0.01790 (-0.05)	0.90375 (2.86)**
N	80	80	80	80
R^2adjusted	0.0472	0.0819	0.0472	0.0623

The relationship of return on the stock over the predicted adjustment period to the change in transaction costs (bid-ask spread, brokerage fees and STT), average market capitalization during the period, turnover rate over the period and market control variables such as interest rate, term structure, exchange rate and US price change. The coefficients are estimated from time series regressions of the following form:

$$\text{Excess return} = \alpha_1 + \beta_1 ((c_t - c_{t-1}) / c_{t-1}) + \beta_2 (\text{Mean Market Cap}) + \beta_3 \tau_t \quad (6)$$

In Equation (6) we include the change in c over the investigated period, where c is measured as the sum of the relative bid-ask spread, the average brokerage fees and the STT. The market capitalization is the average of the market capitalization in t–1 and the market capitalization in t. The total turnover rate τ_t measures number of shares traded to shares outstanding during the period). Alternatively we use the change in turnover rate from the preceding equally long period to the current period. *) The same estimation is performed alternatively with either the change in turnover rate compared to an equally long earlier period or total turnover rate during the period. Which one has no major impact on the other variables, but the total turnover rate has a stronger relation to excess return than the change in turnover rate.

$$\ln(\text{Number of trades }_t) = \beta_1 \ln(\text{Number of trades}_{(t-1)}) + \beta_2 \ln(\text{Trade size }_t) +$$
$$\beta_3 \ln(\text{Brokerage + BidAsk Spread }_{(t-1)}) + \beta_3 \text{ STT change dummy }_t +$$
$$\beta_4 \text{ Currency devaluation dummy }_t + \beta_5 \text{ Foreign ownership change dummy }_t \qquad (8)$$

The dependent variable, the natural logarithm of number of trades is used as a measure of liquidity that is straightforward to compare between companies. The relationship between number of trades and the transaction costs is the main interest in this model. The lagged number of trades is included to allow for partial adjustment and trade size is included to control for company size. For both markets the liquidity and trade size (measured as the number of trades scaled by trade size) has improved significantly after the STT changes. In Sweden the total abolishment had a larger impact on trading activity than the earlier cut of equal size when. In Finland in addition to the STT change a large part of the increase in trading activity is due to the two other major structural changes; devaluation and free foreign ownership of securities.

TABLE 8. Liquidity effects.

Dep. Variable Ln (no of trades t)	**ln(No trds)** (t-1)	**Ln(Trade size)** (t)	**Ln(Trans Cost)** excl STT (t-1)	**STT chng.** Dummy1	**STT chng.** Dummy2	**Curr. Deval.** Dum	**Foreig Own.** Dum	**N**	**$R^2_{adj.}$**
Stockholm									
1.1.90 – 30.11.92	0.6844	0.06983	-0.1157	0.04542	0.1276			58000	0.791
	(204.9)	(98.7)	(5.50)	(7.95)	(21.58)				
Helsinki									
1.5.91 – 30.4.93	0.5490	-0.01397	-0.4116	0.05366		0.1625	0.3778	14850	0.526
	(60.67)	(-4.969)	(-27.84)	(2.314)		(3.913)	(4.556)		

The relationship of the number of trades to lagged number of trades, trade size, STT change dummies, a currency devaluation and a foreign ownership dummy. The coefficients are estimated from a pooled cross-sectional and time series regressions of the following logarithmic form: for Sweden Equation (7) $\ln(\text{Number of trades }_t) = \beta_1 \ln(\text{Number of trades}_{(t-1)}) + \beta_2 \ln(\text{Trade size }_t) + \beta_3 \ln(\text{Brokerage + BidAsk Spread }_{(t-1)}) + \beta_4 \text{ STT change dummy } 1_t + \beta_5 \text{ STT change dummy } 2\ _t$; for Finland Equation (8) $\ln(\text{Number of trades }_t) = \beta_1 \ln(\text{Number of trades}_{(t-1)}) + \beta_2 \ln(\text{Trade size }_t) + \beta_3 \ln(\text{Brokerage + BidAsk Spread }_{(t-1)}) + \beta_4 \text{ STT change dummy }_t + \beta_5 \text{ Currency devaluation dummy }_t + \beta_6 \text{ Foreign ownership change dummy }_t$. For Sweden the first STT change dummy takes the value 1 from 1.1.1991 to 30.11.1991 and the second STT change dummy takes the value 1 from 1.12.1991. For Finland the STT change dummy takes the value 1 from 1.5.1992 except for 18 days around 8.9.1992 when the currency devaluation dummy is 1 and three days after 1.1.1993 when the foreign ownership change dummy is one. T statistics are reported beneath the coefficients in parenthesis. A heteroskedasticity-consistent covariance matrix and autocorrelation-consistent matrix with order 1 by Newey-West correction method is used in the regressions.

