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A dark blue background image showing a large globe on the left and a building with a glass facade on the right, both slightly blurred.

# FINANCIAL TRANSACTION TAXES AND EXPERT ADVICE

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# Financial Transaction Taxes and Expert Advice

Working paper NBS

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## Abstract

This paper models trading on expert advice to study the impact of a financial transaction tax on traders' information and decisions. The tax worsens expert advice by strengthening experts' incentives to misreport information. This result advances the debate on tax suitability beyond the conventional arguments and provides a new explanation for the observed decline in informational efficiency after the tax introduction: the tax makes traders less informed. The model also generates testable predictions regarding the tax impact on mean and variance of trading volume. Finally, it sheds light on the relationship between the tax and regulation of expert compensation.

JEL classification: D83, G12, G14, G18

Keywords: Financial Transaction Taxes, Expert Advice, Trading.

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## NON-TECHNICAL SUMMARY

This paper studies the impact of a financial transaction tax on traders' information and decisions through expert advice. I motivate my analysis with the renewed interest in financial transaction taxes after the crisis and with the pervasiveness of expert advice in trading. The findings offer a novel perspective on the longstanding debate of whether to tax financial transactions.

The global financial crisis has revived interest in financial transaction taxes, a development that has been fueled by the combination of governments' worries about functioning of financial markets and public discontent with the financial industry. France introduced a 0.1 percent tax on security transactions in 2012 (later raised to 0.2), Italy a 0.1 percent tax in 2013, and the European Union is considering the possibility to tax financial transactions in its member states.

Since suggested by Keynes (1936), the idea of taxing financial transactions has been a key policy discussed to foster market efficiency and financial stability. Proponents suggest that the tax primarily affects traders that by trading for reasons unrelated to fundamentals drive the market price away from fundamentals (noise traders). Opponents contend that the tax mainly impacts traders who trade on fundamentals (informed traders) and hence prevents the market from incorporating all available information. They also argue that, by discouraging trading, the tax decreases liquidity thereby slowing the correction of mispricing. The literature studies tax suitability along these lines.

A central but overlooked aspect of trading is that informed traders act on information from experts. Institutional investors trade following advices of sell-side analysts, retail investors trade following recommendations of financial advisors. Experts are remunerated through a commission on trading volume and commission gains shape experts' incentives to (mis)report information. The starting point of my investigation is that the tax discourages trading thereby influencing experts' incentives to report information.

My analysis shows that the tax worsens expert advice to traders. Intuitively, experts would like traders to trade more than what they do since experts are compensated by traders through the commission on trading volume. Experts have hence an incentive to misreport information in order to induce more trading. The tax makes trading less attractive for traders by raising the transaction cost. For this reason, the tax strengthens experts' incentives to misreport information to traders and expert advice becomes less accurate.

This result advances the debate on tax suitability beyond the conventional arguments on how the tax impacts noise versus informed trading and liquidity. In particular, worsened expert advice provides a new explanation for the decline in informational efficiency observed by Colliard and Hoffmann (2017) after the tax introduction in France: the tax makes informed traders less informed.

In line with the empirical literature, I find that the tax curbs trading volume since the tax makes trading less attractive by increasing the transaction cost. For instance, Meyer, Wagener, and

Weinhardt (2015) show that the introduction of a 0.2 percent tax in France decreased trading volume by 20 percent. I also find that the tax influences trading decisions and variance of trading volume through expert advice.

In particular, the tax reduces variance of trading volume for two reasons. First, the tax raises the transaction cost so that for any optimal trading traders trade less. Second, the tax decreases variance of trading volume by worsening expert advice. When advice is accurate, for different optimal trading observed, experts tend to give different advices and thereby induce different trading decisions. When advice becomes inaccurate because of the tax, for several optimal tradings observed experts give the same advice and induce the same trading decision. Thus, variance of trading volume drops.

FIGURE I: EXPERT ADVICE CHANNEL OF THE TAX

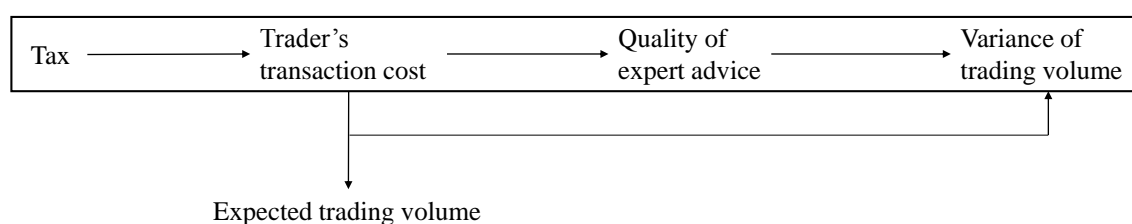


Figure I illustrates the channels through which the tax influences quality of expert advice, mean, and variance of trading volume. First, the tax lowers mean and variance of trading volume since the tax raises the transaction cost. Second, the tax reduces quality of expert advice and variance of trading volume through the expert advice channel. By raising the transaction cost, the tax distorts experts' incentives to report information so expert advice worsens and variance of trading volume declines.

Besides being important for understanding the impact of financial transactions taxes, my analysis more generally informs the debate on transaction costs in financial markets. Specifically, my model demonstrates that both financial transaction taxes and expert trading commissions impact expert advice to traders and trading activity. Yet, financial transaction taxes are debated in the context of financial stability while regulation of expert commissions is separately discussed in the context of investor protection. My findings suggest to jointly consider financial transaction taxes and regulation of expert trading commissions.



# 1. INTRODUCTION

Keynes (1936)'s idea of taxing financial transactions has sparked the policy debate in the wake of the financial crisis. According to proponents like Stiglitz (1989), the tax should improve markets' informational efficiency by curbing the proportion of trading unrelated to information (noise trading).<sup>2</sup> Indeed, noise traders trade excessively and drive the market price away from fundamentals.

Opponents like Edwards (1993) contend that the tax reduces the proportion of informed trading and hence prevents markets from incorporating all available information. In addition, by discouraging trading, the tax decreases liquidity thereby slowing the correction of mispricing.<sup>3</sup>

The theoretical literature discusses tax suitability along these lines. Empirical work indicates that the tax reduces trading volume and efficiency. Meyer, Wagener, and Weinhardt (2015) show that the introduction of a 0.2 percent tax in France decreases trading volume by 20 percent. Colliard and Hoffmann (2017) find that the tax reduces informational efficiency. In an efficient market prices should follow a random walk. Deviations from random walk occur when a stock return is autocorrelated. The tax strengthens return autocorrelations. Thus, the tax appears to hamper informed trading more than noise trading and/or to have a dominant negative impact on liquidity.

