CESifo Working Papers

The Taxation of Bilateral Trade with Endogenous Information

Tri Vi Dang
Florian Morath

CESifo Working Paper No. 5157
Category 1: Public Finance
January 2015

Presented at CESifo Area Conference on Public Sector Economics, April 2014

ISSN 2354-1428

CESifo *Working Paper No. 5157*

The Taxation of Bilateral Trade with Endogenous Information

Abstract

This paper analyzes the effects of taxation on information acquisition and bilateral trade in decentralized markets. We show that a profit tax and a transaction tax have opposite implications for equilibrium outcome in bargaining. A marginal increase of a transaction tax increases the incentive to produce private information which creates adverse selection and reduces the probability of trade. In contrast, a marginal increase of a profit tax reduces the incentive to produce information and increases the probability of trade. In markets where there are gains from trade and private information acquisition creates endogenous lemons problems a profit tax dominates a transaction tax.

JEL-Code: C780, D820, D830, G180, H200.

Keywords: bargaining, information acquisition, taxation, financial transaction tax, funding markets.

Tri Vi Dang
Columbia University
Economics Department
USA - New York, NY 10027
td2332@columbia.edu

Florian Morath
Max Planck Institute for Tax Law and Public Finance / Department of Public Economics
Munich / Germany
florian.morath@tax.mpg.de

November 2014
We thank Felix Bierbrauer, Michael Burda, Maria Coelho, Gaëtan Nicodème, Roland Strausz, Alexander Tarasov, participants of the SFB/TR15 conference in Tutzing 2013, the CESifo Area Conference on Public Sector Economics 2014, the APET meeting in Seattle 2014, the IIPF Conference in Lugano 2014, and seminar participants in Cologne and Munich (MPI) for helpful comments.

1. INTRODUCTION

The financial crisis has drawn attention to a taxation of the financial sector. In February 2013, the European Commission (2013, p.2) proposed to implement a financial transaction tax (FTT) and states: "*The main objectives of this proposal were:* […] *creating appropriate disincentives for transactions that do not enhance the efficiency of financial markets thereby complementing regulatory measures to avoid future crises*." The tax is supposed to make speculative trading activities less attractive. However, some market participants were opposing the FTT. In particular, lobby groups of short term debt funding markets, such as the European Repo Council, part of the International Capital Market Association, lobbied against the FTT.[1] The ongoing debate about the FTT and alternative tax instruments emphasizes both revenue and efficiency aspects. The discussion also distinguishes between different types of markets, such as the treatment of on-exchange versus over-the-counter (off-exchange) trading.[2]

In this paper we provide a theoretical model to analyze the implications of a transaction tax and a tax on profits or capital gains for bilateral trade in over-the-counter (such as funding) markets. In our model agents bargain over the price at which to exchange an asset with uncertain value and can acquire information about the asset's payoff.[3] The main result of the paper is that the two tax instruments have opposite implications for the equilibrium outcome in take-it-or-leave-it bargaining. A marginal increase of a transaction tax increases the incentive to produce information which can cause adverse selection and reduces the probability of trade. In contrast, a marginal increase of a profit tax reduces the incentive to produce information and increases the probability of trade. The policy implications depend on whether an increase in the probability of trade (liquidity) is socially desirable and they are diametrically opposed for the two types of taxation. In markets where there are gains from trade and private information acquisition creates endogenous lemons problems a profit tax dominates a transaction tax.

[1] See Reuters (04/08/2013), *Markets step up fight against EU transaction tax*, by Huw Jones and Bloomberg (05/22/2013), *EU Aides Say Transaction Tax Design Hurts Sovereign Debt*, by Rebecca Christie.

[2] See for instance Matheson (2011) and Darvas and Weizsäcker (2010) for an overview. Some countries (e.g., Italy) that have already implemented a FTT set higher rates on OTC transactions. See also IMF (2010).

[3] Since trade in overt-the-counter markets is of bilateral nature, the workhorse models (Grossman and Stiglitz 1981; Kyle 1985, 1989) in the market microstructure literature on stock trading are less appropriate for studying such markets.

Under both types of tax instruments, taxation has two effects on equilibrium behaviors but the mechanisms of how a profit tax and a transaction tax affect information acquisition and trade are different. We illustrate the intuition behind these results for the case where an uninformed seller proposes a price to sell an indivisible asset to a buyer who can produce information and then decides whether to buy at the proposed price.

Consider a tax on positive profits (capital gains) first. If the buyer is exogenously informed, then profit taxation has no effect on the probability of trade. Taxation reduces the profit, but an informed buyer always trades if the price is smaller than the value of the asset. Now suppose the buyer is uninformed but can acquire costly information about the value of the asset. In an equilibrium with information acquisition, the buyer has non-negative expected utility, i.e., he covers the information costs by making profits in high payoff states. A profit tax reduces the buyer's information rent; therefore, when trading with an endogenously informed buyer, the seller needs to lower the price such that the buyer's profit is sufficient to cover the information cost. Hence, there are more states in which the buyer trades so the probability of trade is higher.

The second and more subtle effect of profit taxation works through the seller's choice between different equilibrium candidate prices. Instead of trading with an (endogenously) informed buyer, the seller can also propose a lower price and avoid information acquisition of the buyer. We show that profit taxation does not affect the candidate price that just prevents information acquisition of the buyer. But since profit taxation leads to a lower price in an equilibrium with information acquisition, this makes is relatively more attractive for the seller to charge a price at which the buyer trades without information acquisition. In other words, profit taxation enlarges the range of information costs for which there is no information acquisition in equilibrium and trade occurs with probability one.

For the transaction tax, we also obtain two effects, but here both effects are exactly the opposite and work through a different mechanism. First, a transaction tax may lead to a higher (tax-inclusive) price in an equilibrium with information acquisition. We show that it is optimal for the seller to shift part of the tax increase to the buyer. But a higher price reduces the equilibrium probability of trade. Second, since the transaction tax increases the price that the buyer has to pay, it also strengthens the buyer's incentives to acquire information. Hence, if the seller wants to avoid information acquisition, he has to lower the net-of-tax price when the transaction tax is increased. Overall, this makes it relatively less attractive for the seller to charge the price for which there is no information acquisition. Therefore, a transaction tax enlarges the range of information costs for which there is information acquisition in equilibrium and trade with probability less than one.

Furthermore, we show that the qualitative effects of taxation do not depend on whether the buyer or the seller is the responder in the bargaining game and can acquire information, even though the agents' incentives to acquire information are different: A buyer decides to acquire information in order to avoid buying the asset in low payoff states, while the seller will acquire information in order to be able to keep the asset in high payoff states. Still we show that the same effects of profit taxes and sales taxes hold in the case where the seller is the responder.

Our model is based on two main assumptions. There are gains from trade. First, this assumption makes the theoretical analysis interesting. In a model with rational agents if there are no gains from trade, then there will be no trade irrespective of whether there is taxation or not. The second and main motivation for this assumption is that our model is supposed to capture key elements of trade in funding markets. The main purpose of trade in decentralized funding markets is short term liquidity management and thus mutually beneficial (Bank of Canada 2012; IMF 2008).[4] We discuss the welfare implications of taxation for the case where individually rational trades might have negative externalities on third parties or are socially excessive in Section 7.

The other assumption is that some agents are sophisticated and can produce information about the value of the asset while others are not (or have high cost of information acquisition). More specifically, we consider the case where an uninformed proposer (without private information) makes an offer to a responder who can acquire information before deciding whether to trade. This assumption is partly reflected in funding markets where some investors (e.g., hedge funds) are more capable to produce information than other investors (e.g., pension funds or insurance companies).[5] The main reason for analyzing the case where an uninformed agent makes an offer is tractability. We discuss alternative information acquisition assumptions in Section 6.

---

[4] The players in funding markets are banks, insurance companies, pension funds, money market funds, hedge funds and cash managers of corporations. These players have large cash balances and typically trade hundreds of millions or even billions of dollars of short term debt instruments (or wholesale funds) such as repos, interbank deposits, government bonds, asset backed commercial papers, Agency mortgage backed securities so as to manage their short term liquidity needs.

[5] The breakdown of some of these markets in the wholesale banking system was a key problem of the recent financial crisis (Gorton and Metrick 2012; Deutsche Bank 2012; McKinsey 2013). A notable example which

We like to think of the analysis of taxation in the canonical take-it-or-leave-it-offer bargaining model as a stylized model that captures trade of e.g. mortgage backed securities in funding markets. However, the structure that we consider is more general in that it applies to many types of bilateral trade and resale markets such as buying and selling real estate properties, trade of other financial assets in over-the-counter markets, mergers and acquisitions or inter-firm trade.

The remainder of the paper is organized as follows. The next section relates the paper to the literature. Section 3 introduces the model. Section 4 provides an equilibrium analysis. Section 5 analyzes the effects of taxation on equilibrium information acquisition and pricing. Section 6 discusses the main assumptions of the paper. Section 7 concludes. All proofs are in the Appendix.

2. RELATED LITERATURE

There is a growing literature on taxation of the financial sector and its impact on financial stability. The literature on financial transaction taxes dates back to Tobin (1978) and his proposal of a tax on foreign exchange markets. Originally proposed in the context of exchange rate systems, the discussion about the "Tobin tax" has subsequently been generalized to a financial transaction tax. Stiglitz (1989) and Summers and Summers (1989) advocate a financial transaction tax as a way to reduce speculative investments, but this view has also been disputed (Ross 1989).[6] Recent contributions to the literature on taxation of the financial sector include Acharya, Pedersen, Philippon and Richardson (2010) on corrective taxation if there is systemic risk, Keen (2011) on taxation and bank borrowing, and Bierbrauer (2012) who contrasts short-term and long-term effects of a transaction tax in a financial market model.[7] Dávila (2013) analyzes trade based on belief disagreement and shows that the optimal financial transaction tax can be positive, as the welfare gain from reducing trade due to belief disagreement outweighs the loss from reduced fundamental trade. Shackelford, Shaviro and Slemrod (2010) and Matheson (2011) provide overviews of the debate on different forms of taxation and the empirical evidence.

---

attracted much public attention was the speculation against mortgage backed securities by the Paulson Hedge Fund. Note that the valuation of MBS requires special expertise and data intensive simulation models. Less sophisticated market participants became concerned about adverse selection, which some market participants and regulators considered as one of the reasons for the breakdown of asset backed securities markets during the financial crisis.

[6] See McCulloch and Pacillo (2011) for an overview of the debate on the Tobin tax and the empirical evidence.

[7] See also Vayanos and Wang (2013) for a survey of the role of different market imperfections including transaction costs in a portfolio choice model.

These papers analyze a financial model of the type of centralized stock trading. In contrast, our paper discusses taxation in a bilateral trade model of the type of decentralized funding markets. Furthermore, our paper hints at an aspect that has not been studied in this discussion: Taxation has an additional effect on trade by influencing the problem of endogenous informational asymmetries.

More generally, the literature on tax incidence has extensively analyzed the conditions that determine the distribution of the burden of taxation among market participants, but this literature typically focuses on complete information (for a survey see Fullerton and Metcalf 2002). Questions of tax incidence with exogenous asymmetric information have been analyzed in competitive markets (Cheung 1998; Jensen and Schjelderup 2011) and for monopoly pricing (Goerke 2011; Kotsogiannis and Serfes 2014).[8] In our paper, the case where the seller makes the offer and where the cost of information is close to zero is similar to a model of monopoly pricing with incomplete information. For higher cost of information, however, the tax incidence effects are also affected by the incentive constraints for information production.[9]

To our knowledge there is very little work that analyzes the impact of taxation on bargaining, bilateral trading and optimal contracting. One reason for this might be that (profit) taxation does not alter equilibrium outcomes when private information is exogenous, which is a common assumption in the bargaining and contracting literature. In particular, the effect of taxation on information acquisition in contracting problems has not yet been explored. While taxation does not only affect incentives to acquire information, it also changes the equilibrium price and hence the parties' gains from trade.