The effects of the currency devaluation appear to be assimilated by the market during the weeks around the devaluation. A dummy variable that gives a different intercept to 18 days around the devaluation picks up most of the effect. The change to freely allow foreign ownership of shares has more long-term effects and is one of the major factors in sustaining the growth in the Finnish market. The effect of the change to free foreign ownership has positive price and turnover effects picked up by the dummy variable during three days after the change of January 1993.

3.7 Observed volatility effects

In the estimations presented in Table 2 the volatility coefficient (measured as the difference between high and low price divided by the average price) takes a significantly negative value when it is regressed against turnover rate. This indicates that the higher turnover associated with lower transaction costs also can be associated with lower volatility. This is confirmed by the regressions of volatility against transaction costs using Equation (9) and reported in Table 9. The long-term transaction cost elasticity in high low dispersion takes a significantly positive value at 0.40 (the long-term coefficient is derived from the short-term and lagged transaction cost variable).

$$\begin{aligned} &\mathit{ln}(\mathit{Daily\ price\ volatility}_{\,t}) = \alpha_1 + \beta_1 \mathit{ln}(\mathit{Daily\ price\ volatility}_{\,(t-1)}) + \\ &\beta_2 \mathit{ln}(\mathit{Transaction\ costs}_{(t-1)}) + \beta_3 \mathit{ln}(\mathit{US\ price\ volatility}_{\,t}) \end{aligned} \tag{9}$$

The Finnish case indicates increasing volatility with higher turnover around the STT change, which we interpret as a result of the extreme volatility on the downside during end of 1992. A more detailed study of 1992 with regard to volatility is suggested for future research. In Table 10 the weekly volatility in the market index is analyzed over a longer time period and a positive relationship between transaction costs and volatility is shown for both markets. US market volatility is included to measure international volatility changes and traded value is included to pick up the relationship volume to volatility, see Equation (10). The argument that higher transaction costs would decrease volatility is subsequently not supported by our findings. Particularly in the Swedish case lower transaction costs appear to decrease volatility in securities prices.

$$\begin{aligned} &\mathit{ln}(\mathit{Weekly\ index\ volatility}_{\,t+5}) = \alpha_1 + \beta_1\ \mathit{ln}(\mathit{Transaction\ costs}_{\,(t-1)}) + \\ &\beta_2\ \mathit{ln}(\mathit{Weekly\ US\ price\ volatility}_{\,(t-1)}) + \beta_3\ \mathit{ln}(\mathit{Traded\ value}_{\,t}) \end{aligned} \tag{10}$$

TABLE 9. Volatility effects, Individual stocks.

Dep. Variable Ln (Volatility $_t$)	Intercept	ln (Volatility) (t-1)	ln (Trans. Costs) (t-1)	ln (US volatility) t	N	$R^2_{adj.}$
Stockholm						
1.1.90–30.11.92	0.42534	0.19024	0.32096	2.2051	57920	0.5679
	(7.94)	(46.62)	(35.87)	(2.49)		
Helsinki						
1.5.91–30.4.93	-23.488	0.13950	-1.4432	39.898	14850	0.2317
	(-3.915)	(17.16)	(-10.29)	(3.92)		

The relationship of volatility to the transaction costs consisting of bid ask spread, brokerage fees and security transaction tax is estimated. The price volatility is measured as the daily high- low-price dispersion. The coefficients are estimated from time series regressions of the following logarithmic form: *ln(Daily price volatility $_t$) = α_1 + $\beta_1$ln(Daily price volatility$_{(t-1)}$) + β_2 ln(Transaction costs $_{(t-1)}$) + β_3 ln(US price volatility $_t$)* (9). T statistics are reported beneath the coefficients in parenthesis. The US volatility is used as a proxy for the world market volatility. The lagged US volatility (not reported) has no significant impact while the same day US volatility has a high positive elasticity vs the volatility of the local market. Observe that Sweden has overlapping trading hours with the US market while Finland closes before the US market opens during the investigated period. The results are still similar supporting the use of the US volatility as a proxy for world market volatility.