A central but overlooked aspect of trading is that informed traders act on information from experts. Institutional investors trade following advices of sell-side analysts. Retail investors trade following recommendations of financial advisors.<sup>4</sup> Jackson (2005) and Inderst and Ottaviani (2012) show that commission gains shape experts' incentives to (mis)report information. In the context of trading, experts are remunerated through a commission on trading volume. The tax discourages trading and thereby influences experts' incentives to report information. A sound assessment of the tax hence requires an investigation of the tax impact on expert advice to traders.

This paper aims to fill this gap by analyzing how the tax affects information and decisions of informed traders through expert advice. In my model an expert issues a trading recommendation to a trader regarding a security, on the basis of private information about optimal trading of the security. The expert is remunerated through a commission on trading volume. Moreover, the expert cares that the trader makes a suitable trading decision, because of liability or reputation concerns. The informed trader makes the trading decision and pays expert commission as well as a tax on trading volume.

The main result is that the tax worsens quality of expert advice. Since the expert is compensated through the commission on trading volume, if the expert correctly reports optimal trading, the purchase (sale) that he would expect the trader to make is too small from the expert perspective. The expert has hence an incentive to exaggerate optimal trading. The tax strengthens expert's incentive to exaggerate by making trading less attractive to the trader. Expert's incentive to exaggerate optimal trading translates into less accurate advice when communication is

<sup>2</sup>See also Tobin (1978), Summers and Summers (1989).

<sup>3</sup>See also Ross (1989).

<sup>4</sup>While the reliance of institutional investors on recommendations of sell-side analysts has long been known, evidence on the reliance of retail investors on financial advisors is more recent. Bergstresser et al. (2007) and Equity Ownership in America 2005 show that, in the U.S., equities and mutual funds are vastly purchased after receiving financial advice. In a 2007 survey of the Investment Company Institute over 80 percent of respondents obtained financial advice from professional advisors or other sources. According to Chater et al. (2010) survey across eight EU countries, around 60 percent of recent buyers of shares were strongly influenced by an advisor.



truthful. Thus, the tax lowers quality of expert advice and the trader relies on less information to make the trading decision.

This novel mechanism through which the tax affects traders' information advances the tax debate beyond its focus on the proportion of noise versus informed trading and on liquidity. In particular, worsened expert advice provides a new explanation for the observed decline in informational efficiency: the tax makes informed traders less informed.

In line with the empirical literature, the tax decreases expected trading volume since the tax makes trading less attractive by raising the transaction cost. Surprisingly, lower quality of expert advice caused by the tax affects trading decisions but not expected trading volume. This is the case because expected trading volume is trader's average belief on optimal trading volume after advice discounted by the transaction cost. Quality of expert advice influences trader's belief on optimal trading volume. However, quality of expert advice does not affect trader's average belief.

The model also predicts that the tax lowers variance of trading volume for two reasons. First, the tax raises the transaction cost and hence reduces variance of trading volume by making trading less attractive for any optimal trading. Second, the tax worsens quality of expert advice. When advice is accurate, for different optimal tradings the expert tends to give different advices thereby inducing different trading decisions. On the contrary, when advice is inaccurate, for several optimal tradings the expert gives the same advice and induces the same trading decision.

Besides being important for understanding the impact of financial transactions taxes, my analysis more generally informs the debate on transaction costs in financial markets. Interestingly, my model points to a relationship between taxes and regulation of experts' trading commission. On the one hand, the tax worsens expert advices and reduces expectation and variance of trading volume. On the other hand, a commission drop improves expert advice and increases expectation and variance of trading volume. Yet, financial transactions taxes and regulation of experts' commissions are discussed separately. The former is debated in the context of financial stability while the latter in that of investor protection. This relationship suggests to jointly consider financial transaction taxes and regulation of experts' trading commissions.

In addition to explaining empirical evidence on the tax impact and providing new testable predictions, this paper complements a number of other theoretical studies. Pallay (1999) shows that the tax raises informational efficiency when the proportion of noise relative to informed traders is high. Song and Zhang (2005) also consider the negative tax impact on liquidity. Davila (2017) derives optimal taxes as a function of noise and informed trading proportions. My focus is different. I aim at shedding light on the tax impact on traders' information and decisions through expert advice.

The remainder of this paper is organized as follows. Section 2 outlines the model. Section 3 characterizes equilibria. Section 4 studies quality of expert advice while Section 5 displays expectation and variance of trading volume. Section 6 describes the tax impact on profits. Section 7 investigates the relationship between financial transaction taxes and regulation of expert commissions. Section 8 concludes. All proofs are in the Appendix.

## 2. MODEL

To model trading on advice with financial transaction taxes, we consider a framework of strategic communication between an expert (E henceforth) and an informed trader (I henceforth).

### 2.1 INFORMATION

The expert privately observes the realization of a state  $x \in [-s, s]$ , with  $s > 0$ . The state captures optimal trading of a security in absence of commission and tax on trading volume. When  $x < 0$  it is optimal to sell  $x$  of the security, when  $x = 0$  it is optimal not to trade, and when  $x > 0$  it is optimal to buy  $x$  of the security. It is common knowledge that  $x$  is uniformly distributed on  $[-s, s]$  with zero mean and variance  $\sigma^2 = s^2/3$ .

### 2.2 PREFERENCES

The informed trader makes trading decision  $y \in [-s, s]$ . If  $y < 0$  the trader sells  $y$  of the security, if  $y = 0$  the trader does not trade, and if  $y > 0$  the trader buys  $y$  of the security. The profit of the informed trader is

$$\pi_I = \Pi_I - (y - x)^2 - (\kappa + \tau)y^2, \quad (1)$$

where  $\Pi_I \in R_+$  is the maximum profit that the trader can realize.<sup>5</sup> The trader wants the trading decision to match optimal trading but pays an expert commission  $\kappa \in (0, 1)$  and a tax  $\tau \in (0, 1 - \kappa]$  on trading volume. The  $-(y - x)^2$  term represents trader's loss from not matching optimal trading of the security while the  $-(\kappa + \tau)y^2$  term captures the transaction cost. After receiving expert advice, the trader updates beliefs and makes the trading decision to maximize the expected profit.

The expert advises the trader on optimal trading of the security. Expert's profit is

$$\pi_E = \Pi_E - (y(m) - x)^2 + \kappa y(m)^2, \quad (2)$$

where  $\Pi_E \in R_+$  is the maximum profit that the expert can realize. The expert has two conflicting objectives. On the one hand, the expert wants the trader to make a suitable trading decision. An unsuitable decision may cause a reputation loss or a punishment by a regulatory authority.<sup>6</sup> On the other hand, the expert wants the trader to trade because the expert obtains the commission on trading volume. The  $-(y - x)^2$  term captures expert's concern for suitability. The  $\kappa y^2$  term represents expert's gain from commission. The expert chooses message  $m \in [-s, s]$  to maximize the profit.

