Transaction Taxes in a Price Maker/Taker Market

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Introduction

- Regulators recently proposed taxing financial transactions.
- Goals of such a tax:
  - Reduce price volatility
  - Raise large revenue from very small tax
  - Solve problem of "too much" trading?
  - Encourage long-term investing
  - Push *harmful* (?) speculators out of the market
- Arguments claimed against such a tax:
  - Reduces: securities' values, market volume, and liquidity
  - Distorts market (reduces market efficiency)
  - Pushes trade to other venues/countries
- Our goal: study costs and (some) benefits of a tax.

Thinking on Transactions Taxes

- Tobin (1974): tax to help economies manage FX rates.
  - More of a political objective than economic.
- Proponents: DeFazio, Merkel, Summers and Summers (1989), Stiglitz (1989), ul Haq *et al* (1996), Spahn (2002), Pollin *et al* (2003).
- Opponents: Friedman (1953), Campbell and Froot (1994), Habermeier and Kirilenko (2001), Forbes (2001).
- Umlauf (1993): Sweden 1%; some trading moved, volatility $\searrow\!\!\!\!\nearrow$.
- Dupont and Lee (2007): asymmetric info $\Rightarrow$ tax lowers volume more.

Are Transaction Taxes Like Trading Fees?

- Some studies have looked at (analogous?) trading fees:
  - Jones and Seguin (1997): lower commissions $\Rightarrow \sigma \downarrow$.
  - Liu and Zhu (2009): lower commissions $\Rightarrow \sigma \uparrow$.
  - Colliard and Foucault (2012): make/take fees
  - Foucault, Kadan, and Kandel (2012): make/take fees; monitoring costs
- However, fees often benefit one side of trading.
- Degryse, Van Achter, and Wuyts (2012): post-trade fees, broker choice; reserve price $= v_H$ or v_L.

Results Preview

We find a transaction tax:

- Widens quoted, effective spreads by more than tax;
- Lowers likelihood of trading (volume); increases search times.
- Greatly reduces value of limit orders and gains from trade;
- Increases volatility (up to $1.5\times$);
- Affects markets with market makers more than those without; and,
- Is revenue-optimal for 60–75 bp.

Extending results to handle destabilizing traders.

Microstructure Approach

- Market microstructure:
  - Study of process of price formation, market dynamics.
  - In particular: trading costs, spreads, volume, liquidity.
- Microstructure lets us study many aspects of market quality.
- Thus microstructure is perfect for analyzing tax effects.

Maker/Taker Models

- Maker/taker model:
  - Traders choose to take a price or make new prices.
  - Endogenizes many aspects of market quality.
- Mirrors current realities of trading:
  - Anand *et al* (2005), Hasbrouck and Saar (2009): Traders make *and* take prices.
  - Parlour and Seppi (2008): Mostly limit order markets.[1]
- High-frequency trading: often reduces spread, inside size.
  - Markets with more HFT look more like our model.

[1] Predicted by Black (1971).

Fouacult (1999) Model

- Foucault (1999): Workhorse maker/taker model.
  - Buyers, sellers take price or make at $v \pm L$.
  - Yields results on spreads, trading rate (volume).
- We extend Foucault (1999) to study costs of transaction tax.
  - Continuous distribution of private reserve values;
  - Fraction μ of traders who are pure market makers; and,
  - Each trader pays tax of τ/share traded.
- Calibrated model allows studying many market phenomena.

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Why Extend Foucault (1999)?

- Traders actively choose price taking versus price making.
  - If tax changes decisions, strategic action is key.
- Why extend? Taxes do not play nicely with Foucault (1999).
  - Traders only have two reservation values, $v \pm L$
  - $\Rightarrow$ either no effect or eliminates trading.
- Extension allows studying endogenized market phenomena:
  - Traders strategically set bid and ask values;
  - Fail to trade if quotes not appealing to next trader;[2]
  - Differences between quoted and effective spreads;
  - Realized volatility.
- Offers insight into how market metrics (*e.g.* volume) change with tax

[2] More fine-grained than buy vs sell in Foucault (1999).