A key insight of the literature on bargaining and contracting is that, when agents have private information, equilibrium outcomes are typically not efficient. In many bilateral transactions in secondary markets, however, rather than there being ex ante asymmetry in the information that agents possess, there is asymmetry in the agents' cost or ability to acquire information. There are

[8] For a second-price auction, Ginsburgh, Legros, and Sahuguet (2010) analyze the incidence effects of commissions, which can also be interpreted as a sales tax.

[9] There is also a literature on taxation and risk-taking (Domar and Musgrave 1944; Stiglitz 1967; see Sandmo 1985 for a survey). Our paper highlights different mechanisms but the effect of profit taxation on incentives for information production is intuitively similar to a reduction in risk. The effects of income and commodity taxation in the context of (exogenous) asymmetric information and moral hazard have been studied by Arnott and Stiglitz (1986), Kaplow (1992) and Banerjee and Besley (1990) and in the context of signaling by Ireland (1994) and Anderson (1996).

a relatively small number of papers that analyze information acquisition in bargaining and optimal contracting. These papers show that when information is endogenous, the equilibrium outcome can be very different from the equilibrium outcome under exogenous asymmetric information.[10]

In Dang, Gorton and Holmstrom (2013a,b), a proposer designs a security that uses an asset as a collateral and trades the security with a responder who can acquire information. Depending on the identity of the proposer, equilibrium outcomes are different. If the seller makes the offer, the buyer may acquire information in equilibrium. If the buyer makes an offer to buy a security, then there is never information production by the seller in equilibrium. We consider a setting where the asset is indivisible, neglecting the question of optimal security design. We use the concept of "information sensitivity" by Dang, Gorton and Holmstrom as a simple way to characterize the properties of equilibrium outcomes in bargaining with information acquisition and taxation. Our paper derives the novel results that transaction and profit taxes affect information acquisition through different mechanisms and have opposite implications for equilibrium behaviors and outcomes.

3. THE MODEL

We consider a game with two agents: a seller S and a buyer B. The seller can sell an indivisible asset with uncertain payoff x at a price p to the buyer. Ex ante the information is symmetric; it is common knowledge that the payoff x is distributed according to the distribution function F on the interval $[x_L, x_H]$ where $0 \leq x_L < x_H$. F is assumed to be continuous and differentiable on $[x_L, x_H]$.

As will be described below, there will be the possibility to acquire information at a cost $\gamma \geq 0$. The ex post utility of agent $i = S,B$ is given by

$$U_i = u_i(x, p, q) - \gamma \cdot 1_{\text{info}}, \quad i = S,B,$$

where $q \in \{0,1\}$ indicates whether there is trade ($q = 1$ if the asset is traded and $q = 0$ otherwise) and the indicator variable 1_{info} indicates whether agent i has acquired information (at cost γ).

[10] For instance, Crémer and Khalil (1992) and Crémer, Khalil and Rochet (1998) analyze information acquisition in bilateral contracting where, as in our model, information has no social value. Both papers focus on information about a private value. Dang (2008) considers a bargaining model with common values and shows that the mere possibility of information acquisition can cause trade to break down. There is also a literature on information acquisition in auctions; recent work includes Persico (2000), Hernando-Veciana (2009), and Morath and Münster (2013).

Specifically, we consider the following objective functions:

$$u_S(x,p,q)=\begin{cases} p-T_S(p,p_0) & \textit{if trade } (q=1) \\ v_S(x)-T_S(x,p_0) & \textit{if no trade } (q=0) \end{cases}$$

and

$$u_B(x,p,q)=\begin{cases} v_B(x)-(p+\kappa)-T_B(x,p+\kappa) & \textit{if trade } (q=1) \\ 0 & \textit{if no trade } (q=0) \end{cases}.$$

Here, $v_i(x)$ is agent i's valuation of the asset, which is assumed to be continuous and strictly increasing in the asset's payoff x. Moreover, $\kappa \geq 0$ is a per unit sales tax to be paid by the buyer.[11] Hence, κ increases the tax-inclusive price from p to $p+\kappa$. Finally,

$$T_i(y,z)=\tau \max\{y-z,0\}$$

represents a tax payment on positive monetary profit y net of some amount $z \geq 0$, which is deductible for tax purposes. More specifically, agent i makes a positive profit if the realized payoff of the asset is larger than the price paid for the asset; in this case, these positive profits are taxed at rate $\tau \in [0,1)$. For the buyer, a positive profit occurs if he buys the asset and the payoff of the asset is larger than the price p. The seller's profit may be subject to taxation either if he does not sell the asset and realizes a payoff x that is larger than some price p_0 that he initially paid for the asset (the 'book value') or if he sells the asset and receives a price p that is larger than the 'book value' p_0. This 'book value' p_0 represents a cost that may be deductible for tax purposes and we assume that $0 \leq p_0 < x_H$.

Given $u_S(x,p,q)$ and $u_B(x,p,q)$, the outside options of seller and buyer are

$$\bar{u}_S := E_x[u_S(x,p,0)] = E_x[v_S(x)] - E_x[\tau \max\{x-p_0,0\}]$$

and

$$\bar{u}_B := E_x[u_B(x,p,0)] = 0.$$

[11] Note that our main results on the effects of profit and sales taxes (Propositions 2 and 3) are independent of whether the seller or the buyer has to pay the sales tax (that is, independent of the statutory tax incidence) so that we can make this assumption without loss of generality (the case where the seller pays the sales tax only requires some adaptations in the comparative statics results on information acquisition and equilibrium price without affecting the main conclusions).

We make the following assumption:

$$v_S(x) < v_B(x) \text{ } \textit{for all } x \in (x_L, x_H].$$

This assumption implies that trade is efficient since the buyer derives a higher value from holding the asset than the seller.[12]

We analyze a bargaining game where one of the agents – the proposer P – offers a price; the other agent – the responder R – can acquire information (at cost γ) to learn about the true realization of x and then decides whether to trade. We assume that the responder is risk neutral, i.e.

$$v_R(x) = x,\ R \in \{S, B\},$$

and we only consider a tax on the responder's monetary profit which, due to $v_R(x) = x$, is equal to his utility u_R.[13]

We briefly provide a motivation of the main assumptions of the model which is supposed to capture trade in decentralized funding markets, specifically the trade of asset backed securities. (i) There are gains from trade, as liquidity management is the main purpose of trade in funding markets. (ii) Both traders have symmetric information ex ante. Before the financial crisis, asymmetric information was not considered as an issue among participants in funding markets (Deutsche Bank 2012; McKinsey 2013). Dang, Gorton and Holmstrom (2013) actually argue that funding markets can only function if agents can maintain symmetric information. (iii) Some but not all traders can produce information about the payoff of the asset. We argue that large banks and hedge funds are more sophisticated and capable to produce information than pension funds, insurance companies and corporate cash managers.[14] (iv) For tractability, we assume that only the responder can acquire information. Section 6 discusses alternative information acquisition assumptions.

---

[12] This assumption ensures that the parties have an incentive to trade. An example is when the seller needs to raise cash and the buyer wants to store cash by investing in the asset.

[13] Hence, the responder's gains from trade coincide with the monetary profit subject to taxation. By ignoring a tax on the proposer's profit we can isolate the effect of taxation on the responder's incentives to produce information.

[14] For example, even though all investors have access to documents about asset backed securities (ABS), a small bank is less capable than hedge funds to produce information about the payoff of ABS because the valuation of these structured products requires special expertise and data intensive simulation models.

4. EQUILIBRIUM ANALYSIS

The analysis proceeds in two steps. First, we consider the responder's incentives to acquire information and his best reply to a given price *p*. Second, we derive the equilibrium price chosen by the proposer. In this section taxation is implicitly captured in the utility function. In the next section we use these results to explicitly analyze the effect of profit taxation and sales taxes on the responder's incentives to acquire information and the consequences for the equilibrium price and trade.

4.1. Incentives for information production

Observing a price *p* chosen by the proposer, the responder has three options. He can decide not to trade (choose his outside option), he can trade at price *p* without information production, and he can acquire information and decide whether to trade conditional on the information received. The responder's *value of information* depends on the alternative option he considers to choose.

Definition 1 (*Value of information*)

(i) $q^*(x,p)$ is defined such that $q^*(x,p)=\begin{cases}1 & \text{if } u_R(x,p,1)\geq u_R(x,p,0)\\ 0 & \text{otherwise}\end{cases}$.

(ii) $V_I(p)$ is defined as $V_I(p)=E_x\left[u_R\left(x,p,q^*(x,p)\right)\right]-E_x\left[u_R(x,p,1)\right]$.

(iii) $V_{II}(p)$ is defined as $V_{II}(p)=E_x\left[u_R\left(x,p,q^*(x,p)\right)\right]-E_x\left[u_R(x,p,0)\right]$.

The function q^* in Definition 1(i) describes the *optimal decision rule* according to which an informed responder trades: He chooses $q = 1$ if and only if his utility from trading is larger than his utility from not trading, knowing the price and the true payoff *x*. Second, V_I is defined as the responder's expected utility conditional on knowing the true payoff *x* of the asset (and deciding to trade according to q^*), minus his expected utility if he trades with probability one. Hence, V_I is the responder's *value of information* when deciding between information acquisition and trading without information acquisition ($q = 1$). Third, V_{II} is defined as the responder's expected utility conditional on knowing the true payoff *x* minus his expected utility if he does not trade at all. In other words, V_{II} is the responder's *value of information* when deciding between information acquisition and not trading at all without information acquisition (q = 0).[15] Following directly from Definition 1, Observation 1 below is useful for the proof of subsequent results and therefore stated here explicitly.

Observation 1

$V_I(p) \geq V_{II}(p)$ *if* $E_x[u_R(x, p, 0)] \geq E_x[u_R(x, p, 1)]$.

An uninformed responder does not trade if $V_I(p) > V_{II}(p)$. In the absence of taxation, $V_I(p) = V_{II}(p)$ if $p = E(x)$: Since $v_R(x) = x$, an uninformed responder is indifferent between trading and not trading if the price is equal to the expected payoff of the asset.

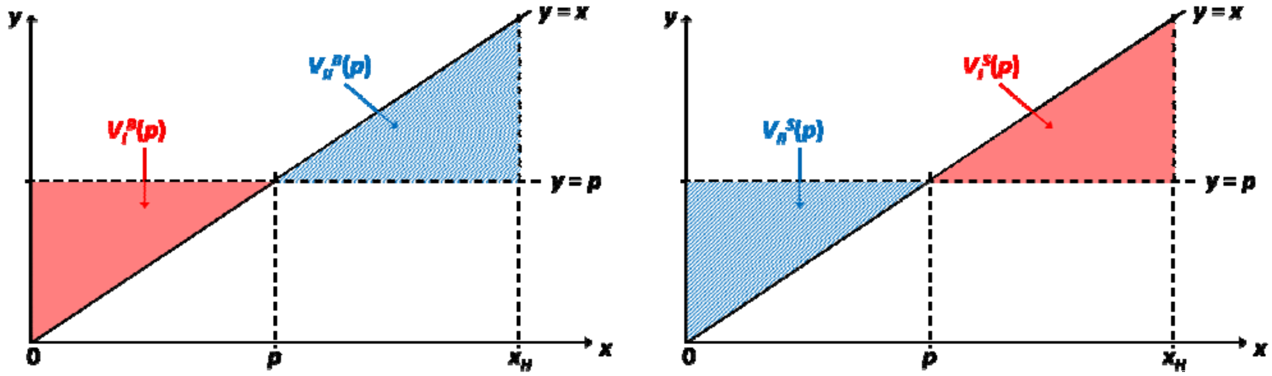
Figure 1 illustrates the value of information V_I and V_{II} in the absence of taxation, depending on whether the buyer or the seller is the responder and decides about information production. Consider first the buyer's incentives for information production in Figure 1(a). An informed buyer does not buy if the payoff x is lower than the price p. Hence, compared to the option of buying uninformed, the informed buyer avoids a loss $p - x$ in low payoff states ($x < p$); in other words, the buyer gains from having acquired information if and only if the true return of the asset is low. The difference in expected utility between these two options (acquiring information and trading uninformed) is defined as the value of information V_I and is equal to the highlighted triangle below the curve $y = p$ in Figure 1(a), weighted by the probability distribution $F(x)$. Moreover, since the buyer gets $p - x$ if he trades and zero otherwise, the value of information V_{II} (when deciding between acquiring information and not trading) is equal to the highlighted triangle above the curve $y = p$. Hence, V_{II} measures the expected gain in high payoff states which the buyer gets if he acquires information and participates.