Without loss of generality, we set  $\Pi_E = \Pi_I = 0$ .

<sup>5</sup>The quadratic utility functions and the uniform distribution of  $x$  are assumptions commonly used in the literature for the sake of tractability.

<sup>6</sup>In addition to regulations that encourage sell-side analysts and financial advisors to correctly report information, sell-side analysts are frequently ranked according to the accuracy of their past recommendations. See Jackson (2005).



## 2.3 TIMING

Figure 1 summarizes the model. First, the expert privately observes optimal trading of the security. Second, the expert advises the trader. Third, the trader makes the trading decision. Finally, the trader pays commission and tax on trading volume.

FIGURE 1: Timeline



All aspects of the model except optimal trading are common knowledge. We require expert advice to be truthful and we look for Perfect Bayesian equilibria.

## 2.4 TRADING DECISION

To investigate incentives at work in expert advice and then characterize equilibria, it is useful to first consider informed trader's decision. In response to expert advice  $m$ ,  $E(x|m)$  is the trader's belief on optimal trading in absence of commission and tax. The trader then chooses to trade as follows

$$\begin{aligned} \max_y E(\pi_I|m) &= E\left[-(y-x)^2 - (\kappa + \tau)y^2|m\right] \\ &= -[y - E(x|m)]^2 - \text{Var}(x|m) - (\kappa + \tau)y^2 \end{aligned} \quad (3)$$

The trading decision is

$$y = \frac{E(x|m)}{1 + \kappa + \tau}. \quad (4)$$

We see from (4) that trader's decision is trader's belief on optimal trading after expert advice discounted by the transaction cost. In absence of advice the trader does not trade.<sup>7</sup>

## 2.5 INCENTIVES TO MISREPRESENT INFORMATION

We can now study expert's incentives to misrepresent information. For this purpose, we compare expert's and trader's preferred trading decisions.

Expert's preferred decision maximizing (2) is

$$y_E = \frac{x}{1 - \kappa}. \quad (5)$$

<sup>7</sup>In this case  $y = E(x)/(1 + \kappa + \tau) = 0$  since  $E(x) = 0$ .

If the informed trader knew  $x$ , from (4) the trader's preferred decision would be

$$y_I = \frac{x}{1 + \kappa + \tau}. \quad (6)$$

We see from (5) and (6) that  $y_E > y_I$  for  $x > 0$ ,  $y_E = y_I$  for  $x = 0$ , and  $y_E < y_I$  for  $x < 0$ . Whenever the informed trader would like to buy (sell) a certain volume of the security, the expert would like the trader to buy (sell) more. If the expert correctly communicates that optimal trading is  $x > 0$  ( $x < 0$ ), the purchase (sale)  $y_I$  that he would expect the trader to make is too small from the expert's perspective. To induce the trader to trade more, the expert exaggerates optimal trading of the security by reporting  $m > x$  if  $x > 0$  and  $m < x$  if  $x < 0$ .

Expert's incentive to exaggerate optimal trading originates from the differing attractiveness of trading. Trading is less attractive for the informed trader than for the expert for two reasons. First, the trader pays commission and tax on trading volume. Second, the expert receives the commission. While it is apparent that the commission creates an incentive for the expert to exaggerate optimal trading, the tax origin of the incentive is more subtle. The tax leads the expert to exaggerate optimal trading because the tax reduces expert's potential commission gain on trading volume by making trading less attractive for the trader. For a given commission, expert's incentive to exaggerate is stronger, the larger are tax and optimal trading volume  $|x|$ .

### 3. EQUILIBRIUM

The model has a multiplicity of perfect Bayesian equilibria. Each equilibrium partitions  $[-s, s]$  into intervals. The expert communicates in which interval optimal trading  $x$  is in. Expert's incentive to exaggerate determines the size of intervals, that is, how accurate is expert advice.

Formally, an equilibrium is defined by (i) expert's advice strategy, (ii) trader's trading strategy after advice, (iii) trader's belief on optimal trading after advice. Expert's advice strategy defines probability  $q(m|x)$  of giving advice  $m$  if the expert observes  $x$ . Trader's trading strategy after advice  $m$  is  $y^*(m)$ . Trader's belief on optimal trading after advice  $\mu(x|m)$  is the probability of  $x$  given advice  $m$ .

Perfect Bayesian equilibria require that (a) expert's advice strategy is optimal given trader's trading strategy, (b) trader's trading strategy is optimal given trader's belief on optimal trading after advice, (c) trader's belief on optimal trading after advice is derived from expert's advice strategy using Bayes's rule whenever possible.

Since perfect Bayesian equilibria partition  $[-s, s]$  into intervals, we denote

$(a_0, a_1, \dots, a_{i-1}, a_i, a_{i+1}, \dots, a_N)$  the partition points of  $[-s, s]$  into  $N$  intervals with  $a_0 = -s$ ,  $a_N = s$  and  $a_i < a_{i+1}$  for  $i \in \{0, 1, 2, \dots, N-1\}$ .

The first result characterizes equilibria.

**Proposition 1 (Equilibrium)** *For every positive integer  $N$ , there exists at least one equilibrium  $(q(m|x), y^*(m), \mu(x|m))$ , where*

(i)  $q(m|x)$  is uniform, supported on  $[a_{i-1}, a_i]$  if  $x \in (a_{i-1}, a_i)$ ;

(ii)  $\mu(x|m)$  is uniform, supported on  $[a_{i-1}, a_i]$  if  $m \in (a_{i-1}, a_i)$ ;

(iii)  $a_{i+1} - a_i = a_i - a_{i-1} + \frac{4(2\kappa+\tau)}{1-\kappa} a_i$  for  $i \in \{1, 2, \dots, N-1\}$  with  $a_0 = -s$  and  $a_N = s$ ;

(iv)  $y^*(m) = \frac{a_{i-1}+a_i}{2(1+\kappa+\tau)}$  for all  $m \in (a_{i-1}, a_i)$ .

Moreover,

(v) In each equilibrium intervals are symmetric around zero;

(vi) The number of intervals can be infinite.

All other equilibria are economically equivalent.