Setup

- v = asset value (constant)
- Sequence of iid traders enter market, one per period
- Traders iid; may be market maker w.p. μ or investor.
  - Private reservation value: $v + d_t$ where $d_t \overset{iid}{\sim} F$.
  - Market maker: $d_t = 0$;
  - Investors: $d_t \overset{iid}{\sim} (0, L^2)$.
- Market continues w.p. $\rho \in (0, 1)$ after each period.
- Each trader taxed τ/share at position entry+exit.

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Strategic Quoting

Traders choose strategically whether or not to quote a bid and ask.

- Consider traders at time t (Ilsa), $t+1$ (Rick), $t+2$ (Sam).
- Price maker/taker model; Rick strategically chooses:
  - Take: Trade against Ilsa's quote, or
  - Make: Quote bid $v-\delta$ and ask $v+\beta$ for Sam.
- Rick must also determine his optimal δ and β.
- Thus Rick chooses $\max(R_T|d_{t+1}, R_Q|d_{t+1})$ where:

$R_T|d_{t+1}$ = benefit of taking Ilsa's bid/ask
$R_Q|d_{t+1}$ = benefit of quoting optimal bid, ask for Sam

Taking and Quoting Benefits

- Ilsa is in the same position.
- Denote prior trader's (Ugarte's?) quotes by $v - \delta_{t-1}$, $v + \beta_{t-1}$.

$$R_T|d_t = \max(-d_t - \delta_{t-1}, d_t - \beta_{t-1}) - 2\tau \tag{1}$$

$$\begin{aligned} R_Q|d_t = \rho \overbrace{F(-R_Q^{0*} - \delta - 2\tau)}^{P(\text{Rick sells at bid})}(d_t + \delta - 2\tau) + \\ + \rho \underbrace{F(-R_Q^{0*} - \beta - 2\tau)}_{P(\text{Rick buys at ask})}(\beta - d_t - 2\tau) \end{aligned} \tag{2}$$

$$R_Q^{0*} = \int_\Omega R_Q|d_t dF \tag{3}$$

- Ilsa also faces strategic choice:[3]
  - Take known benefit $R_T|d_t$ or expected benefit $R_Q|d_t$?

[3] Assuming that R_Q^{0*} exists.

Characterizing Propositions

We characterize equilibrium by proving some propositions.

1. Rick will only want to buy from Ilsa, sell to her, or quote.
2. If $d_t > 0$, the bid-ask quote is shifted higher $(\beta > \delta)$[4]
3. Bid-ask spread $\delta + \beta > 4\tau$ = twice trader's tax.
4. Quoting benefit is positive: $R_Q | d_t > 0$.
5. For $F = \Phi$ (Gaussian): unique Markov perfect equilibrium.
6. For $F = \Phi$, bid-ask spread $\delta + \beta \leq \frac{L}{R_Q^{0*} + 4\tau} + 4\tau$.

[4] And likewise for $d_t < 0$.

Model Setup: Numerical Analysis

Consider a market calibrated to typical characteristics:

- Value $v = \$20$; private reservation values $v + d_t$.
- P(trading continues next period) $\rho = 0.9$
- Transaction tax τ: \$0–\$0.10/share traded (0–50 bp).
- Traders: $d_t \overset{iid}{\sim} F$
  - Market-maker: w.p. μ, $d_t = 0$.
  - Investor: w.p. $1 - \mu$, $d_t \overset{iid}{\sim} N(0, L^2)$
- Reserve price volatility $L = \$0.5 = 2.5\%$[5]

[5] If daily net trades $\Rightarrow$ 40% annual volatility.