The seller's incentives to acquire information are exactly the opposite, as shown in Figure 1(b). If the seller trades with probability one, he obtains the price p. His value of information V_I is equal to the expected gain in high payoff states, which the seller realizes if he acquires information and learns that the payoff of the asset is high (in which case he does not sell). Therefore, $V_I^S(p)$ is

[15] Dang, Gorton and Holmstrom (2013a,b) introduce the terminology "information sensitivity" for the value of information in an optimal security design setting but without taxation. So V_I and V_{II} in Definition 1 generalize Lemma 1 in Dang, Gorton and Holmstrom (2013a) to the case where the value of information includes profit and sales taxes.

Figure 1: Value of information V_I and V_{II} if (a) the buyer or (b) the seller is the responder.

(a) Buyer is responder (b) Seller is responder



Note: $v_R(x) = x$; example for $x_L = 0$, $\tau = 0$, $\kappa = 0$.

represented by the highlighted triangle *above* the curve $y = p$. Moreover, the seller's outside option of not trading is equal to the expected payoff of the asset (the area below the curve $y = x$.) Compared to this option, if the seller acquires information, he will sell the asset if $x < p$ and realizes an expected gain equal to the highlighted triangle $V_{II}^S(p)$ below the curve $y = p$.

To summarize, compared to the option of trading uninformed, the buyer would like to acquire information in order to avoid a loss when buying the asset at a too high price, while the seller would like to acquire information in order to avoid to have sold the asset at a too low price. In contrast, compared to the option of not participating, the buyer's value of information is the gain from buying in high payoff states, while the seller's value of information is the gain from selling in low payoff states at a higher price.

Before we solve for the responder's best reply given a price p, the following lemma summarizes comparative statics results on the incentives for information production. Recall that the buyer has to pay a sales tax $\kappa \geq 0$, and hence the buyer's utility when buying depends on the tax-inclusive price $p+\kappa$ (compare the definition of $u_B(x,p,q)$ above), while the seller's utility depends on the net-of-tax price p.

Lemma 1 (*Comparative statics of V_I*)

(*i*) *Suppose that $p + \kappa > x_L$. If the buyer is the responder, then V_I is (a) strictly increasing in the price p, (b) independent of the profit tax τ, and (c) strictly increasing in the sales tax κ.*

(*ii*) *Suppose that $p < x_H$. If the seller is the responder, then V_I is (a) strictly decreasing in the price p, (b) strictly decreasing in the profit tax τ, and (c) independent of the sales tax κ.*

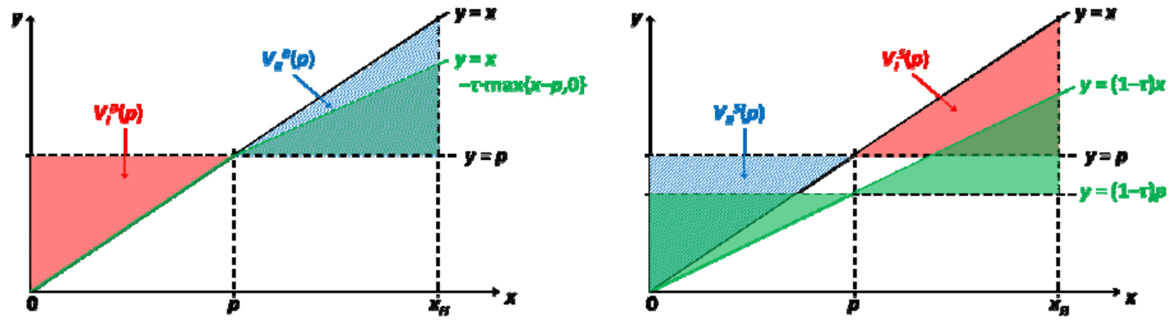
The comparative statics results for price p and sales tax κ on V_I can be highlighted with Figure 1 above. The buyer cares about the tax-inclusive price $p+\kappa$; the higher this price, the larger becomes the highlighted triangle below the $y = p$ curve (where, in Figure 1(a), p has to be replaced by $p+\kappa$). The higher the tax-inclusive price $p+\kappa$, the higher is the probability that the true payoff of the asset is below $p+\kappa$; consequently, it becomes more valuable for the buyer to acquire information, compared to the option of trading uninformed. On the other hand, in Figure 1(b), the seller's value of information V_I is reduced when the net-of-tax price p that the seller receives is increased: A higher price p makes it more attractive for the seller to sell without information acquisition. Since the buyer pays the sales tax (by assumption), the seller's value of information V_I is independent of κ.

The effect of the profit tax is illustrated in Figure 2. For the buyer as responder, V_I corresponds to the expected loss when buying in low payoff states. Thus, a tax on positive profits has no impact on the avoidance of a potential loss and does not affect the value of information V_I (the highlighted triangle below $y = p$ in Figure 2(a)).[16] For the seller, however, it becomes less valuable to find out about a high payoff state and keep the asset if the payoff is subject to taxation; the highlighted triangle above $y = p$ in Figure 2(b) becomes smaller the larger τ.

[16] We discuss the effect of a loss offset on our main results in Section 6.

Figure 2: Effect of the profit tax τ on the value of information V_I and V_{II}.

(a) Buyer is responder (b) Seller is responder



Note: $v_R(x) = x$; example for $x_L = 0$, $\kappa = 0$, $p_0 = 0$.

Lemma 2 (*Comparative statics of V$_{II}$*)

(*i*) *Suppose that $p + \kappa < x_H$. If the buyer is the responder, then V_{II} is (a) strictly decreasing in the price p, (b) strictly decreasing the profit tax τ, and (c) strictly decreasing in the sales tax κ.*

(*ii*) *If the seller is the responder, then V_{II} is (a) strictly increasing in the price p, (b) decreasing in the profit tax τ (strictly decreasing if and only if $p_0 < p$), and (c) independent of the sales tax κ.*

The comparative statics results for the value of information V_{II} are basically just the opposite of the previous case. Recall that V_{II} measures the utility of the responder when acquiring information and trading according to q^* minus the utility of no trade. For the buyer, a higher the tax-inclusive price $p+\kappa$ reduces the value of information V_{II} because an informed buyer then buys with lower probability and at a higher cost. In addition, an increase of a profit tax strictly reduces the buyer's information rent V_{II}, as illustrated in Figure 2(a). For the seller, V_{II} represents his gain from selling the asset in low payoff states (where $x < p$). This gain is higher the higher the price p that the seller receives, but it is reduced if the information rent (the difference between p and x) is subject to the profit tax. The latter effect is illustrated in Figure 2(b). Again, since the buyer pays the sales tax, V_{II} of the seller is independent of κ.

4.2. The optimal choice of the responder

The properties of V_I and V_{II} can be used to determine the best reply of the responder. Facing a price p, the optimal decisions on information production and trading can directly be characterized as a function of the information cost γ. We assume that (a) if the responder is indifferent between trading and not trading, he decides to trade and (b) if the responder is indifferent between information acquisition and no information acquisition, he does not acquire information.[17]

Lemma 3 (*Best response of responder*)

Let (p, τ, κ) *be given.*

(i) *If* $V_I \leq \min\{\gamma, V_{II}\}$*, then the responder trades without information acquisition.*

(ii) *If* $\gamma < V_I$ *and* $\gamma \leq V_{II}$*, then the responder acquires information and trades according to* $q^*(x,p)$.

(iii) *If* $V_{II} < \min\{\gamma, V_I\}$*, then the responder does not acquire information and does not trade.*

The responder decides to acquire information if and only if both V_I and V_{II} are larger than the cost of information γ. Otherwise, the responder does not acquire information; the comparison of V_I and V_{II} reveals whether or not an uninformed responder prefers to trade. An uninformed responder does not trade if $V_I > V_{II}$ (which, by Observation 1, is equivalent to $E_x[u_R(x,p,1)] < E_x[u_R(x,p,0)]$).

4.3. Equilibrium price setting

Taking into account the responder's best reply, there are three candidate equilibrium prices that the proposer may choose.

[17] These tie breaking rules are chosen as to avoid the problem that a best reply of the proposer may not exist in a continuous strategy space, but they are not crucial for the subsequent results. As will become clear below, if, for instance, an indifferent responder decided in favor of information acquisition, then the proposer would want to adjust his price by an infinitesimally small amount in order to prevent information acquisition.

Definition 2 (*Candidate equilibrium prices*)

(i) $\overline{p}$ is defined such that $E_x[u_R(x,\overline{p},1)] = E_x[u_R(x,\overline{p},0)]$.

(ii) p_I is defined such that $V_I(p_I) = \gamma$.

(iii) p_{II} is defined as $p_{II} \in \arg\max_p \; E_x[u_P(x,p,q^*(x,p))]$ s.t. $V_{II}(p_{II}) \geq \gamma$.

The price $\overline{p}$ is defined such that the responder is exactly indifferent between trading with probability one at $\overline{p}$ and choosing his outside option $\overline{u}_R$ (no trade, no information acquisition).[18] Moreover, p_I is defined such that, when being offered a price p_I, the responder is indifferent between producing information and trading according to q^* on the one hand and not producing information and trading with probability one on the other hand.[19] Finally, p_{II} is the price that maximizes the proposer's expected utility in case the responder acquires information and trades according to q^*.[20] Here, p_{II} takes into account the responder's participation constraint such that the responder's expected utility from producing information is weakly larger than his utility $\overline{u}_R$ from not participating ($V_{II}(p_{II}) \geq \gamma$).

If the proposer's gains from trade are sufficiently small, he will not trade with an informed responder but rather choose his outside option $\overline{u}_P$. This is the case, for instance, if $v_P(x)$ is close to $v_R(x)$: Then, a proposer will most likely make a loss when trading with an informed responder (who only trades if it is beneficial for him); hence, the proposer might choose not to participate. In the following, we will concentrate on situations where the proposer's incentives to trade are sufficiently strong or, in other words, $\overline{u}_P$ is sufficiently low. Technically, we assume

[18] By Definition 1(ii)-(iii), this is equivalent to $V_I(\overline{p}) = V_{II}(\overline{p})$.

[19] As shown in Lemma 1, V_I is strictly monotone in p for prices between x_L and x_H. For sufficiently low γ, p_I is uniquely defined. If γ is high and the seller is the responder, then $V_I(p) < \gamma$ for all $p \geq 0$, but then p_I will never be relevant for the equilibrium characterization. To keep the definitions as simple as possible, we omit this case in Definition 2(ii).

[20] For arbitrary functions F as well as v_S and v_B, p_{II} is not necessarily unique. When considering the effects of taxation, we neglect this possibility of multiple p_{II} as optimal solutions (where all yield the same expected utility to the proposer), which could be easily ruled out by some further assumptions on F.

that $E_x\left[u_P\left(x, p_{II}, q^*\left(x, p_{II}\right)\right)\right] \geq \bar{u}_P$, i.e., the proposer is willing to trade with an (endogenously) informed responder.[21]

Proposition 1

Define $\underline{\gamma}$ *such that* $E_x\left[u_P\left(x, p_I, 1\right)\right] = E_x\left[u_P\left(x, p_{II}, q^*\left(x, p_{II}\right)\right)\right]$ *and suppose that* $E_x\left[u_P\left(x, p_{II}, q^*\left(x, p_{II}\right)\right)\right] \geq \bar{u}_P$.