FIGURE 2: Equilibria

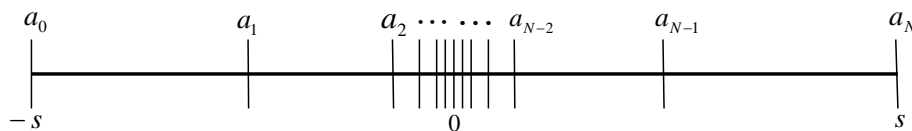


Figure 2 illustrates equilibria. In each equilibrium, the expert communicates in which interval is optimal trading. The second-order difference equation in (iii) defines the size of intervals. The size of an interval ( $a_{i+1} - a_i$ ) is the size of the preceding interval ( $a_i - a_{i-1}$ ) plus  $\frac{4(2\kappa+\tau)}{1-\kappa} a_i$ . Expert's incentive to exaggerate optimal trading determines how information is distorted. Since expert's incentive to exaggerate increases in tax and optimal trading volume, so does the size of intervals. Thus, expert advice becomes less accurate, the larger are tax and optimal trading volume.

Intervals are symmetric around zero because expert's incentive to exaggerate is symmetric for sales and purchases. The equilibrium number of intervals can be infinite since the expert has an incentive to exaggerate for any optimal trading except zero.

Next, we show that both expert and informed trader are better off in the equilibrium with an infinite number of intervals.

**Proposition 2 (Efficiency)** *In the equilibrium in which  $N \rightarrow \infty$ , expert's expected profit  $E(\pi_E)$  and informed trader's expected profit  $E(\pi_I)$  are higher than in any other equilibrium.*

In the equilibrium with an infinite number of intervals the expert communicates more information than in any other equilibrium. Since both expert and trader are better off in more informative equilibria, the equilibrium with an infinite number of intervals is the most efficient.

Figure 2 illustrates the equilibrium with an infinite number of intervals. Intervals are infinitesimally small close to zero and become larger as optimal trading moves away from zero. Expert advice is accurate when optimal trading is close to zero. Expert advice becomes less accurate the further is optimal trading from zero because the higher optimal trading volume strengthens expert's incentive to exaggerate.

Since both expert and trader are better off in this equilibrium, we plausibly assume that they manage to coordinate on the equilibrium with infinite number of intervals and we focus the analysis on this equilibrium.

## 4. QUALITY OF EXPERT ADVICE

We can now study quality of expert advice. We measure quality of expert advice as the residual variance faced by the informed trader after expert advice  $RV = E \left[ (x - E(x|m))^2 \right]$ . The higher is residual variance, the lower is quality of expert advice.

The next result characterizes quality of expert advice.

**Proposition 3 (Quality of Expert Advice)** *In the most efficient equilibrium in which  $N \rightarrow \infty$ , the residual variance is*

$$RV = E \left[ (x - E(x|m))^2 \right] = \frac{2\kappa + \tau}{3 + 5\kappa + 4\tau} \sigma^2. \quad (7)$$

Moreover,

(i) *The tax reduces quality of expert advice, i.e.,  $\partial RV / \partial \tau > 0$ ;*

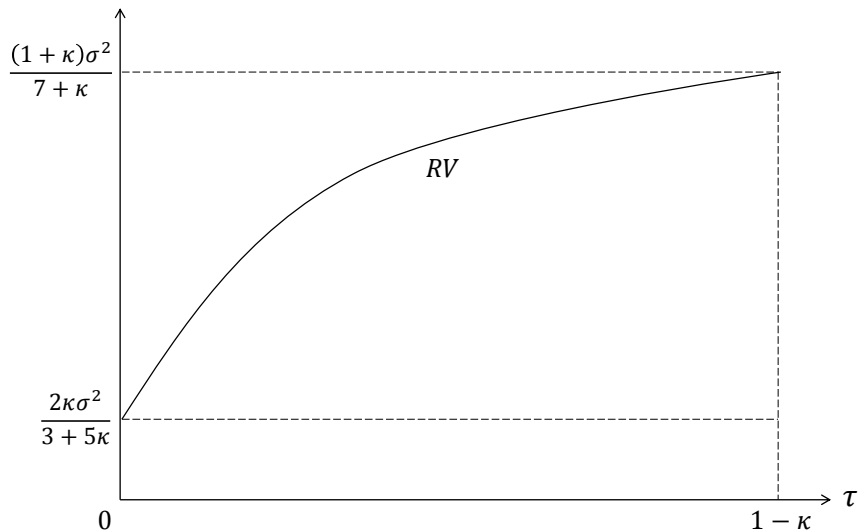
(ii)  $\lim_{\tau \rightarrow 0} RV = \frac{2\kappa}{3+5\kappa} \sigma^2$ ,  $\lim_{\tau \rightarrow 1-\kappa} RV = \frac{1+\kappa}{7+\kappa} \sigma^2$ .

Figure 3 illustrates the detrimental effect of the tax on quality of expert advice. The tax strengthens expert's incentive to exaggerate so expert advice becomes less accurate and less information is communicated in equilibrium. Thus, quality of expert advice declines.

This novel mechanism through which the tax affects traders' information advances the tax debate beyond its focus on the proportion of noise versus informed trading and on liquidity. In particular, worsened expert advice provides a new explanation for the decline in informational efficiency observed by Colliard and Hoffmann (2017): the tax makes informed traders less informed.

The prediction that the tax worsens expert advice could be tested using panel data. To do that, one would need information about tradings of institutional investors advised by sell-side analysts of a brokerage firm or about tradings of retail investors advised by financial advisors of a bank. One would also need information about quality of expert advice. To measure quality of sell-side analyst advice, one could use the rankings of sell-side analysts that compare accuracy of analysts' past recommendations as in Jackson (2005). Instead, quality of financial advisors' recommendations could be indirectly measured by the number of complaints concerning financial advisors received by investor protection authorities.

FIGURE 3: Quality of expert advice



With these data, one could test Proposition 3(i) studying the tax introduction in Italy or France with a difference-in differences analysis. Specifically, the prediction that the tax worsens expert advice implies that after the tax introduction one should observe a drop in accuracy of sell-side analysts recommendations and an increase in the number of complaints concerning financial advisors.

## 5. TRADING VOLUME

In this section we analyze how the tax affects trading through expert advice. We focus on mean and variance of trading volume. Trading volume is  $|y|$  since trading decision  $y$  is positive in case of purchase, zero in case of no trade, and negative in case of sale.

### 5.1 EXPECTED TRADING VOLUME

The next result presents the main features of informed trader's expected trading volume.