4. CONCLUSIONS

We set out to propose a model that accurately predicts and measures the effects STT changes have on the turnover rate and asset prices. The suggested model predicts changes in turnover rate and asset prices that are close to the observed effects. We conclude that STT changes have a significant impact on the price levels and the trading activity in Sweden and Finland. The price reactions to the announcements of STT adjustments downwards are positive. The transaction cost elasticity in asset prices is estimated to be between –0.12 and –0.21 for Sweden and between –0.18 and –0.33 for Finland. The estimations of the effects on turnover rate show significantly negative coefficients for transaction costs. The transaction cost elasticity in turnover for the Swedish stocks is estimated to be between –0.906 and –1.002. The elasticity for the Finnish stocks is estimated to be between –1.27 and –1.39. On both markets other transaction costs such as brokerage fees and bid ask spreads have rapidly followed the change in STT in the expected proportion. In the framework of exogenous changes in transaction costs, our dynamic asset-pricing model incorporating endogenous trading appears to explain asset

TABLE 10. Volatility effects, All Share Index.

Dep. Variable Ln (Volatility t)	Intercept	ln(Trans. Costs) (t-1)	Ln(US volatility) (t)	Ln (Traded value) (t)	N	$R^2_{adj.}$
Stockholm						
1.1.87–31.12.98	-0.00118 (-7.78)	0.00021 (8.96)	0.24019 (19.32)	0.00010 (9.11)	2993	0.1384
1.1.87–31.12.92	-0.00261 (-8.60)	0.00033 (4.68)	0.21006 (14.22)	0.00020 (10.04)	1478	0.1858
1.1.93–31.12.98	-0.00206 (-7.97)	0.00011 (4.63)	0.69686 (13.00)	0.00012 (8.02)	1506	0.1696
Helsinki						
1.1.87–31.12.98	-0.00069 (-7.15)	0.00010 (2.90)	-0.00002 (-1.13)	0.00008 (7.27)	2998	0.0275
1.1.87–31.12.92	0.00013 (0.51)	0.00015 (1.64)	-0.00001 (-0.87)	0.00003 (2.10)	1503	0.0015
1.1.93–31.12.98	0.00039 (1.11)	0.00070 (7.12)	-0.00003 (-1.25)	0.00017 (10.22)	1495	0.0705

The relationship of volatility to the transaction costs consisting of bid ask spread, brokerage fees and security transaction tax. The all share index volatility is measured as the weekly variance in logarithmic returns from t to t+5. The coefficients are estimated from time series regressions of the following logarithmic form: $ln(Weekly\ index\ volatility_{t+5}) = \alpha_1 + \beta_1\, ln(Transaction\ costs_{(t-1)}) + \beta_2\, ln(Weekly\ US\ price\ volatility_{(t-1)}) + \beta_3\, ln(Traded\ Value_t)$ **(10). T statistics are reported beneath the coefficients in parenthesis.**

prices more correctly than traditional models such as the Capital Asset Pricing Model. We also show empirically that the long run transaction cost elasticity in turnover for two Nordic markets is greater than one in absolute value. This would make the application of the Amihud and Mendelson (1986b) model problematic, since in their model a higher elasticity than 1 gives rise to an unexpected relationship between transaction costs and prices.

Transaction costs have remained on a higher level in Finland than in Sweden. The transaction cost elasticity levels also remain higher in Finland after the STT changes, probably due to the smaller more concentrated market and because the brokerage fees have not been as flexible as in Sweden. This indicates that there are further means to increase the efficiency of the Finnish stock market through lower costs. A more flexible and public brokerage fee policy in Finland would have a significant impact on the liquidity and as a result the size of the market.

Some of the improvements in market liquidity of the Nordic markets can be attributed to an international increase in stock market activity. Internal changes in exchange rate policy and the liberalization of foreign ownership of shares in Nordic companies have a large impact on the activity of the local stock markets as well. After controlling for these effects we still find that the abolition of STT is an important factor explaining the increase in activity on these markets. Our findings indicate that in other markets an introduction of a STT can be expected to decrease demand for trading, have a negative effect on turnover (with an elasticity of minus one or higher in absolute magnitude), to decrease liquidity and thus to have a negative impact on asset prices. A decrease in STT on the other hand can be expected to compensate for the loss in tax revenue by an increase in liquidity and asset prices that improve the total social welfare by more than the loss of revenue. We find it reasonable to propose that the remarkable increases in volume, liquidity and prices the Swedish and Finnish stock markets have experienced since 1993 would not have been possible if the security transaction taxes had been retained. These findings also emphasize that transaction taxes are very likely to have negative effects other markets such as real estate.

Appendix A.

Condensed summary of Swan (2003)[5].