(*i*) *If* $\gamma \geq V_I(\bar{p})$, *then* $p^* = \bar{p}$ *and the responder trades without information acquisition.*

(*ii*) *If* $\underline{\gamma} \leq \gamma < V_I(\bar{p})$, *then* $p^* = p_I$ *and the responder trades without information acquisition.*

(*iii*) *If* $\gamma < \underline{\gamma}$, *then* $p^* = p_{II}$ *and the responder acquires information and trades according to* q^*.

Proposition 1 characterizes the equilibrium properties which hold both for the case where the buyer and where the seller makes the offer. The result on the equilibrium price p^* is quite intuitive. If the cost of information is high, information production becomes irrelevant. In this case, the proposer offers the price $\bar{p}$ that gives the responder his outside option, i.e. no rents. Since trade occurs with probability one, this is the optimal price (Proposition 1(i)). Note that, in the absence of taxation, for instance, this price would be equal to the responder's expected valuation $E[v_R(x)]$ of the asset.

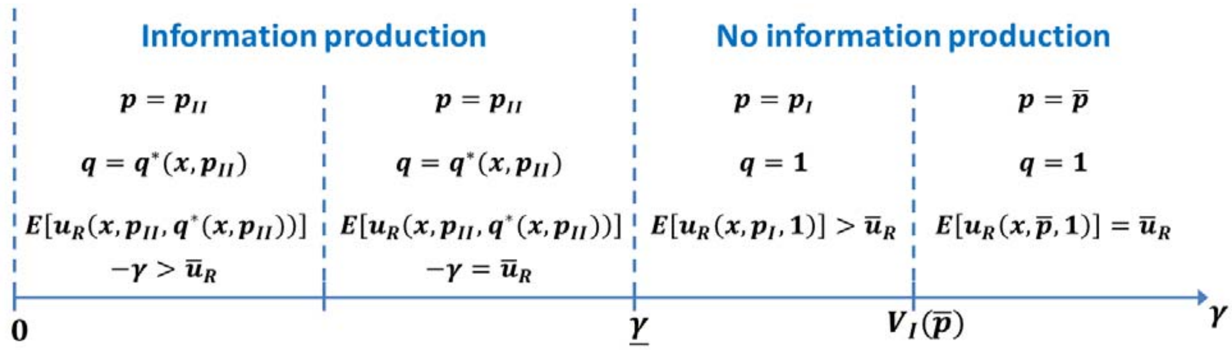
For intermediate cost of information, the responder would react to such an "unfavorable" price by producing information and then trading only when a gain can be realized. The proposer, however, is better off by adjusting the price such that the responder has no incentives to produce information (Proposition 1(ii)). Technically, he chooses a price p_I such that the value of information is $V_I(p_I) = \gamma$.[22] Here, even if, in equilibrium, there is no information production, the responder gets an information rent (his equilibrium utility is higher than $\bar{u}_R$).

The lower the cost of information, the more costly it becomes for the proposer to prevent information production (the higher is the share of the surplus he has to offer to the responder). So there is a threshold $\underline{\gamma}$ below which the nature of the equilibrium changes and the proposer chooses

[21] We assume this so as to save on notations.

[22] The buyer as a proposer will increase the price while the seller as a proposer will decrease the price so as to prevent information production by the responder.

Figure 3: Equilibrium price setting and information production.



a price that induces the responder to produce information (Proposition 1(iii)). This price, however, has to take into account that the responder is being compensated for the cost of information in that his expected surplus from trade covers the cost of information production (i.e. $V_{II} \geq \gamma$). While for very low cost of information this condition will always be fulfilled, it can be binding if γ is sufficiently close to $\underline{\gamma}$. In the former case, the responder gets a positive net surplus ($V_{II}(p) > \gamma$); in the latter case, the responder's equilibrium surplus from trade net of information cost is zero ($V_{II}(p) - \gamma = 0$, i.e., his expected utility is equal to $\bar{u}_R$). The results of Proposition 1 are summarized in Figure 3 which hold both for the case where the buyer and where the seller makes the offer.[23]

It is worth noting that the equilibrium payoff of the responder is not monotonic in the information cost. For low information cost, he obtains some rents in the equilibrium with information acquisition. If the information cost increases, the responder's rents in the equilibrium with information acquisition are reduced to zero. If information cost is in a middle range, the responder gets rents again since he is "bribed" so as to trade without information acquisition. And if the information cost is high, the proposer is not concerned about information acquisition and the responder gets no rents as in a standard take-it-or-leave-it offer game.

[23] Thus, the results of Proposition 1 differ from those in Dang, Gorton and Holmstrom (2013a,b). Dang, Gorton and Holmstrom (2013a) show that if the asset is divisible or can be used as the collateral that backs the payoff of another contract (security) and the seller can acquire information and the uninformed buyer makes an offer, there is never information acquisition in equilibrium even if information cost is vanishingly small. Dang, Gorton and Holmstrom (2013b) show that if the buyer can acquire information and the uninformed seller makes an offer, then an equilibrium with information exists when information cost is low but the responder never obtains any surplus.

5. THE EFFECTS OF TAXATION ON EQUILIBRIUM PRICE AND TRADE

The equilibrium analysis in the previous section has taxation implicitly captured in the utility functions. Using the results for the incentives to acquire information and the equilibrium price setting, we now explicitly analyze the effects of a marginal increase in the profit tax and in the sales (transaction) tax, respectively, in two steps: First, we derive the effects of each of the tax instruments on the equilibrium candidate prices $\overline{p}$, p_I and p_{II} (taking into account the responder's best reply). Then, we show how a tax increase affects the proposer's choice between these candidate prices and in this way affects equilibrium information acquisition.

5.1. The effect of a profit tax

We first consider the price effects of a profit tax increase.[24]

Lemma 4 (*Comparative statics of equilibrium prices*)

Let $\overline{p}$, p_I, and p_{II} be defined as in Definition 2 and consider the effect of a profit tax τ.

(*i*) *If the buyer is the responder, then (a) $\partial\overline{p}/\partial\tau < 0$, (b) $\partial p_I/\partial\tau = 0$, and (c) $\partial p_{II}/\partial\tau \le 0$ (with strict inequality if and only if $V_{II}(p_{II}) = \gamma$).*

(*ii*) *If the seller is the responder, then (a) $\partial\overline{p}/\partial\tau \le 0$ (with strict inequality if and only if $p_0 > x_L$), (b) $\partial p_I/\partial\tau < 0$, and (c) $\partial p_{II}/\partial\tau \ge 0$ (with strict inequality if and only if $V_{II}(p_{II}) = \gamma$).*

To understand the intuition behind Lemma 4, suppose first that the cost of information is high and the proposer offers a price $\overline{p}$ such that the responder trades without information acquisition and obtains no rents, that is, expected gains and losses are equalized. If the buyer is the responder, then his gains become smaller the higher the profit tax; thus, the seller must reduce the price in order to induce the buyer to participate. If the seller is the responder and the profit tax is increased, this biases the seller's choice towards selling at price p (where he pays less taxes since higher payoffs are now taxed more heavily), and the buyer can lower his offer.

[24] The results on the price effects of taxation hold for "interior prices" (between x_L and x_H); otherwise, depending who is the responder, profit taxation has no effect (since no tax payment has to be made if, for instance, the buyer buys at a price above x_H). Moreover, as mentioned above, we assume for the following comparative statics analysis that there is a unique solution p_{II} to the proposer's maximization problem when facing an informed responder.

For intermediate cost of information, the proposer chooses a price p_I which just prevents information acquisition of the responder. Recall that the buyer's value of information V_I (the value of avoiding a loss if the asset's payoff is low) is independent of τ, while the seller's value of information (realizing a gain if the asset's payoff is high) is decreasing in τ. Thus, if the profit tax is increased, the seller as the proposer does not have to adjust p_I, while the buyer as the proposer can lower p_I and still prevent information acquisition of the responder.

Finally, if the cost of information is very low, then the responder acquires information. His information rent is reduced by a profit tax increase, but his trading decision is not directly affected by an increase in τ. Thus, the proposer's optimal price p_{II} does not change unless the responder's participation constraint is binding (that is, $V_{II} = \gamma$). In the latter case, the proposer must adjust the price p_{II} in order to compensate the responder for the higher profit tax. (The seller as the proposer must lower the price while the buyer as the proposer must increase the price.)

The most interesting cases emerge for intermediate cost of information where incentives for information production have a decisive role for equilibrium price setting. As Lemma 4 shows, profit taxation can have a direct effect on the equilibrium price. Therefore, profit taxation can change the probability of trade (and thus efficiency) *within* an equilibrium that involves information production (where trade occurs with probability less than one). Moreover, due to the price effects, taxation of the responder's profits also affects the proposer's utility and hence his choice *between* the different candidate equilibrium prices.

Proposition 2

An increase in the profit tax τ

(i) *increases the probability of trade in an equilibrium with information production* ($\gamma < \underline{\gamma}$)

(ii) *and lowers the threshold* $\underline{\gamma}$ *below which there is information production in equilibrium.*

Proposition 2 identifies a direct and an indirect effect of a profit tax increase. First, in an equilibrium with information acquisition (that is, for $\gamma < \underline{\gamma}$), profit taxation increases the probability of trade by reducing the responder's information rent, which must be compensated by a more favorable price for the responder. Hence, if the proposer trades with an informed responder, the price must be adjusted such that there is more trade in order to leave more rents to the responder (Proposition 2(i)). Second, as the indirect effect, a profit tax increase affects the proposer's choice between the equilibrium candidate prices. Since taxation of profits (weakly) reduces the incentives to acquire information (strictly for the seller), this makes it relatively more attractive for the proposer to prevent information production by offering a price p_I (Proposition 2(ii)).

Both effects summarized in Proposition 2 lead to a higher equilibrium probability of trade. Moreover, Proposition 2 holds independently of the identity of the proposer and the responder. Even though the incentive effects of taxation on information acquisition and the choice of prices are different for the buyer and the seller (Lemmas 1, 2 and 4), the effect of a profit tax on equilibrium trade works in the same direction.

While profit taxation can affect the equilibrium price when information is endogenous, a profit tax increase has no effect on the equilibrium probability of trade if asymmetric information is exogenous.

Corollary 1

Suppose that the responder is informed ($\gamma = 0$). Then, an increase in the profit tax τ does not affect the equilibrium probability of trade.

Since the case where the responder is informed can be interpreted as $\gamma = 0$, the proposer's choice p_{II} is independent of τ.[25] Hence, although it reduces the responder's information rent, a marginal increase in τ has no effect on the equilibrium probability of trade if the responder is informed. Recall that we assume that the gains from trade are large such that an uninformed proposer is willing to trade with an informed responder. So the proposer's problem is similar to a monopoly pricing problem where the proposer chooses a price p_{II} that maximizes the expected revenue, i.e., the probability of trade times the price. When γ is small, this behavior is also present in the equilibrium with information production.

[25] A proof is omitted since this result follows from Lemma 3(ii) by setting $\gamma = 0$ as well as from Lemma 4(i)c and (ii)c (for the case of $V_{II} > \gamma$).

5.2. The effect of a sales tax (transaction tax)

The effects of a transaction or sales tax can be derived along similar lines.[26] Consider first the effects of a marginal increase in the sales tax κ on the equilibrium candidate prices.[27]

<u>Lemma 5 (*Comparative statics of equilibrium prices*)</u>

Let $\overline{p}$, p_I, and p_{II} be defined as in Definition 2 and consider the effect of a sales tax κ.