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Optimal Bid and Ask Offsets

Optimal quote: bid @ $v - \delta$, ask @ $v + \beta$ where

$$\delta = L\frac{(1-\mu)\Phi(B(\delta)) + \mu\mathbb{I}(B(\delta) \geq 0)}{(1-\mu)\phi(B(\delta))} - d_t + 2\tau, \quad (4)$$

$$\beta = L\frac{(1-\mu)\Phi(A(\beta)) + \mu\mathbb{I}(A(\beta) \geq 0)}{(1-\mu)\phi(A(\beta))} + d_t + 2\tau. \quad (5)$$

and

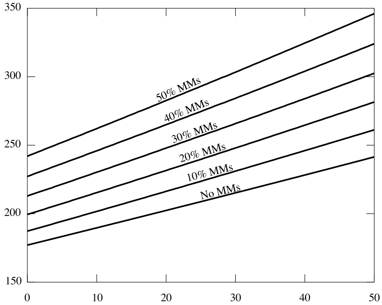
$$B(\delta) = \frac{-R_Q^{0*} - \delta - 2\tau}{L} \quad (6)$$

$$A(\beta) = \frac{-R_Q^{0*} - \beta - 2\tau}{L} \quad (7)$$

Solving for Equilibrium

- Solving for equilibrium is a bit involved.
- For a given tax τ, fraction of market makers μ:
  1. Iterate over "all possible" d_t's.
     - By symmetry, just iterate from (-3,0).
     - Take care with center of distribution; tail expectation.
  2. For each d_t, find optimal $R_Q|d_t$.
     - Need 3 cases for which/none of indicator functions active.
  3. Then compute expectation of all $R_Q|d_t$'s.
  4. Back to (1); iterate until stable $R_Q^{0*} = E(R_Q)$ found.
  5. With R_Q^{0*}, re-iterate for expected spread, trading rate.
- Then redo all of the above for another tax rate.

Quoted Spread



Spread (bp) vs. tax (bp)

From no tax to 50 bp tax:

- Quoted spread: 175→240 bp (no MMs), 240→345 bp (50% MMs).
- More MMs make spread slightly more sensitive to tax.
- More MMs compete for fill: quoted spread ↑.

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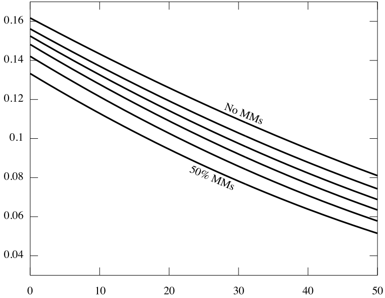
Optimal Quoting Benefit R_Q^{0*}

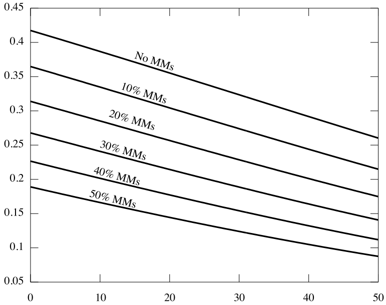


Optimal Quoting Benefit R_Q^{0*} vs. tax (bp)

From no tax to 50 bp tax:

- R_Q^{0*}: $\underbrace{\$0.16}_{80bp} \rightarrow \underbrace{\$0.08}_{40bp}$(no MMs), $\underbrace{\$0.13}_{65bp} \rightarrow \underbrace{\$0.05}_{25bp}$ (50% MMs)
- More MMs: value of quoting more sensitive to tax.
- MMs compete for fill: quoting value ↓

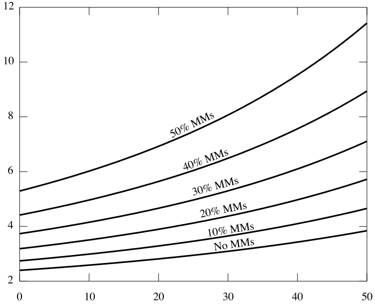
Fill Rate



Fill Rate vs. tax (bp)

- Fill rate: 42%→26% (no MMs), 19%→8% (50% MMs)
- Roughly: Fill rates halved.
- More MMs make fill rate more sensitive to tax.