**Proposition 4 (Expected Trading Volume)** *In the most efficient equilibrium in which  $N \rightarrow \infty$ , the informed trader's expected trading volume is*

$$E(|y|) = \frac{\sqrt{3\sigma^2}}{2(1 + \kappa + \tau)} \quad (8)$$

Moreover,

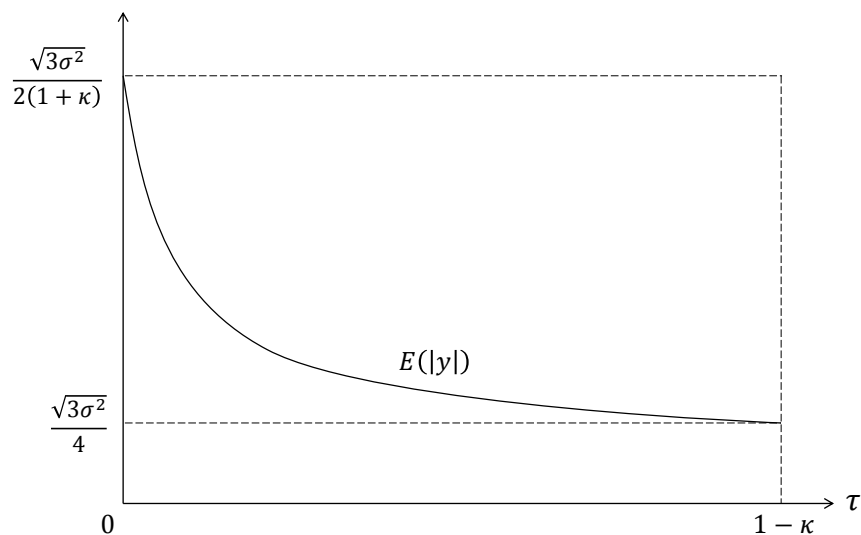
(i) *Quality of expert advice does not influence expected trading volume;*

(ii) *The tax reduces expected trading volume, i.e.,  $\partial E(|y|) / \partial \tau < 0$ ;*

$$(iii) \lim_{\tau \rightarrow 0} E(|y|) = \frac{\sqrt{3\sigma^2}}{2(1+\kappa)}, \lim_{\tau \rightarrow 1-\kappa} E(|y|) = \frac{\sqrt{3\sigma^2}}{4}.$$

Figure 4 illustrates the negative tax impact on the informed trader's expected trading volume. Expected trading volume is the *average* trader's belief on optimal trading volume after advice discounted by the transaction cost. Expected trading volume is unrelated to quality of expert advice. Quality of expert advice influences trader's belief on optimal trading volume. However, quality of expert advice does not affect the *average* trader's belief. For this reason, the tax reduces expected trading volume by raising the transaction cost only.

FIGURE 4: Expected trading volume



The negative tax impact on expected trading volume is in line with empirical evidence. Meyer, Wagener, and Weinhardt (2015) show that the introduction of a 0.2 percent tax in France decreases trading volume by 20 percent. Becchetti, Ferrari, and Trenta (2014) and Gomber, Haderkorn, and Zimmermann (2016) find similar results. Taxing financial transactions reduces trading volume also in Italy according to Cohelo (2016), in China according to Baltagi, Li, and Li (2006), in the US according to Jones and Seguin (1997), and in Sweden according to Umlauf (1993).

## 5.2 VARIANCE OF TRADING VOLUME

The next result features the variance of informed trader's trading volume as well as its relationship with quality of expert advice and tax.

**Proposition 5 (Variance of Trading Volume)** *In the most efficient equilibrium in which  $N \rightarrow \infty$ , the variance of informed trader's trading volume is*

$$V(|y|) = \frac{\sigma^2 - 4RV}{4(1 + \kappa + \tau)^2} \quad (9)$$

where  $RV$  is given by 7.

Moreover,

(i) *Better expert advice raises the variance of trading volume, i.e.,  $\partial V(|y|) / \partial RV < 0$ ;*

(ii) *The tax reduces variance of trading volume, i.e.,  $\partial V(|y|) / \partial \tau < 0$ ;*

$$(iii) \lim_{\tau \rightarrow 0} V(|y|) = \frac{3(1-\kappa)\sigma^2}{4(3+5\kappa)(1+\kappa)^2}, \quad \lim_{\tau \rightarrow 1-\kappa} V(|y|) = \frac{3(1-\kappa)\sigma^2}{16(7+\kappa)}.$$

We see from (i) that while quality of expert advice does not influence expected trading volume of the informed trader, better expert advice raises the variance of trading volume. This is the case because when advice is inaccurate, for several optimal tradings the expert gives the same advice (same interval) and induces the same trading decision. On the contrary, when advice is accurate, for different optimal tradings the expert tends to give different advices thereby inducing different trading decisions. Thus, an increase in quality of expert advice engenders a mean-preserving spread in trading volume of the informed trader.

FIGURE 5: Variance of trading volume

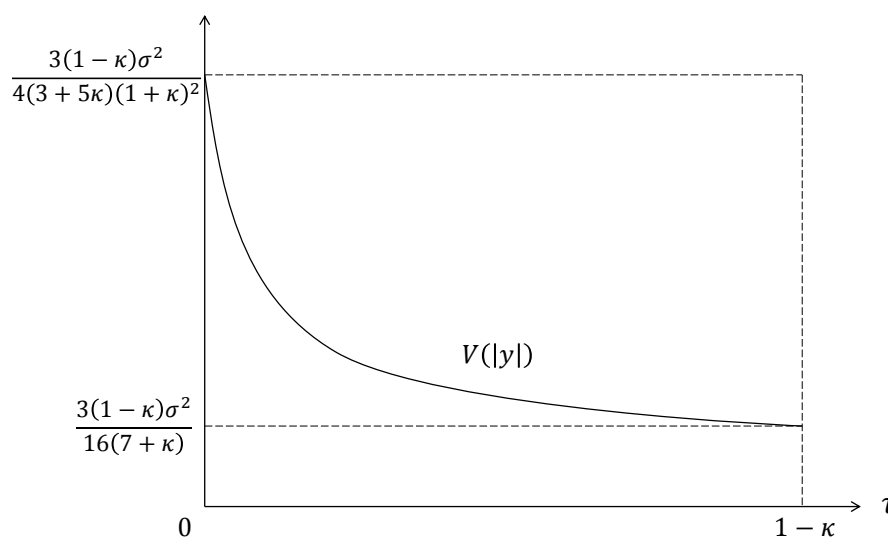


Figure 5 illustrates the negative tax impact on the variance of informed trader's trading volume. The tax reduces variance of trading volume for two reasons. First, the tax raises the transaction cost and therefore reduces variance of trading volume by making trading less attractive for any



optimal trading. Second, by making trading less attractive, the tax worsens expert advice and engenders a mean-preserving contraction in trading volume.

Tax reduction of trading volume's variance is an empirically attractive implication of the model. Indeed, there is no empirical evidence on how the tax affects variance of trading volume. The model also predicts that the tax decreases variance of trading volume through the transaction cost and through quality of expert advice. One would need to test the relevance of each channel in the tax impact on variance of trading volume. Disentangling the two channels might be empirically challenging because the tax affects quality of expert advice through the transaction cost.

## 6. PROFITS

We can now state expected profits and how they depend on the tax.