To examine the possible impact of liquidity and thus investor trading on required security returns it is necessary to generate a motive or preference for trading into investor utility functions. That is, to incorporate the value of endogenous stock market trading into investor preferences (see Swan (2003)). In this model of a risk-neutral investor's decisions, decisions to trade are utility enhancing and hence voluntary. They are not an exogenous event as in earlier models. The model incorporates the liquidity benefits of turnover and the expected discounted bid-price of the security, which is measured net of turnover costs. This illiquidity-based capital asset pricing model can be expressed as follows when we assume a power utility function involving turnover (liquidity):

$$ep = [1/(1-\beta)](\tau_e c_e - \tau_b c_b) \equiv \alpha[1/(1-\beta)](c_e^{1-\beta} - c_b^{1-\beta}) \equiv \alpha^{\mu}[\mu/(\mu-1)](\tau_e^{1-\mu} - \tau_b^{1-\mu}) \tag{a1}$$

where ep is the expected equity premium[6] over treasury bills and security turnover, τ_e for equity and τ_b for treasury bills depends generally on transaction costs for the two respective securities, ce and cb:

[5] © Peter L. Swan, School of Banking and Finance, University of New South Wales, Australia.

$$\tau_e = \alpha c_e^{-\beta} \text{ and } \tau_b = \alpha c_b^{-\beta} \qquad \text{(a2)}$$

with the "intrinsic" liquidity parameter, a, and absolute value of the transaction cost elasticity[7], treated as a constant.

The equity premium has been obtained from the maximization of the representative investor's utility function, which is linear in wealth and thus risk neutral, and subject to the individual's budget constraint which incorporates the cost of trading. For the last unit of the security traded the marginal utility or benefit from trading must exactly equal the transaction cost c_e incurred. Knowing how turnover or trading responds to transaction costs as given by the turnover function enables the utility function to be constructed via integration over the turnover/transaction cost path.

All utility functions consistent with "endogenous" utility-enhancing trading are generated and optimized in order to derive the equity premium. The premium itself depends stochastically on the difference between the expected "amortized spread"[8] for equity given by the product of the rate of transactions and transaction cost less the equivalent amortized spread for treasury bills. This difference is deflated by a term, which is given by unity minus the absolute value of the transaction cost elasticity, β. The utility function from which the equity premium has been derived is such that on the last unit of equity traded the marginal benefit is exactly equal to the marginal (and average) transaction cost.

If trading volume and turnover would be treated as exogenous and thus not "explained" by the model then the equity premium depends only on the amortized spread and is thus tiny in comparison with the observed equity premium. Because trader/investors rationally value the ability to trade and the transaction cost elasticity is typically in the vicinity of unity, the deflator, 1 – β, is usually small in magnitude so that the implied equity premium is usually high and thus consistent with persistently high premia observed over long periods of time. Moreover, since turnover for most stocks is highly volatile the stochastic discount factor generated by the equity premium is also highly volatile.

In the equity premium Equation the coefficient for the amortized spread, $\tau_e c_e$ can be estimated linearly to obtain the transaction cost elasticity. In a non-linear regression α and β can be estimated individually and simultaneously. For a formal derivation of Equation (a1) see Swan (2003), where he confirms the applicability ofthe proposed model in simulations and empirical tests on US and Australian data. According to the model, the "investor surplus" from trading liquid Treasury bills relative to less liquid equity is exactly compensated for by the equity premium. In all countries examined treasury bills and government bonds are far more liquid (turn over more rapidly) than equity securities. The presented propositions are confirmed in tests on daily NYSE data (source CRSP and Schwert (1990)) for the years 1955 to 1998. Similar results are found using monthly data on approximately 576 Australian stocks covering the years 1994 to 1998.

In addition to the theoretical definition referred to above a perhaps more intuitive graphical derivation of the model is also an option. In Figure (a1) the demand for turnover Equation (a2) and equilibrium turnover levels for equity and T-bills are represented graphically. The sloping curve expresses the turnover demand function for the aggregated financial markets. The points E and B express two equilibriums. The equilibrium on the equity market and on the T-bill market. A rational investor would demand a premium if he or she needs to shift from the more liquid market to the less liquid market. This premium or investor surplus is the compensation required to induce a representative investor/trader to hold both equity with a transaction cost of c_e and turnover τ_e and Treasury bills with a transaction cost of c_b and turnover of τ_b in their portfolio. The investor surplus is represented by the shaded area in Figure a1.