(i) *If the buyer is the responder, then (a)* $\partial(\overline{p}+\kappa)/\partial\kappa = 0$, *(b)* $\partial(p_I+\kappa)/\partial\kappa = 0$, *and (c)* $\partial(p_{II}+\kappa)/\partial\kappa \geq 0$ *(with strict inequality if and only if $V_{II}(p_{II}) > \gamma$).*

(ii) *If the seller is the responder, then (a)* $\partial\overline{p}/\partial\kappa = 0$, *(b)* $\partial p_I/\partial\kappa = 0$, *and (c)* $\partial p_{II}/\partial\kappa \leq 0$ *(with strict inequality if and only if $V_{II}(p_{II}) > \gamma$).*

The comparative statics results in Lemma 5 distinguish whether the buyer or the seller is the responder. The intuition for the results, however, is the same, taking into account that the buyer as the responder bases his buying decision on the tax-inclusive price $p+\kappa$ while the seller as the responder cares about the net-of-tax price p. If the sales tax is increased, the relevant prices which make the responder indifferent between trading uninformed and (a) his outside option and (b) information acquisition have to remain unchanged. Hence, the seller as the proposer has to adjust his offer such that the tax-inclusive prices $\overline{p}+\kappa$ and $p_I+\kappa$ remain unchanged, while the buyer as the proposer has to ensure that the net-of-tax prices $\overline{p}$ and p_I remain unchanged. The same argument holds for the price p_{II} whenever the responder's participation constraint is binding ($V_{II}(p_{II}) = \gamma$).

The interesting case is a situation where $V_{II}(p_{II}) > \gamma$ and the responder gets a strictly positive payoff when trading at p_{II}. Here, the proposer is able to shift (part of) the tax increase on to the responder by adjusting the price accordingly. This will lead to an increase in the (tax-inclusive)

[26] Recall that we consider a per-unit sales tax levied on the buyer. The statutory tax incidence does not affect our results; moreover, qualitatively the same results are obtained for the case of an ad valorem sales tax (for details compare the remarks in the proofs of Lemma 5 and Proposition 3).

[27] As for the comparative statics results for the profit tax, we assume that tax-inclusive prices are in some "interior" range (between x_L and x_H) and that p_{II} is unique.

price if the seller makes the offer and to a decrease in the (net-of-tax) price if the buyer makes the offer.

Just as for the profit tax, a sales tax increase can have direct and indirect effects on the probability of trade, but both effects go in the opposite direction compared to the profit tax.

Proposition 3

An increase in the sales tax κ

(i) *lowers the probability of trade in an equilibrium with information production ($\gamma < \underline{\gamma}$)*

(ii) *and increases the threshold $\underline{\gamma}$ below which there is information production in equilibrium.*

If the cost of information is low and there is information acquisition in equilibrium, an increase in the sales tax makes trade less attractive. Intuitively, whenever possible, the proposer shifts part of the increased tax burden to the responder, accepting that this reduces the probability of trade with an informed responder (Proposition 3(i)). Moreover, a sales tax increase (weakly) increases the incentives to produce information (strictly for the buyer as the responder); in addition, the tax burden is higher in the equilibrium candidate without information acquisition because there trade occurs with higher probability. This makes it less attractive for the proposer to offer a price that prevents information production (Proposition 3(ii)). Altogether, the direct and indirect effects of a sales tax increase lead to less trade and more information production.

Propositions 2 and 3 imply that the two different types of taxes can have exactly the opposite welfare effects. Profit taxation mitigates the (endogenous) lemons problem, whereas sales taxes make it worse. Since the sum of the welfare of the trading parties and tax revenue is highest if there is trade with probability one and no information acquisition, profit taxation can be welfare-improving, while sales taxes reduce welfare.[28] But the policy implications depend, of course, on the welfare criterion and on whether an increase in the probability of trade is socially desirable (compare also the discussion in Section 7). If, for instance, there is a negative externality of trade not captured by the seller's and buyer's utility, then a reduction of the probability of trade might be socially optimal, in which case the transaction tax is superior to the profit tax.

[28] Due to the effect on the probability of trade, this result still holds if the cost of information is not socially wasteful but only redistributive for welfare purposes.

The results in Lemma 4 and Lemma 5 also allow for a direct conclusion on the tax incidence effects. Sales taxes always weakly reduce the utility both of the seller and of the buyer; whenever there is no information acquisition in equilibrium, however, the responder's utility is not affected by a sales tax increase but the proposer bears the full burden of the sales tax. In contrast, if the seller is the responder and the tax on the seller's profit is increased, this strictly increases the buyer's utility whenever the information cost is sufficiently high and either $\overline{p}$ or p_I is offered in equilibrium. Here, taxation reduces the seller's incentives to acquire information and to choose his outside option of no trade, respectively, which enables the buyer to trade at a lower price.

6. DISCUSSION

In this section we discuss some of the assumptions made in the main analysis and their implications for our results on the effects of taxation.

6.1. Profit taxation and deductibility of losses

The analysis of profit taxation above only considered a tax on positive profits but did not take into account a tax treatment of losses. Sometimes, negative profits can, at least to some extent, be credited against future gains and/or other current income, and our results on the effects of taxation on the probability of trade are reinforced if the possibility of a loss offset exists.

For illustration, consider the following tax function:

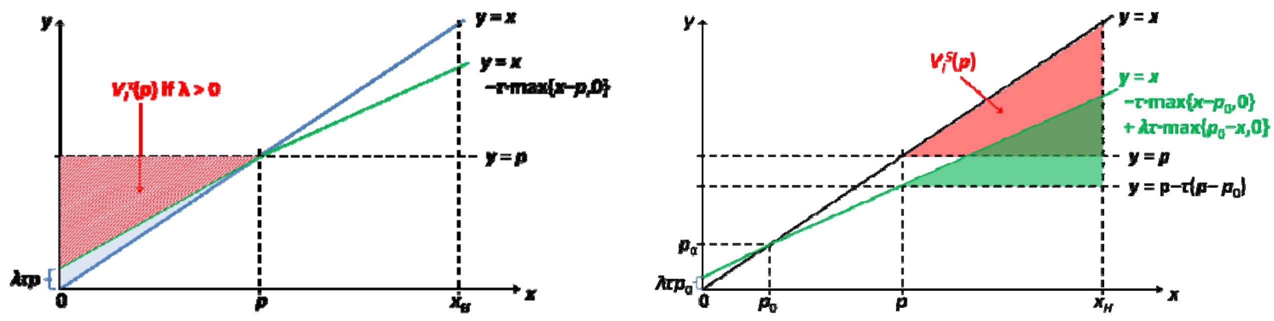
$$T_i(y,z) = \tau \max\{y - z, 0\} - \lambda\tau \max\{z - y, 0\}, \ \ \lambda \in [0,1] .$$

As before, y is a monetary profit and the amount z is deductible for tax purposes. If z is larger than y (for example, because the price $p = z$ paid by the buyer is larger than the realized payoff $x = y$ of the asset), then the agent receives a "subsidy" equal to $\lambda\tau \max\{z - y, 0\}$. In other words, a share λ of the loss can be credited against other income which is also subject to the profit tax τ.

Consider first the case where the buyer is the responder and can acquire information. Now, if $\lambda > 0$, the buyer's value of information V_I is strictly decreasing in the profit tax τ, as shown graphically in Figure 4. Recall that the buyer's value of information is equal to the value of avoiding a loss in case the payoff of the asset is low. Since this loss is lower the higher τ (the higher the "negative tax payment" in case of a loss), profit taxation reduces the buyer's value of

Figure 4: Effect of profit taxation on the value of information V_I in case of a loss offset.

(a) Buyer is responder (b) Seller is responder



Note: $v_R(x) = x$; example for $x_L = 0$, $\kappa = 0$, $p_0 < p$.

information. Intuitively, buying the asset without information acquisition becomes less risky because the loss offset rule acts like a subsidy on the loss. It can also be interpreted as security insurance.[29]

Lemma 6

Suppose that $\lambda > 0$ and consider the case where the buyer is the responder and can produce information. Then, $\partial p_I/\partial\tau > 0$ and $\partial p_{II}/\partial\tau \leq 0$ (with strict inequality if and only if the buyer's participation constraint is binding).

A proof of Lemma 6 follows the same arguments as the proof of Lemma 4 and is therefore omitted. Since p_I is the price that makes the buyer indifferent between producing information and buying without information production and since an increase in τ strictly reduces the buyer's value of information V_I, this implies that the price p_I is strictly increasing in τ. The seller can charge a higher price and still avoid information production of the buyer. On the other hand, p_{II} is decreasing in τ.[30] Therefore, if $\lambda > 0$, the threshold $\underline{y}$ below which there is information production

[29] Such an effect is observable in the markets for Agency mortgage backed securities (MBS). There is implicit guarantee that Agency MBS do not default which the US government made explicit in early September 2008. This is a prime example of trade of information insensitive securities where market participants have no incentive to produce private information so that the market is very liquid. See also the discussion in Section 7.

[30] The result on p_{II} is exactly as in the main analysis where $\lambda = 0$. Since an informed buyer only trades if $x > p$, the possibility of a loss offset neither affects an informed buyer's utility nor his outside option (V_{II} is independent of λ).

is strictly decreasing in τ because it becomes more attractive for the seller to charge p_I if τ is increased. Hence, as above, the profit tax has a direct positive effect on the probability of trade because it may lead to a decrease in the equilibrium price (given that p_{II} is charged) and an indirect effect because it makes it more attractive to the seller to charge a price $p = p_I$ that avoids information production of the buyer.

The same holds for the case where the seller is the responder and can acquire information. Here, without the possibility of a loss offset (as in the main analysis above), the seller's value of information V_I has already been decreasing in τ. This still holds if a share λ of a negative profit can be credited against other (future) profits. Therefore, all results on the effects of profit taxation continue to hold. To sum up, the possibility of a loss offset does not qualitatively affect any of the results on the effects of taxation; in the case where the buyer can acquire information, it may even strengthen the results on the profit tax.

6.2. Information production of the proposer

Although in this paper we focus on the effects of taxation when the responder may be able to produce information, taxation can also affect information production and price setting when the proposer is able to produce information before making the offer. We will illustrate possible effects of profit taxation in a simplified example. Broadly speaking, profit taxation reduces the proposer's incentive to make use of his informational advantage and can thus mitigate the lemons problem and lead to more trade, just as in the previous section.

Suppose that the buyer makes the offer and that $v_B(x) > v_S(x) = x$. Moreover, suppose for simplicity that the return of the asset can be either low (x_L, with probability μ) or high (x_H, with probability $1-\mu$). Now, the buyer decides whether to produce information before making the offer to the seller.

For illustrative purposes, we assume that only the buyer is able to produce information and that he cannot credibly reveal any private information.[31] If information production is unobservable to the seller and the cost of information is sufficiently low, the buyer cannot commit to not

[31] If the buyer could credibly reveal his private information, he would prefer to do so: This would allow him to extract the entire surplus by setting a price equal to the seller's valuation $v_S(x)$. Hence, a proposer without private information as in the main analysis is a reasonable assumption in situations in which private information can be credibly revealed.

producing information and, in equilibrium, he will produce information. Then, there is an equilibrium where the buyer sets a price equal to the seller's valuation of the asset: $p_H = v_S(x_H)$ if $x = x_H$ and $p_L = v_S(x_L)$ if $x = x_L$. The seller sells with probability one if he is offered the high price p_H, and he sells with probability q^* if he is offered the low price p_L. In fact, the seller is exactly indifferent between selling and not selling; in equilibrium, q^* will be chosen such that the buyer has no incentive to lie (that is, no incentive to offer the low price if the payoff of the asset is high). Analytically, q^* will be such that, given that $x = x_H$, the buyer's after-tax profit is the same when offering p_H and when offering p_L:

$$v_B(x_H) - p_H - T_B(x_H, p_H) = q^*[v_B(x_H) - p_L - T_B(x_H, p_L)].$$

Now, since $v_S(x) = x$, the buyer does not make any monetary profit if he buys the asset from the seller at its true payoff. If, however, he lies, he does make a monetary profit which is lower the higher the profit tax τ. In other words, taxation of profits reduces the buyer's incentives to signal wrong information, and therefore q^* is strictly increasing in τ.[32] Again, taxation of profits will increase the (ex ante) probability of trade.