**Proposition 6 (Expected Profits)** *In the most efficient equilibrium in which  $N \rightarrow \infty$*

(i) *Expert's expected profit is*

$$E(\pi_E) = -\sigma^2 + \frac{1 + 3\kappa + 2\tau}{(1 + \kappa + \tau)^2} (\sigma^2 - RV) \quad (10)$$

*where  $RV$  is given by 7. Better expert advice raises expert's expected profit, i.e.,  $\partial E(\pi_E) / \partial RV < 0$ . The tax reduces expert's expected profit, i.e.,  $\partial E(\pi_E) / \partial \tau < 0$ .*

(ii) *Informed trader's expected profit is*

$$E(\pi_I) = -\sigma^2 + \frac{\sigma^2 - RV}{1 + \kappa + \tau} \quad (11)$$

*where  $RV$  is given by 7. Better expert advice raises informed trader's expected profit, i.e.,  $\partial E(\pi_I) / \partial RV < 0$ . The tax reduces informed trader's expected profit, i.e.,  $\partial E(\pi_I) / \partial \tau < 0$ .*

Both expert and informed trader are better off with higher quality of expert advice because more information is communicated in equilibrium. The tax makes expert and trader worse off for two reasons. First, the tax raises the transaction cost of the trader and reduces the commission gain of the expert by lowering expected trading volume. Second, the tax worsens expert advice. The trader hence acts on less accurate information and makes less accurate decisions. Less accurate trading decisions hurt both expert and trader since they both care about decisions' suitability.

## 7. TAX AND REGULATION OF COMMISSION

In the wake of the financial crisis many countries have introduced regulations on expert commissions that aim at aligning experts' and investors' objectives to improve expert advice. Inderst (2015) summarizes various regulatory interventions. Regulation of expert commissions and financial transaction taxes are discussed separately. The former is debated in the context of investor protection, the latter in that of financial stability.





Yet, my model points to a relationship between tax and regulation of commission. This is the case because both tax and commission determine transaction costs and expert's incentives to report information. We have seen that the tax reduces quality of expert advice, expectation and variance of trading volume as well as expert's and informed trader's profits. To further investigate this relationship, we study the impact of a commission drop. Such drop could for instance be caused by the introduction of a commission cap.

**Proposition 7 (Commission Decrease)** *In the most efficient equilibrium in which  $N \rightarrow \infty$ , a decrease in expert trading commission*

- (i) Raises quality of expert advice, i.e.,  $\partial RV / \partial \kappa > \partial RV / \partial \tau > 0$  where  $RV$  is given by 7;*
- (ii) Raises informed trader's expected trading volume, i.e.,  $\partial E(|y|) / \partial \kappa = \partial E(|y|) / \partial \tau < 0$  where  $E(|y|)$  is given by 8;*
- (iii) Raises variance of informed trader's trading volume, i.e.,  $\partial V(|y|) / \partial \kappa < \partial V(|y|) / \partial \tau < 0$  where  $V(|y|)$  is given by 9;*
- (iv) Has an ambiguous impact on expert's expected profit and raises informed trader's expected profit, i.e.,  $\partial E(\pi_E) / \partial \kappa > < = 0$  and  $\partial E(\pi_I) / \partial \kappa < \partial E(\pi_I) / \partial \tau < 0$  where  $E(\pi_E)$  and  $E(\pi_I)$  are given by 10 and 11, respectively.*

We see from (i) that a commission decrease improves expert advice since the commission strengthens expert's incentives to misreport information. Moreover, the commission influences quality of expert advice more than the tax. This is the case because the trader pays commission and tax on trading volume while the expert receives the commission but not the tax.

Part (ii) shows that a commission drop increases informed trader's expected trading volume. Like the tax, the commission affects expected trading volume only through the transaction cost. For this reason, the commission impact has the same strength as the tax impact.

Part (iii) tells us that a commission decrease raises variance of informed trader's trading volume. This is the case because the commission drop reduces the transaction cost and improves expert advice. The commission effect on variance of trading volume is stronger than the tax effect because commission and tax have the same impact on transaction costs but the commission has a stronger impact on quality of expert advice.

Finally, part (iv) demonstrates that a commission reduction has an ambiguous effect on the expected profit of the expert while it raises that of the informed trader. A commission decrease (1) fosters trading by reducing the transaction cost; (2) makes trader's decision more accurate by improving expert advice; (3) reduces the expert commission gain per unit traded. Expert's expected profit raises if the first and the second positive effects dominate the third negative one, it decreases otherwise. The trader is better off since the transaction cost is lower and improved expert advice allows him to make more accurate decisions.

These results and those on the tax uncover a relationship between the tax and regulation of expert commission. On the one hand, a tax aimed at curbing noise trading worsens expert advice. On the other hand, a regulation-induced commission drop aimed at improving expert advice may increase trading volume of informed but also of noise traders. Thus, it could be useful to jointly consider the tax and regulation of expert commission.

## 8. CONCLUSION

This paper models trading on expert advice with a financial transaction tax in order to shed light on how the tax affects traders' information and decisions. I find that the tax worsens expert advice to traders. This result advances the debate on tax suitability beyond the conventional arguments regarding the tax impact on the proportion of noise versus informed trading and on liquidity. In particular, worsened expert advice provides a new explanation for the observed decline in informational efficiency after the tax introduction: the tax makes informed traders less informed.

In line with the empirical literature, I show that the tax curbs trading volume since the tax makes trading less attractive by raising the transaction cost. Moreover, the tax influences trading decisions and variance of trading volume through expert advice. A testable prediction of the model is that the tax reduces variance of trading volume by worsening expert advice and by increasing the transaction cost.

Besides being important for understanding the impact of financial transactions taxes, my analysis more generally informs the debate on transaction costs in financial markets. Specifically, my model demonstrates that both financial transaction taxes and expert trading commissions impact expert advice to traders and trading activity. Such relationship suggests to jointly consider financial transaction taxes and regulation of expert trading commissions.

The findings of this paper are highly relevant from both academic and regulatory standpoints. To my knowledge, my analysis is the first to study the impact of financial transaction taxes through expert advice. This novel perspective on a longstanding debate started with Keynes (1936) opens new avenues for research on financial transaction taxes and transaction costs in general.