FIGURE a1. The Equity Premium Corresponds to the Net Welfare Trapezoid Area Welfare Loss Arising from the Difference in Transaction Cost between Equity and Treasury Bills

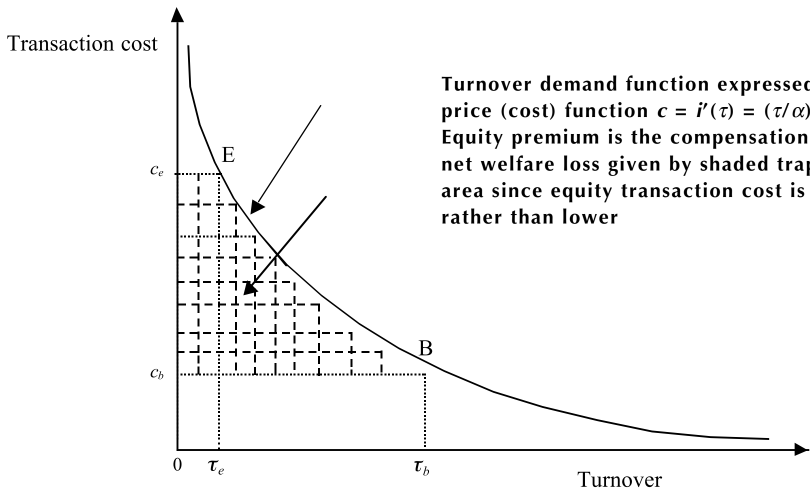

Figure a1 shows the compensation required to induce a representative investor/trader to hold both equity with a transaction cost of c_e and turnover τe and Treasury bills with a transaction cost of c_b and turnover of τ_b in their portfolio. The endogenous trading model shows that the investor must be compensated by exactly the large shaded trapezoid area made up of a rectangle of height $c_e - c_b$ and width τ_e plus the shaded triangular area between τ_e and τ_b. It represents the investor/trader gain from trading at transaction cost c_b rather than the higher cost c_e. This area is commonly known as the consumer surplus change or the equivalent/compensating variation. By contrast the conventional model incorrectly attributes the equity premium to the amortized spread for equity given by the small rectangle with width τ_e and height c_e.

The shaded area can be calculated by integrating over the transaction cost, thus mirroring the diagram in the function $t = c$. The surplus becomes:

$$\int_{c_b}^{c_e} \alpha \cdot c^{-\beta} \cdot dc = \alpha \cdot \int_{c_b}^{c_e} c^{-\beta} \cdot dc = \alpha \cdot \left[\frac{c^{1-\beta}}{1-\beta}\right]_{c_b}^{c_e} = \frac{\alpha}{1-\beta} \cdot \left[c_e^{1-\beta} - c_b^{1-\beta}\right] \beta \neq 1$$

This is the same result as obtained for the equity premium in Equation (a1).

APPENDIX B.

Return and turnover rate variables.

a) In all estimations we use the continuously compounded return denoted *excess return.* The interest rate observations are not converted to continuous interest rate. We expect this to have little impact on our results. See Equation (b1).

$$\textit{Excess Return} = \ln \frac{\textit{Closing Price}_t}{\textit{Closing Price}_{t-1}} - \frac{\textit{Interest Rate p.a.}}{365} \tag{b1}$$

b) The turnover rate measures the rate at which the total amount of outstanding stock is turned over. See Equation (b2).

$$\textit{Turnover rate}_t = \frac{\textit{Number of shares traded}_t}{\textit{Number of shares outstanding}_t} \tag{b2}$$

Transaction cost variables.

c) The bid-ask spread [BAS] in our study is measured as the daily closing bid-ask spread in the limit order book market from Sweden and Finland and calculated as the relative bid-ask spread. See Equation (b3)

$$\textit{Bid} - \textit{Ask Spread} = \textit{relative spread} = \textit{Ask}_c - \textit{Bid}_c \div \left(\frac{\textit{Ask}_c + \textit{Bid}_c}{2}\right) \tag{b3}$$

d) The amortized spread in Equation (b4) is calculated as the daily closing bid ask spread in the limit order book multiplied by the turnover rate. The turnover rate is obtained as the number of shares traded during the day divided by number of shares outstanding that day.

$$\text{Amortized spread}_c = \frac{(\textit{Ask}_c - \textit{Bid}_c)}{(\textit{Ask}_c + \textit{Bid}_c) \div 2} \times \frac{\text{daily shares traded}}{\text{shares outstanding}} \tag{b4}$$

Sensitivity variables

e) Stock price volatility measures the company specific risk or how much the stock price varies unrelated to other variables. We apply less volume sensitive measure of volatility than the generally used standard deviation, the intraday high low price dispersion measure in Equation (b5).

$$\textit{Stock price volatility measure} = \frac{\textit{Daily high price} - \textit{Daily low price}}{\textit{Daily mean price}} \tag{b5}$$

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