The result that taxation may help to solve the signaling problem by reducing the incentives to make use of the informational advantage and to lie is quite intuitive; however, a model where both parties may produce information can potentially lead to different results. In particular, for the efficiency effects of taxation it will be crucial whether information acquisition leads to asymmetric information or helps to restore a situation of symmetric information (where both parties produced the same signal). While a full analysis of such a scenario is clearly beyond the scope of this paper, we believe that it could yield further interesting results that complement the results derived in the present setting which focuses on the responder's incentives for information acquisition.

7. CONCLUDING REMARKS

In this paper we analyze the effects of taxation on information acquisition in bilateral trade and connect the literature on taxation, the finance literature on over-the-counter markets and the

[32] This result does not depend on the assumption of $v_S(x) = x$ (and the consequence that the buyer does not make a monetary profit when telling the truth) but holds as long as $v_B(x_H) > x_H > v_S(x_L)$. (If $v_S(x_L) = p_L \geq x_H$, q^* is independent of τ because the tax payment is zero even if the buyer lies and offers p_L in case $x = x_H$.)

bargaining literature. We derive the novel result that profit taxes and sales (transaction) taxes have opposite implications for the equilibrium behavior in take-it-or-leave-it offer bargaining. A marginal increase of a transaction tax increases the incentive to acquire private information which creates adverse selection and reduces the probability of trade. In contrast, a marginal increase of a profit tax reduces the incentive to acquire information and increases the probability of trade.

We show that a profit tax dominates a transaction tax in decentralized markets such as funding markets, in which agents trade for liquidity reasons and thus realize gains from trade and private information acquisition creates endogenous adverse selection. Proponents of transaction taxes often refer to the disincentive effects that transaction taxes would generate for speculative trading that does not enhance market efficiency (compare European Commission 2013, p.2). Our paper, however, shows that a transaction tax can potentially lead to more speculation in decentralized trading and increase the problem of asymmetric information.[33]

A key question in terms of policy implications is whether individually rational trades might be socially excessive because e.g. they have negative externalities on tax payers. One of the most liquid markets is the TBA market of Agency mortgage backed securities (MBS). The average daily trading volume of Agency MBS was around \$320 billion in the years between 2007 and 2012. This is twice as large as the daily trading volume of all stocks at the NYSE and Nasdaq together for the same period (SIFMA 2012). There is no clear cut answer on whether trade of \$320 billion a day is excessive but some views express that high liquidity is desirable in funding markets.[34]

The phenomenon of excessive trade is also controversially discussed in the context of high frequency trading in stock markets, emphasizing distortionary and manipulative effects on equity prices as opposed to liquidity increases and the reduction of bid ask spreads and transaction costs for stock investors. Thus, parallel questions on the effects of profit taxes compared to transaction

[33] In the trivial case of a prohibitive high transaction tax, there will be no trade. But this is equivalent to de facto forbidding trade. Similarly, if the profit tax is 100%, the buyer will not buy. In this paper we discuss the marginal effects of taxation and tax rates that are at basis point levels as proposed by the European Commission.

[34] The US Federal Housing Finance Agency (FHFA) took Fannie Mae and Freddie Mac into conservatorship so as to stabilize the primary and secondary MBS markets. The FHFA (2008, p.3) states that market participants, including *"central banks ceased buying and began selling Enterprise securities. Relatively small sales triggered large price moves"*. More recently, the Banking Senate Committee (2014, p.4) states that one of the goals of the reform of the housing finance system is to preserve the TBA market "*by maintaining broad liquidity in the To-Be-Announced (TBA) market*". See also the European Central Bank and Bank of England (2014) which call for a revival of ABS markets. Vickery and Wright (2013) provide an institutional discussion of the TBA markets. See also Duffie (2014).

taxes arise in market microstructure models with high frequency traders. Moreover, the question extends to credit and interest rates swap markets as well as currency markets which are also very liquid decentralized markets but different in nature than funding markets. A further dimension of the problem relates to the choice between different types of information and situations in which information has a social value and agents can learn about the gains from trade.[35]

These are interesting questions from a theory perspective and important for regulation but are beyond the scope of this paper which focuses on funding markets where agents trade to manage their short term liquidity needs. Asymmetric information has been considered a main problem in these markets in the course of the financial crisis when investors became concerned about complexity and quality of the securities used to trade. In a setting where there are gains from trade and private information acquisition generates endogenous adverse selection, our theoretical analysis suggests that a profit tax dominates a transaction tax. In contrast to a transaction tax, a tax on profits reduces the incentive to acquire information, mitigates endogenous adverse selection and increase liquidity and welfare in equilibrium.

APPENDIX

A.1 Proof of Lemma 1

This result follows directly from the definition of V_I. Consider first part (i). The buyer pays a profit tax if and only if he buys and the payoff of the asset is above the price paid. Hence,

$$\begin{aligned} V_I(p) &= \int_{p+\kappa}^{x_H} (1-\tau)\big(x-(p+\kappa)\big)dF(x) \\ &\quad - \left[\int_{x_L}^{p+\kappa}\big(x-(p+\kappa)\big)dF(x) + \int_{p+\kappa}^{x_H}(1-\tau)\big(x-(p+\kappa)\big)dF(x)\right] \\ &= \int_{x_L}^{p+\kappa}\big((p+\kappa)-x\big)dF(x), \end{aligned}$$

which is strictly increasing in p and in κ but independent of τ.

For part (ii), the seller pays a profit tax if he does not sell and the return is above the 'book value' p_0 or if he sells at price p above p_0. Thus, we get

[35] An alternative is to employ a mechanism design approach. But the analysis of a general mechanism design setting with information acquisition or endogenous type space requires a dynamic approach and looks demanding even without the issue of taxation. Besides technical difficulties, the analysis of taxation in different types of financial market structures can provide interesting theoretical insights since institutional details seem to matter a lot for outcomes in real markets.

$$V_I(p)=\int_{x_L}^{p}(p-T_S(p,p_0))dF(x)+\int_{p}^{x_H}(x-T_S(x,p_0))dF(x)-\int_{x_L}^{x_H}(p-T_S(p,p_0))dF(x)$$
$$=\int_{p}^{x_H}(x-p-(T_S(x,p_0)-T_S(p,p_0)))dF(x),$$

which is strictly decreasing in p (as the integrand is positive and $\partial T_S(p,p_0)/\partial p \leq \tau$) and independent of κ (since by definition the relevant price for the seller is the net-of-tax price p). Moreover,

$$\frac{\partial V_I}{\partial \tau}=\int_{p}^{x_H}(\max\{p-p_0,0\}-\max\{x-p_0,0\})dF(x)$$
$$<\int_{p}^{x_H}(\max\{x-p_0,0\}-\max\{x-p_0,0\})dF(x)=0.$$

Thus, V_I is strictly decreasing in τ if the seller is the responder.

A.2 Proof of Lemma 2

Part (i) follows directly from that fact that

$$V_{II}(p)=\int_{p+\kappa}^{x_H}(1-\tau)(x-(p+\kappa))dF(x).$$

For part (ii), note that

$$V_{II}(p)=\int_{x_L}^{p}(p-x-(T_S(p,p_0)-T_S(x,p_0)))dF(x),$$

which is independent of κ and strictly increasing in p (due to $\partial T_S(p,p_0)/\partial p \leq \tau$). Finally,

$$\frac{\partial V_{II}}{\partial \tau}=\int_{x_L}^{p}(\max\{x-p_0,0\}-\max\{p-p_0,0\})dF(x)$$
$$\leq\int_{x_L}^{p}(\max\{x-p_0,0\}-\max\{x-p_0,0\})dF(x)=0,$$

therefore V_{II} decreases in τ (strictly if and only if $p_0 < p$; otherwise, V_{II} is independent of τ).

A.3 Proof of Lemma 3

Part (i): Since $V_I \leq V_{II}$, the responder prefers to trade uninformed over no trade (Observation 1). Moreover, $V_I \leq \gamma$ implies that the responder prefers to trade uninformed over information acquisition.

Part (ii): With $V_I > \gamma$, the responder prefers information acquisition over trading uninformed. Moreover, the responder's expected gain from information acquisition compared to his outside option is $V_{II} - \gamma \geq 0$; hence, he can cover the information cost.

Part (iii): Since $V_{II} < V_I$, an uninformed responder does not trade (Observation1). Moreover, since $V_{II} < \gamma$, the gain from information acquisition is smaller than the cost, and the responder's optimal choice is his outside option (no information acquisition and no trade), irrespectively of whether $V_I > \gamma$ or not.

A.4 Proof of Proposition 1

At $\gamma = \underline{\gamma}$, the proposer is indifferent between inducing the responder to trade with probability one (without information acquisition) on one hand and information acquisition and trade according to q^* on the other hand.

Part (i): Suppose that $\gamma \geq V_I(\overline{p})$. With Definition 2(i) and the definitions of V_I and V_{II}, this implies that $V_I(\overline{p}) = V_{II}(\overline{p}) \leq \gamma$; hence, by Lemma 3(i), the responder trades without information acquisition. In fact, the responder's expected utility is the same as if he chooses not to participate; therefore, there is no other price that the proposer strictly prefers to $\overline{p}$ and where the responder still trades with probability one. Moreover, the proposer also strictly prefers $\overline{p}$ to p_{II} since, at p_{II}, there is trade with lower probability and, in addition, the responder has to be compensated for the cost of information (he must still get at least what he gets when choosing not to participate). This shows part (i).

Part (ii): Note first that $E_x[u_P(x, p_I, 1)]$ is continuous and increasing in γ. Continuity in γ follows from continuity of $u_P(x,p,1)$ in p and the definition of p_I. For monotonicity in γ, notice that $p_I \in \arg\max_p E_x[u_P(x, p_I, 1)]$ s.t. $V_I(p) \leq \gamma$ and that, at the optimal price p_I, the constraint $V_I(p) \leq \gamma$ must be binding. Hence, if p_I is charged and trade occurs with probability one, then an increase in the cost of information makes the proposer strictly better off. (Intuitively, the constraint $V_I(p) \leq \gamma$ is relaxed.)

By part (i), at $\gamma = V_I(\overline{p})$ the proposer strictly prefers an offer $\overline{p} = p_I$ over an offer p_{II}. By continuity and monotonicity of $E_x[u_P(x, p_I, 1)]$, there exists $\delta > 0$ such that the proposer strictly prefers p_I over p_{II} for all $\gamma \in (V_I(\overline{p}) - \delta, V_I(\overline{p})]$. Finally, if $\gamma < V_I(\overline{p})$ and the proposer offers $\overline{p}$, then the responder will acquire information; thus, by definition of p_{II}, the proposer (weakly) prefers p_{II} over $\overline{p}$. Altogether this shows part (ii).

Part (iii): First of all, if γ approaches zero, then the proposer cannot avoid information acquisition of the responder, and therefore the proposer's optimal choice will be p_{II}. (This requires, of course, that the proposer is willing to trade with an informed responder, i.e., it requires that the value of the proposer's outside option is sufficiently low such that $E_x[u_P(x, p_{II}, q^*(x, p_{II}))] \geq \overline{u}_P$.) Second, $E_x[u_P(x, p_{II}, q^*(x, p_{II}))]$ is (weakly) decreasing in γ: If p_{II} is the unconstrained optimum, i.e. $V_{II}(p_{II}) < \gamma$, then a marginal increase in γ does not affect p_{II} (because then the proposer's utility does not depend on γ). If, however, $V_{II}(p_{II}) = \gamma$, an increase in γ makes the proposer worse off. (Intuitively, the proposer must leave a higher share in the surplus to the responder in order to compensate him for the higher cost of information and to ensure that the responder does not choose his outside option $\overline{u}_R$.) Therefore, the monotonicity properties of $E_x[u_P(x, p_I, 1)]$ and $E_x[u_P(x, p_{II}, q^*(x, p_{II}))]$ imply there is a threshold $\underline{\gamma}$ such that the proposer offers p_{II} if and only if $\gamma < \underline{\gamma}$.