## APPENDIX

**Proof of Proposition 1:** We first prove the existence of perfect Bayesian equilibria and then characterize them.

In the spirit of Kawamura (2015), let  $x_A$  be the optimal trading such that the expert's and the informed trader's preferred decisions coincide, that is  $y_E(x_A) = y_I(x_A)$ . From 5 and 6 we have  $x_A = 0$ . 5 and 6 also imply that the expert's preferred decision given optimal trading is larger than that of the informed trader, that is  $y_E(x) > y_I(x)$  for  $x > 0$  and  $y_E(x) < y_I(x)$  for  $x < 0$ . Furthermore, 5 and 6 imply that the expert's preference is continuous in  $y$  and the informed trader's preferred decision is continuous in  $x$ . We can therefore use Theorem 4 of Gordon (2010) to determine that there exists an equilibrium with an infinite number of intervals (hence (vi) is true). Existence then follows from Theorem 2 of Gordon (2010) which shows that if there is an infinite equilibrium, then there is an equilibrium with  $N$  intervals for every positive integer  $N$ .

To characterize perfect Bayesian equilibria, let  $\underline{a}$  and  $\bar{a}$  be two points in  $[-s, s]$  such that  $\underline{a} < \bar{a}$ . Suppose the expert communicates  $x \in (\underline{a}, \bar{a})$ . Since  $x$  is uniformly distributed, the informed trader's belief becomes

$$E[x|x \in (\underline{a}, \bar{a})] = \frac{\underline{a} + \bar{a}}{2}. \quad (\text{A.1})$$

Then, from (4) the informed trader's trading decision after expert's advice is

$$y^*(\underline{a}, \bar{a}) = \frac{\underline{a} + \bar{a}}{2(1 + \kappa + \tau)}. \quad (\text{A.2})$$

For equilibria to be truthful, the expert observing optimal trading in  $(a_{i-1}, a_i)$  must prefer to report such interval rather than the interval  $(a_i, a_{i+1})$ . This is the case when the expert observing  $x = a_i$  is indifferent between reporting the two intervals, that is,  $\pi_E(y^*(a_{i-1}, a_i), a_i, \kappa) = \pi_E(y^*(a_i, a_{i+1}), a_i, \kappa)$ , or, using 2 and A.2

$$\begin{aligned} & - \left( \frac{a_{i-1} + a_i}{2(1 + \kappa + \tau)} - a_i \right)^2 + \kappa \left( \frac{a_{i-1} + a_i}{2(1 + \kappa + \tau)} \right)^2 \\ & = - \left( \frac{a_i + a_{i+1}}{2(1 + \kappa + \tau)} - a_i \right)^2 + \kappa \left( \frac{a_i + a_{i+1}}{2(1 + \kappa + \tau)} \right)^2 \\ & \Leftrightarrow a_{i+1} = \frac{2(1 + 3\kappa + 2\tau)}{1 - \kappa} a_i - a_{i-1}. \end{aligned} \quad (\text{A.3})$$

This second-order difference equation defines the unique equilibrium partition for given  $\kappa$ ,  $\tau$ , and  $N$  where

$$a_0 = -s; \quad a_N = s \quad (\text{A.4})$$

and  $a_i < a_{i+1}$  for all  $i \in \{0, 1, 2, \dots, N - 1\}$ . Subtracting  $a_i$  from both sides of A.3 we can characterize equilibria as in (iii). These results also prove (i), (ii), and (iv).

Using A.3 and boundary conditions A.4, the solution of the second-order difference equation is

$$a_i = \frac{s}{(z_1^N - z_2^N)} \left[ (1 + z_2^N) z_1^i - (1 + z_1^N) z_2^i \right] \quad \text{for all } i \in \{0, 1, 2, \dots, N\}$$

where the distinct roots of the second-order difference equation are

$$z_1 = \frac{1}{1 - \kappa} \left[ 1 + 3\kappa + 2\tau + \sqrt{(1 + 3\kappa + 2\tau)^2 - (1 - \kappa)^2} \right] \quad (\text{A.6})$$

$$z_2 = \frac{1}{1 - \kappa} \left[ 1 + 3\kappa + 2\tau - \sqrt{(1 + 3\kappa + 2\tau)^2 - (1 - \kappa)^2} \right] \quad (\text{A.7})$$

and satisfy  $z_1 z_2 = 1$  with  $z_1 > 1$ .

(v) It is readily seen from A.5 that for any integer  $0 \leq K \leq N$ ,  $a_K = -a_{N-K}$ , that is, intervals are symmetrically distributed around zero.

*Q.E.D.*

For the proofs of Propositions 2, 3, 5 and 6 we use the following Lemma.

**Lemma A:** Let  $\bar{m} = E(x|m)$ . Then,

(i)  $E(\bar{m}x) = E(\bar{m}^2)$ ;

(ii)

$$E(\bar{m}^2) = \frac{s^2}{4} \left[ \frac{(z_1^{3N} - 1)(z_1 - 1)^2}{(z_1^N - 1)^3 (z_1^2 + z_1 + 1)} - \frac{z_1^N (z_1 + 1)^2}{z_1 (z_1^N - 1)^2} \right]; \quad (\text{A.8})$$

(iii)  $E(\bar{m}^2)$  is strictly increasing in the number of intervals  $N$ ;



(iv)

$$\lim_{N \rightarrow \infty} E(\bar{m}^2) = \frac{3(1 + \kappa + \tau)}{3 + 5\kappa + 4\tau} \sigma^2 = (1 - S)\sigma^2 \quad (\text{A.9})$$

where  $S = (2\kappa + \tau)/(3 + 5\kappa + 4\tau)$ .

**Proof of Lemma A:** The proof of Lemma A (i) follows that of Lemma A2 (i) in Alonso et al. (2008). The proofs of Lemma A (ii) and (iii) follow that of Lemma A2 (ii) in Alonso et al. (2008).

(iv) Following the proof of Lemma 1 in Alonso et al. (2008) we have

$$\lim_{N \rightarrow \infty} E(\bar{m}^2) = \frac{s^2}{4} \frac{(z_1 + 1)^2}{z_1^2 + z_1 + 1} = s^2 \frac{1 + \kappa + \tau}{3 + 5\kappa + 4\tau} = \frac{3(1 + \kappa + \tau)}{3 + 5\kappa + 4\tau} \sigma^2 = (1 - S)\sigma^2 \quad (\text{A.10})$$

where  $S = (2\kappa + \tau)/(3 + 5\kappa + 4\tau)$ .

*Q.E.D.*

**Proof of Proposition 2:** Taking the expectation of 2, using Lemma A (i), the informed trader's decision  $y = \bar{m}/(1 + \kappa + \tau)$  and  $\sigma^2 = E(x^2)$  we have

$$E(\pi_E) = -\sigma^2 + \frac{1 + 3\kappa + 2\tau}{(1 + \kappa + \tau)^2} E(\bar{m}^2). \quad (\text{A.11})$$

Hence,  $\partial E(\pi_E)/\partial E(\bar{m}^2) > 0$ . Since from Lemma A (iii)  $E(\bar{m}^2)$  is strictly increasing in  $N$  we conclude that  $E(\pi_E)$  is strictly increasing in  $N$  and therefore is the highest when  $N \rightarrow \infty$ .