Search Costs

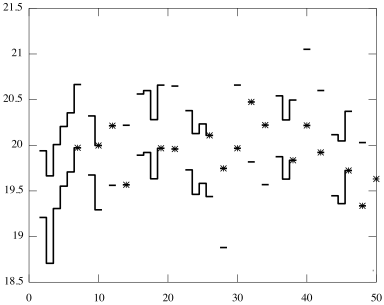


Search Costs (periods) vs. tax (bp)

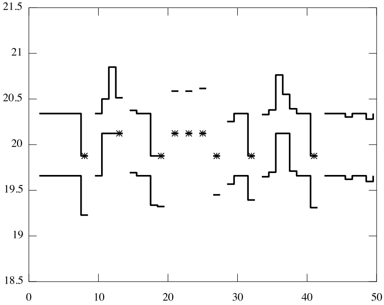
- Search costs (1/fill rate): 5→11.5 (no MMs), 2.3→4 (50% MMs)
- Roughly: search costs doubled.
- More MMs make search costs more sensitive to tax.

Simulated Trades

- Can then simulate trading ($N = 5000$) to see more effects.
- Example quote and price paths for no tax:



No MMs, No Tax



50% MMs, No Tax

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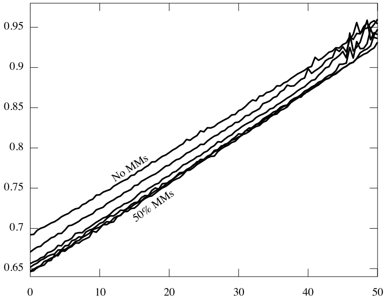
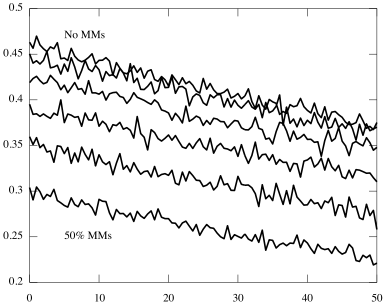
Effective Spread



Effective Spread (bp) vs. tax (bp)

- Effective spreads are lower with MMs (opposite of quoted).

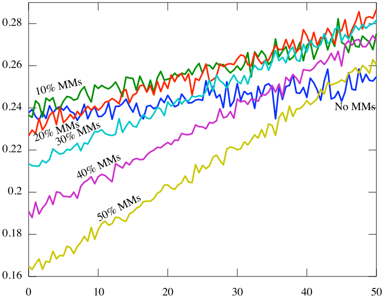
Gains from Trade



Gains from Trade vs. tax (bp)

- Gains from trade $:= \max(R_T|d_t, R_Q|d_t)$
- MMs: $d_t = 0$, compete for fill
  - Lowers $R_Q|d_t$; and, MMs do not trade with MMs.
  - $\Rightarrow$ both effects lower gains from trade.
- 50 bp tax roughly halves gains from trade.

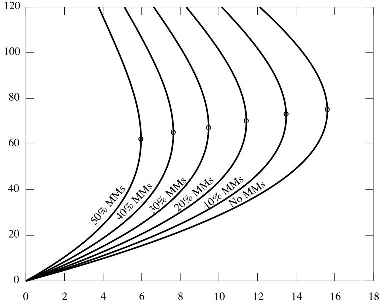
Volatility



Volatility ($) vs. tax (bp)

- No MMs: Highest volatility at 0 tax, least sensitive.
- 50% MMs: lowest volatility below 40 bp, most sensitive.
- At high taxes, lower volatility w/o MMs than with MMs.
- Taxes increase volatility, up to 1.5×.

Tax Revenues



Tax (bp) vs. Revenue

- Revenue-optimal tax: 60–75 bp.
- More MMs ⇒ lower optimal tax.

Conclusion

We find that a transaction tax:

- Widens quoted and effective spreads by $> 2\times$ the tax;
- Reduces the likelihood of trading (volume);
  - $\Rightarrow$ increases search times.
- 50 bp: Halves value of limit orders and gains from trade;
- Yields higher price volatility (less stable prices); and,
- Is revenue-optimal for 60–75 bp. (!)

Currently being extended to add destabilizing traders:

- De Long *et al* (2006) positive feedback traders.
- Preliminary evidence: Tax still increases volatility.