A.5 Proof of Lemma 4

Part (i): Consider first the effect on $\overline{p}$. By Definition 2(i), $V_I(\overline{p}) = V_{II}(\overline{p})$. If the buyer is the responder, then V_I is independent of τ (Lemma 1(i)). Since V_{II} is strictly decreasing in τ and in p (Lemma 2(i)), an increase in τ must be compensated by a decrease in p; thus, $\partial\overline{p}/\partial\tau < 0$. By a similar argument, since V_I is independent of τ and p_I is defined such that $V_I(p_I) = \gamma$ (Definition 2(ii)), we get $\partial p_I/\partial\tau = 0$.

Now consider the effect on p_{II}. Suppose first that the buyer's participation constraint is binding: $V_{II}(p_{II}) = \gamma$. Since V_{II} is strictly decreasing in τ, the seller must strictly lower the price p_{II} if τ is increased; otherwise, $V_{II} < \gamma$ and the buyer strictly prefers his outside option $\overline{u}_B = 0$ to information acquisition (Lemma 3(iii)). If the buyer's participation constraint does not bind (that is, $V_{II}(p_{II}) > \gamma$), a marginal increase in the profit tax τ has no effect on the price p_{II}; it does not affect the buyer's buying decision but only reduces the buyer's profit that results from his informational advantage. Altogether, this shows part (i).

Part (ii): Consider first the effect on $\overline{p}$ and suppose that $p_0 \leq x_L$. If the seller sells without information acquisition at price p, his profit is $(1-\tau)(p-p_0)$; if he does not sell, his expected profit is $(1-\tau)(E(x) - p_0)$ since there is a positive tax payment independently of the realization of x. Hence, $\overline{p} = E(x)$ and $\partial\overline{p}/\partial\tau = 0$. Now suppose that $x_L < p_0 < E(x)$ and the buyer still offers $p = E(x)$. Then, the seller's expected tax payment if he does not sell is

$$\tau\int_{p_0}^{x_H}(x - p_0)dF(x) > \tau\int_{x_L}^{x_H}(x - p_0)dF(x) = \tau(E(x) - p_0)$$

where the last term is the seller's tax payment if he sells at $p = E(x)$. Therefore, at $p = E(x)$, the seller strictly prefers to sell and the buyer can lower his offer such that $\overline{p} < E(x)$. (Intuitively, there is a "tax disadvantage" from not selling: The tax payment in case he sells at $p = E(x)$ is equal to a tax payment on a return x that includes a negative tax payment in case the return x turns out to be lower than p_0.) The same argument applies to the case of $E(x) \leq p_0 < x_H$ where the expected tax payment is strictly positive if the seller does not sell, but is zero if the seller sells at $p = E(x)$. Since the difference in the tax payment from not selling and selling is strictly increasing in τ, it holds that $\partial\overline{p}/\partial\tau < 0$ if $x_L < p_0 < x_H$.

Now turn to p_I. Since V_I is strictly decreasing in p and strictly decreasing in τ (Lemma 1), we have $\partial p_I/\partial\tau < 0$. Similarly, since V_{II} is strictly decreasing in τ and strictly increasing in p, we must have $\partial p_{II}/\partial\tau > 0$ if $V_{II}(p_{II}) = \gamma$ such that the seller's participation constraint binds. Otherwise, if $V_{II}(p_{II}) > \gamma$, then profit taxation reduces the seller's information rents but does not affect the price p_{II}, just as in the case where the buyer is the responder.

A.6 Proof of Proposition 2

Part (i) follows directly from Lemma 4. If the buyer is the responder and the price p_{II} decreases, then the probability of trade is increased (as an informed buyer trades if and only if $x > p$). If the seller is the responder and the price p_{II} increases, then again the probability of trade is increased (as an informed seller trades if and only if $x < p$). In both cases, an increase in the profit tax *strictly* increases the probability of trade if and only if $V_{II}(p_{II}) = \gamma$.

For part (ii), recall that, at $\gamma = \underline{\gamma}$, we have $E_x[u_P(x, p_I, 1)] = E_x[u_P(x, p_{II}, q^*(x, p_{II}))]$. Suppose first that the seller makes the offer. By Lemma 4(i), $\partial p_I/\partial\tau = 0$ and $\partial p_{II}/\partial\tau \leq 0$. Therefore, the seller's utility from charging p_I is not affected by an increase in τ, but his expected utility in the equilibrium candidate with information acquisition is (weakly) reduced because the price p_{II} decreases. (Since, in the equilibrium candidate with information acquisition, the seller could have charged a lower price already before the tax increase, lowering the price p_{II} must make him (weakly) worse off.) Therefore, at $\gamma = \underline{\gamma}$, the seller now (weakly) prefers p_I over p_{II}, which shifts the threshold $\underline{\gamma}$ to the left. If $\partial p_{II}/\partial\tau = 0$, then $\partial\underline{\gamma}/\partial\tau = 0$, and if $\partial p_{II}/\partial\tau < 0$, then $\partial\underline{\gamma}/\partial\tau < 0$.

Now suppose that the buyer makes the offer. By Lemma 4(ii), a marginal increase in τ leads to a reduction in p_I, which makes the buyer strictly better off (he still gets the asset with probability one but at a lower price). Moreover, a marginal increase in τ (weakly) increases p_{II}, which makes the buyer (weakly) worse off: He gets the asset with a higher probability but pays a higher price for it. Since the buyer could have offered this higher price already before the increase in τ, the price increase must reduce his profit. (Note that for prices p above p_{II}, an informed seller's participation constraint $E_x[u_S(x, p, q^*(x, p))] - \gamma \geq \overline{u}_S$ is still fulfilled.) The two effects of an increase in τ on p_I and p_{II} directly imply that, at $\gamma = \underline{\gamma}$, the buyer now strictly prefers p_I over p_{II}. Therefore, $\underline{\gamma}$ shifts to the left if τ is increased: $\partial\underline{\gamma}/\partial\tau < 0$.

A.7 Proof of Lemma 5

Part (i): Since, by definition, the sales tax has to be paid by the buyer, the relevant price for the buyer is the tax-inclusive price $p+\kappa$. At $\overline{p}$, it holds that $E_x[u_B(x, \overline{p}, 1) = 0$. Thus, if κ is increased, the net-of-tax price $\overline{p}$ must be lowered by exactly the same amount such that the tax-inclusive price remains unchanged: $\partial(\overline{p} + \kappa)/\partial\kappa = 0$. By definition of p_I, the same arguments shows that $\partial(p_I+\kappa)/\partial\kappa = 0$.

Regarding p_{II}, recall that V_{II} is strictly decreasing in κ (Lemma 2(i)). Therefore, if the buyer's participation constraint is binding at p_{II} ($V_{II}(p_{II}) = \gamma$) and κ is increased, then again p_{II} must be lowered by the same amount such that $\partial(p_{II}+\kappa)/\partial\kappa = 0$. Now suppose instead that the buyer's participation constraint is not binding ($V_{II}(p_{II}) > \gamma$). Then, p_{II} is the solution to the first order condition $\partial E_x[u_S(x,p,q^*(x,p))/\partial p = 0$; hence, p_{II} solves

$$\left(v_S\left(p_{II}+\kappa\right)-p_{II}\right)F'\left(p_{II}+\kappa\right)+1-F\left(p_{II}+\kappa\right)=0.$$

With $\partial(p_{II}+\kappa)/\partial\kappa = \partial p_{II}/\partial\kappa + 1$, total differentiation yields

$$\begin{aligned}\frac{\partial\left(p_{II}+\kappa\right)}{\partial\kappa}&=-\frac{\left(v_S'\left(p_{II}+\kappa\right)-1\right)F'\left(p_{II}+\kappa\right)+\left(v_S\left(p_{II}+\kappa\right)-p_{II}\right)F''\left(p_{II}+\kappa\right)}{\left(v_S'\left(p_{II}+\kappa\right)-2\right)F'\left(p_{II}+\kappa\right)+\left(v_S\left(p_{II}+\kappa\right)-p_{II}\right)F''\left(p_{II}+\kappa\right)}+1\\&=-\frac{F'\left(p_{II}+\kappa\right)}{\partial^2E_x[u_S(x,p,q^*(x,p))]/\partial p^2\ |_{p=p_{II}}}>0.\end{aligned}$$

Therefore, a marginal increase in κ strictly increases the tax-inclusive price $p_{II}+\kappa$ if the buyer's participation constraint is not binding.[36] It is worth mentioning that this result is robust to the case of an ad valorem sales tax (where the tax-inclusive price equals $(1+\kappa)p$).[37]

Part (ii): Since the seller's decision whether to trade is based only on the net-of-tax price p, it follows directly that $\overline{p}$ and p_I are independent of κ. Moreover, if for a price p_{II} the seller's participation constraint is binding such that $V_{II}(p_{II}) = \gamma$, then $\partial V_{II}/\partial\kappa = 0$ (Lemma 2(ii)) implies that $\partial p_{II}/\partial\kappa = 0$. (Even if the buyer wants to shift part of the tax increase to the seller by lowering his offer, this is not possible because then the seller would prefer his outside option of no trade.)

If instead $V_{II}(p_{II}) > \gamma$, then p_{II} solves the first order condition

$$\frac{\partial}{\partial p}E_x\left[u_B\left(x,p,q^*(x,p)\right)\right]=\left(v_B(p)-(p+\kappa)\right)F'(p)-F(p)=0.$$

Total differentiation yields

$$\frac{\partial p_{II}}{\partial\kappa}=-\frac{-F'(\kappa)}{\left.\frac{\partial^2}{\partial p^2}E_x\left[u_B\left(x,p,q^*(x,p)\right)\right]\right|_{p=p_{II}}}<0.$$

Again, this result on the sales tax does not qualitatively depend on the sales tax being a per unit tax; if instead we consider an ad valorem sales tax κ, which raises the buyer's price from p to $(1+\kappa)p$, then, by total differentiating, we also obtain $\partial p_{II}/\partial\kappa < 0$ if the seller's participation constraint is not binding.

---

[36] Note that, for the net-of-tax price, it is not obvious whether $\partial p_{II}/\partial\kappa$ is positive or negative. If, for instance, F is a uniform distribution and $v_S(x) = 0$ (the seller derives no value from holding the asset), then $\partial p_{II}/\partial\kappa = -0.5$: The seller shifts 50% of the tax increase to the buyer and reduces the net-of-tax price by the remaining amount.

[37] For an ad valorem sales tax, we obtain, $\partial((1+\kappa)p_{II})/\partial\kappa = -v_S((1+\kappa)p_{II})F'((1+\kappa)p_{II})/(\partial^2E_x[u_S(x,p,q^*(x,p))]/\partial p^2)$ which is strictly positive unless $v_S(x) = 0$. The latter case is a special case in which the optimal tax-inclusive price $z = (1+\kappa)p_{II}$ is independent of κ.

A.8 Proof of Proposition 3

Part (i): By Lemma 5(i), if the seller makes the offer, the tax-inclusive price is increasing in κ, which reduces the probability that an informed buyer buys. By Lemma 5(ii), if the buyer makes the offer, the net-of-tax price is decreasing in κ, which again leads to less trade. In both cases, the probability of trade is *strictly* reduced if and only if the responder's participation constraint does not bind ($V_{II}(p_{II}) > \gamma$).