Similarly, taking the expectation of 1 we obtain

$$E(\pi_I) = -\sigma^2 + \frac{E(\bar{m}^2)}{1 + \kappa + \tau}. \quad (\text{A.12})$$

Hence,  $\partial E(\pi_I)/\partial E(\bar{m}^2) > 0$ . Since from Lemma A (iii)  $E(\bar{m}^2)$  is strictly increasing in  $N$  we conclude that  $E(\pi_I)$  is strictly increasing in  $N$  and therefore is the highest when  $N \rightarrow \infty$ .

*Q.E.D.*

**Proof of Proposition 3:** Using Lemma A (i) and (iv) we obtain

$$RV = E\left[(x - E(x|m))^2\right] = \sigma^2 - E(\bar{m}^2) = S\sigma^2 = \frac{2\kappa + \tau}{3 + 5\kappa + 4\tau} \sigma^2 \quad (\text{A.13})$$

(i) From A.13 we have  $\partial RV/\partial \tau > 0$ .

(ii) It follows directly from A.13.

*Q.E.D.*

For the proofs of Propositions 4 and 5 we use the following Lemma.

**Lemma B:** Let  $\bar{m} = E(x|m)$  and  $j = \operatorname{argmin}_i \{a_i | a_i > 0\}$ . Then,

(i)

$$E(|\bar{m}|) = \frac{s}{2} - \frac{a_{j-1}^2}{2s}; \quad (\text{A.14})$$

(ii)

$$\lim_{N \rightarrow \infty} E(|\bar{m}|) = \frac{\sqrt{3\sigma^2}}{2}. \quad (\text{A.15})$$

**Proof of Lemma B:** (i) It follows from  $j = \operatorname{argmin}_i \{a_i | a_i > 0\}$  that when the equilibrium number of elements is even  $a_{j-1} = 0$  and when the equilibrium number of elements is odd  $a_{j-1} = -a_j < 0$  with  $(a_j + a_{j-1})/2 = 0$ . Then, since intervals are symmetric around zero, we have

$$\begin{aligned} E(|\bar{m}|) &= \frac{1}{2s} \sum_{i=1}^N \int_{a_{i-1}}^{a_i} \left| \frac{a_i + a_{i-1}}{2} \right| dx = \frac{1}{2s} 2 \sum_{i=j}^N \int_{a_{i-1}}^{a_i} \frac{a_i + a_{i-1}}{2} dx \\ &= \frac{1}{2s} (a_N^2 - a_{j-1}^2) = \frac{s}{2} - \frac{a_{j-1}^2}{2s}. \end{aligned} \quad (\text{A.16})$$

(ii) Taking the limit for  $N \rightarrow \infty$  of A.16 we have

$$\lim_{N \rightarrow \infty} E(|\bar{m}|) = \lim_{N \rightarrow \infty} \left( \frac{s}{2} - \frac{a_{j-1}^2}{2s} \right) = \frac{s}{2} - \frac{1}{2s} \lim_{N \rightarrow \infty} a_{j-1}^2 = \frac{s}{2} = \frac{\sqrt{3\sigma^2}}{2} \quad (\text{A.17})$$

where  $\lim_{N \rightarrow \infty} a_{j-1}^2 = 0$  since  $a_{j-1} \rightarrow 0$  as  $N \rightarrow \infty$ , i.e., the intervals closest to zero become infinitesimally small as  $N \rightarrow \infty$  and the last equality follows from  $\sigma^2 = s^2/3$ .

*Q.E.D.*

**Proof of Proposition 4:** Using the informed trader's decision  $y = \bar{m}/(1 + \kappa + \tau)$  and Lemma B (ii) we have

$$E(|y|) = \frac{E(|\bar{m}|)}{1 + \kappa + \tau} = \frac{\sqrt{3\sigma^2}}{2(1 + \kappa + \tau)}. \quad (\text{A.18})$$

(i) It is readily seen from A.18 that expected trading volume depends on trading cost  $\kappa + \tau$  only. Quality of expert advice (RV) does not influence expected trading volume because from Lemma B (ii)  $E(|\bar{m}|)$  is constant for any  $\kappa, \tau$ .

(ii) From A.18 we have  $\partial E(|y|)/\partial \tau < 0$ .

(iii) It follows directly from A.18.

*Q.E.D.*

**Proof of Proposition 5:** Using the informed trader's decision  $y = \bar{m}/(1 + \kappa + \tau)$ , Lemma A (iv), and 8 we have

$$V(|y|) = E(|y|^2) - [E(|y|)]^2 = E(y^2) - [E(|y|)]^2 = \frac{\sigma^2 - 4RV}{4(1 + \kappa + \tau)^2} \quad (\text{A.19})$$



or, using 7

$$V(|y|) = \frac{3(1 - \kappa)\sigma^2}{4(3 + 5\kappa + 4\tau)(1 + \kappa + \tau)^2}. \quad (\text{A.20})$$

(i) From A.19 we have that given  $\kappa$  and  $\tau$ ,  $\partial V(|y|) / \partial RV < 0$ .

(ii) It is readily seen from A.20 that  $\partial V(|y|) / \partial \tau < 0$ .

(iii) It follows directly from A.20.

*Q.E.D.*

**Proof of Proposition 6:** (i) Using Lemma A (iv) and A.11 we have

$$E(\pi_E) = -\sigma^2 + \frac{1 + 3\kappa + 2\tau}{(1 + \kappa + \tau)^2} (\sigma^2 - RV) \quad (\text{A.21})$$

or, using 7

$$E(\pi_E) = -\sigma^2 + \frac{3(1 + 3\kappa + 2\tau)}{(3 + 5\kappa + 4\tau)(1 + \kappa + \tau)} \sigma^2. \quad (\text{A.22})$$

From A.21 we have  $\partial E(\pi_E) / \partial RV < 0$ . From A.22 we get  $\partial E(\pi_E) / \partial \tau < 0$ .

(ii) Using Lemma A (iv) and A.12 we have

$$E(\pi_I) = -\sigma^2 + \frac{\sigma^2 - RV}{1 + \kappa + \tau} \quad (\text{A.23})$$

or, using 7

$$E(\pi_I) = -\sigma^2 + \frac{3\sigma^2}{3 + 5\kappa + 4\tau}. \quad (\text{A.24})$$

From A.23 we have  $\partial E(\pi_I) / \partial RV < 0$ . From A.24 we get  $\partial E(\pi_I) / \partial \tau < 0$ .

*Q.E.D.*

**Proof of Proposition 7:** The proofs of Proposition 7 (i), (ii), (iii), and (iv) on the impact of a commission drop are analogous to those on the tax impact.

*Q.E.D.*

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