Part (ii): Suppose first that the seller is the proposer. From Lemma 5(i), $\partial(p_I+\kappa)/\partial\kappa = 0$ and $\partial(p_{II}+\kappa)/\partial\kappa \geq 0$. Since $u_S(x,p_I,1) = p_I$, we get

$$\partial u_S(x, p_I, 1)/\partial\kappa = \partial p_I/\partial\kappa = \partial(p_I+\kappa)/\partial\kappa - 1 = -1.$$

Regarding the candidate price p_{II}, notice that

$$E_x\left[u_S\left(x, p_{II}, q^*(x, p_{II})\right)\right] = \int_{x_L}^{p_{II}+\kappa} v_S(x)dF(x) + \int_{p_{II}+\kappa}^{x_H} p_{II}dF(x).$$

Suppose first that $\partial(p_{II}+\kappa)/\partial\kappa = 0$. Then,

$$\partial E_x\left[u_S\left(x, p_{II}, q^*(x, p_{II})\right)\right]/\partial\kappa = \left(1 - F(p_{II}+\kappa)\right)\left(\partial p_{II}/\partial\kappa\right) = -\left(1 - F(p_{II}+\kappa)\right).$$

Thus, the seller's profit from charging p_{II} decreases by less than his profit from charging p_I, and $\underline{\gamma}$ shifts to the right if κ is increased ($\partial\underline{\gamma}/\partial\kappa > 0$). Now suppose that $\partial(p_{II}+\kappa)/\partial\kappa > 0$. If the equilibrium candidate price $p_{II}+\kappa$ is increased following a tax increase, the seller must be strictly better off than if he had not changed the price (which would have been possible; lower prices would not violate the buyer's participation constraint). But as shown before, even if $p_{II}+\kappa$ remained unchanged, the seller would, at $\gamma = \underline{\gamma}$, strictly prefer p_{II} over p_I. Therefore, this must still hold true if the seller adjusts the price p_{II} such that $\partial(p_{II}+\kappa)/\partial\kappa > 0$. Hence, again we get $\partial\underline{\gamma}/\partial\kappa > 0$.[38]

If the buyer is the proposer, indifference of the buyer as the proposer at $\gamma = \underline{\gamma}$ implies that

$$E[v_B(x)] - (p_I+\kappa) = \int_{x_L}^{p_{II}} \left(v_B(x) - (p_{II}+\kappa)\right)dF(x).$$

By Lemma 5(ii), a marginal increase in κ has no effect on p_I but increases the buyer's tax burden. The marginal change in the buyer's profit is −1 (which can be obtained by deriving the left hand side in the above equality with respect to κ). Again by Lemma 5(ii), if the seller's participation constraint is binding, a marginal increase does not have any effect on p_{II} either; however, the buyer faces a higher tax burden only with probability $F(p_{II})$ (in case he buys).[39] Therefore, the marginal change in the buyer's profit when

[38] Qualitatively the same result holds for an ad valorem sales tax: Due to the same comparative statics effects for p_I and p_{II} as in Lemma 5 (unless $v_S(x) = 0$ for all $x < (1+\kappa)p_{II}$ in the case where the seller is the proposer), similar arguments as in the proof of Proposition 3 can be applied for an ad valorem sales tax.

[39] In case of a per unit sales tax, the change in the tax burden does not depend on the price. For an ad valorem sales tax, this is no longer true; here, however, the argument becomes even stronger: Since it holds that $p_{II} < p_I$ (the buyer

offering p_{II} is equal to $-F(p_{II}) > -1$. Moreover, if the seller's participation constraint is not binding, it holds that $\partial p_{II}/\partial\kappa < 0$. The first order effect of this marginal change in the optimal price p_{II}, however, is equal to zero, and again the marginal change in the buyer's profit when offering p_{II} is equal to $-F(p_{II}) > -1$. (This can easily be verified by deriving the right hand side of the above equation with respect to κ, taking into account that, if p_{II} is the unconstraint maximum, we must have $\partial E_x[u_B(x,p_{II},q^*(x,p_{II}))]/\partial p_{II} = 0$.) Since the buyer's expected profit from offering p_I is reduced more strongly than his expected profit from offering p_{II}, the buyer now strictly prefers p_{II} over p_I if $\gamma = \underline{\gamma}$. Hence, $\partial\underline{\gamma}/\partial\kappa > 0$.

REFERENCES

ACHARYA, Viral V., PEDERSEN, Lasse Heje, PHILIPPON, Thomas, RICHARDSON, Matthew P., 2010. Measuring Systemic Risk. FRB of Cleveland Working Paper No. 10-02.

ANDERSON, Fredrik, 1996. Income taxation and job-market signaling. Journal of Public Economics 59, 277-298.

ARNOTT, Richard, STIGLITZ, Joseph E., 1986. Moral hazard and optimal commodity taxation. Journal of Public Economics 29, 1-24.

BANERJEE, Anindya, BESLEY, Timothy, 1990. Moral hazard, limited liability and taxation: a principal-agent model. Oxford Economic Papers 42(1), 46-60.

BANK OF CANADA 2012. Improving the resilience of core funding markets. Working paper.

BIERBRAUER, Felix, 2012. On the incidence of a financial transaction tax in a model with fire sales. CESifo Working Paper Series No. 3870.

CHEUNG, Francis K., 1998. Excise taxes on a non-uniform pricing monopoly: ad valorem and unit taxes compared. Canadian Journal of Economics 31(5), 1192-1203.

CRÉMER, Jacques, KHALIL, Fahad, 1992. Gathering information before signing a contract. American Economic Review 82(3), 566-578.

CRÉMER, Jacques, KHALIL, Fahad, ROCHET, Jean-Charles, 1998. Strategic information gathering before a contract is offered. Journal of Economic Theory 81(1), 163-200.

DANG, Tri Vi, 2008. Bargaining with endogenous information. Journal of Economic Theory 140, 339-354.

DANG, Tri Vi, GORTON, Gary, HOLMSTRÖM, Bengt, 2013a. The information sensitivity of a security. Working Paper.

DANG, Tri Vi, GORTON, Gary, HOLMSTRÖM, Bengt, 2013b. Ignorance, debt, and financial crises. Working Paper.

DARVAS, Zsolt, VON WEIZSÄCKER, Jakob, 2010. Financial-transaction tax: Small is beautiful. Bruegel Policy Contribution Issue 2010/02.

DÁVILA, Eduardo, 2013. Optimal financial transaction taxes. Working Paper.

offers a lower price when buying from an informed seller who only sells in low payoff states), the increase in the tax-inclusive price for a given increase in the ad valorem sales tax is lower if the buyer offers p_{II}.

DEUTSCHE BANK, 2012. Capital market bank funding. DB Research August.

DOMAR, Evsey D., MUSGRAVE, Richard A., 1944. Proportional income taxation and risk-taking. Quarterly Journal of Economics 58(3), 388-422.

DUFFIE, Darrell, 2014. Challenges to a policy treatment of speculative trading motivated by differences in beliefs. Journal of Legal Studies, forthcoming.

EUROPEAN CENTRAL BANK AND BANK OF ENGLAND, 2014. The Impaired EU Securitization Market: Causes, Roadblocks And How To Deal With Them. (http://www.bankofengland.co.uk/publications/Documents/news/2014/paper070.pdf)

EUROPEAN COMMISSION, 2013. Proposal for a COUNCIL DIRECTIVE implementing enhanced cooperation in the area of financial transaction tax. (http://ec.europa.eu/taxation_customs/resources/documents/taxation/com_2013_71_en.pdf)

FEDERAL HOUSING FINANCE AGENCY (FHFA), 2008. Statement of the Honorable James B. Lockhart III. Before the House Committee on Financial Services on the Conservatorship of Fannie Mae and Freddie Mac on 9/25/2008.

FULLERTON, Don, METCALF, Gilbert E., 2002. Tax incidence. Handbook of Public Economics, Volume 4, Chapter 26, 1787-1872.

GINSBURGH, Victor, LEGROS, Patrick, SAHUGUET, Nicolas, 2010. On the incidence of commissions in auction markets. International Journal of Industrial Organization 28, 639-644.

GOERKE, Laszlo, 2011. Commodity tax structure under uncertainty in a perfectly competitive market. Journal of Economics 103, 203-219.

GORTON, Gary, METRICK, Andrew, 2012. Securitized banking and the run on repo. Journal of Financial Economics 104(3), 425-451.

GROSSMAN, Sanford J., STIGLITZ, Joseph E., 1980. On the impossibility of informationally efficient markets. American Economic Review 70(3), 393-408.

HERNANDO-VECIANA, Ángel, 2009. Information acquisition in auctions: sealed bids vs. open bids. Games and Economic Behavior 65(2), 372-405.

IRELAND, Norman J., 1994. On limiting the market for status signals. Journal of Public Economics 53, 91-110.

IMF, 2008. Stress in bank funding markets and implications for monetary policy. In International Monetary Funds: Global Financial Stability Report, Chapter 2.

IMF, 2010. A fair and substantial contribution by the financial sector: Final report for the G-20. (http://www.imf.org/external/np/g20/pdf/062710b.pdf)

JENSEN, Sissel, SCHJELDERUP, Guttorm, 2011. Indirect taxation and tax incidence under nonlinear pricing. International Tax and Public Finance 18, 519-532.

KAPLOW, Louis, 1992. Income tax deductions for losses as insurance. American Economic Review 82(4), 1013-1017.

KEEN, Michael, 2011. The taxation and regulation of banks. IMF Working Paper 11/206.

KOTSOGIANNIS, Christos, SERFES, Konstantinos, 2014. The comparison of ad valorem and specific taxation under uncertainty. Journal of Public Economic Theory 16(1), 48-68.

KYLE, Albert S., 1985. Continuous auctions and insider trading. Econometrica 53(6), 1315-1335.

KYLE, Albert S., 1989. Informed speculation with imperfect competition. Review of Economic Studies 56(3), 317-355.

MATHESON, Thornton, 2011. Taxing financial transactions: issues and evidence. IMF Working Paper 11/54.

MCCULLOCH, Neil, PACILLO, Grazia, 2011. The Tobin tax: A review of the evidence. IDS Research Report 68, Institute of Development Studies, University of Sussex.

MCKINSEY, 2013. Between deluge and drought: The divided future of European bank funding markets. McKinsey Working Papers on Risk, No.41.

MORATH, Florian, MÜNSTER, Johannes, 2013. Information acquisition in conflicts. Economic Theory 54(1), 99-129.

PERSICO, Nicola, 2000. Information acquisition in auctions. Econometrica 68(1), 135-148.

ROSS, Stephen A., 1989. Commentary: Using tax policy to curb speculative short-term trading. Journal of Financial Services Research 3, 117-120.

SANDMO, Agnar, 1985. The effects of taxation on savings and risk taking. Handbook of Public Economics, Volume 1, Chapter 5, 265-311.

SENATE BANKING COMMITTEE, 2014. Summary of Senate Banking Committee Leaders'

Bipartisan Housing Finance Reform Draft.

SHACKELFORD, Douglas A., SHAVIRO, Daniel N., SLEMROD, Joel, 2010. Taxation and the financial sector. National Tax Journal 63(4), 781-806.

SIFMA, 2012. Security Industry and Financial Market Association, Quarterly Reports.

STIGLITZ, Joseph E., 1969. The effects of income, wealth, and capital gains taxation on risk-taking. Quarterly Journal of Economics 83, 263-283.

STIGLITZ, Joseph E., 1989. Using tax policy to curb speculative short-term trading. Journal of Financial Services Research 3(2-3), 101-115.

SUMMERS, Lawrence H., SUMMERS, Victoria P., 1989. When financial markets work too well: a cautious case for a securities transactions tax. Journal of Financial Services Research 3(2-3), 261-286.

TOBIN, James, 1978. A proposal for international monetary reform. Eastern Economic Journal 4(3/4), 153-159.

VAYANOS, Dimitri, WANG, Jiang, 2013. Market liquidity - Theory and empirical evidence. In: Handbook of the Economics of Finance, Volume 2, Chapter 19, 1289-1361.

VICKERY, JAMES AND JOSHUA WRIGHT, 2013. TBA Trading and Liquidity in the Agency MBS Market. FRBNY Policy Review May, 1-18.