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## Cross-border or Online - Tax Competition with Mobile Consumers under Destination and Origin Principle

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# Cross-border or Online – Tax Competition with Mobile Consumers under Destination and Origin Principle

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## Abstract

This paper studies the effect of an online retailer on spatial tax competition with mobile consumers. If taxation for online purchases follows the destination principle, in many cases, the entry of the online retailer mitigates tax competition. If taxation for online purchases follows the origin principle, the entry of the online retailer typically enhances tax competition. Cooperation between government reverses this effect. For sufficiently low (high) online shopping costs, welfare in the online retailer's home country is higher under the origin (destination) principle, while welfare in the other country is higher under the destination (origin) principle. Global welfare is higher under the destination principle.

JEL Classification: F12, H20, L13

Keywords: tax competition, cross-border shopping, online retailer, destination principle, origin principle

## 1 Introduction

Tax differentials may motivate consumers to disregard buying at local retailers, but instead to shop at retailers in neighboring jurisdictions or online retailers. For tax revenue maximizing governments attracting cross-border or online shoppers may also be a goal in tax policy.

In the European Union, cross border shopping is a frequent phenomenon, with the single market and the free movement of goods, capital, services, and persons weakening the importance of national borders. In 2008, 25% of consumers in the European Union have purchased goods or services in other member states (Eurostat, 2009). The extent of cross-border shopping is determined by country size, geographical location, and the close proximity of neighboring

countries.<sup>1</sup> With the growth of internet use, online shopping has also become more important (European Commission, 2010). In 2014, 50% of citizens in the European Union have made purchases online (European Commission, 2015).<sup>2</sup>

At the same time, autonomous decisions of member states on tax policy may give rise to tax competition. Member states are free to set value added tax rates with a minimum standard tax rate of 15% (Art. 97 Directive 2006/112/EC). Tax rates vary between high tax countries such as Hungary (27%), Denmark (25%), Sweden (25%), and Romania (24%) and low tax countries such as Luxembourg (15%), Cyprus (18%), Malta (18%), and Germany (19%).

The impact of tax competition on tax rates depends heavily on tax treatment of cross-border transactions. Two main principles can be distinguished: the origin principle and the destination principle. Under the origin principle, the tax rate of the origin country applies, under the destination principle, the tax rate of the destination country applies. While under the origin principle, tax competition occurs, tax competition is neutralized under the destination principle.

For cross-border shopping within the EU, the origin principle applies (Art. 31 Directive 2006/112/EC). For online purchases, also the origin principle applies (Art. 32 Directive 2006/112/EC), unless the recipient is a private household. In this case, the destination principle applies (Art. 33 Directive 2006/112/EC). If sales are below a threshold of 100,000 Euros, the origin principle may apply (Art. 34 Directive 2006/112/EC). This is, for the majority of online purchases by private households, the destination principle applies. In general, for the supply of services to private households, the origin principle applies (Art. 45 Directive 2006/112/EC). For electronic services such as telecommunications services, broadcasting services, supply of software, supply of music, films and games, and distance teaching, however, the taxation principle has changed and the destination principle applies since January 2015 (Art. 5 Directive 2008/8/EC, Art. 58 and Annex II Directive 2006/112/EC). According to European Commission (2014), the 2008-amendment implies that "the advantage for companies to relocate [...] [to member states with a low VAT] for tax reasons is removed". Especially Luxembourg with a

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<sup>1</sup>68 % of consumers in Luxembourg have purchased purchase goods or service in other member states. In contrast, in countries at the European periphery the prevalence of cross-border shopping is much lower, e.g. 10 % of consumers in Greece and 9 % of consumers in Portugal and Bulgaria have purchased goods abroad (Eurostat, 2009).

<sup>2</sup>Consumers show a substantial degree of home bias for online shopping: In 2014, 44% of consumers purchased online nationally, only 15% bought from an online retailer from another EU country (European Commission, 2015). Cowgill, Dorobantu & Martens (2013) estimate from Google e-commerce data that over the period 2008-2011, online consumers in the EU were up to 55 times more likely to buy in their own country than in another EU country. Consumers from smaller countries are more likely to purchase from retailers from other member states, e.g. 42% of consumers in Malta have purchased from an online retailer from another country vs. 11% who purchased from a domestic online seller (Flash Eurobarometer 358, 2012).

very low standard tax rate of 15% might lose its attractiveness for companies such as Amazon, Skype, and PayPal. It is estimated that this new rule will result in a loss of tax revenues of € 200 million per year for Luxembourg (Castle, 2007).

In the USA, most states levy sales taxes, but there is no uniform sales tax on the federal level. With regard to interstate e-commerce, whether the tax is levied automatically at destination countries depends on whether the exporting firm has a physical presence in the destination state. If this is not the case (as in many cases), the tax authorities depend on the tax declaration by users for (“use tax”) (Hu & Tang, 2014). This may create a substantial tax differential between buying at home in a brick and mortar shop or at an online shop in another state. Agrawal (2017) shows that in the US, an increase of online sales decreases local tax rates, with a larger effect for states with relatively low tax rates than for states with high tax rates. Currently, there is a lively discussion about the so-called Federal Marketplace Fairness Act, that would enable the states to collect sales taxes on remote sales (PricewaterhouseCoopers, 2015).

Previous literature on tax competition and cross-border shopping has emphasized the importance of differences between countries (see e.g. Kanbur & Keen, 1993; Nielsen, 2001), typically finding that the smaller country undercuts the tax rate of the larger country. In their seminal paper, Kanbur & Keen (1993) study revenue-maximizing governments in an open economy with two countries differing in population size. In the non-cooperative Nash equilibrium, the tax rate of the smaller country is lower than the tax rate in the larger country. Subsequent studies have also focused on differences between countries, in population size (Trandel 1994; Wang 1999) or geographical size (Ohsawa 1999; Nielsen 2001, 2002)<sup>3</sup>.

The literature on tax competition when consumers are able to shop cross-border has regularly assumed that taxation follows the origin principle, e.g. Mintz & Tulkens (1986), Kanbur & Keen (1993), and Nielsen (2001). Keen & Lahiri (1998) compare commodity taxation under the destination and origin principle under imperfect competition. They find that for non-cooperatively set tax rates, the Cournot equilibrium under the origin principle is potentially Pareto-superior to the equilibrium under the destination principle. Comparing destination and origin principle in a framework with possible tax spillovers, Lockwood (2001) finds that welfare is higher under the destination principle, unless there are producer price or rent spillovers.

Several empirical studies have analyzed the effect of taxes on the shopping decision. Goolsbee

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<sup>3</sup>See Leal, Lopez-Laborda & Rodrigo (2010) for a survey on theoretical and empirical studies on cross-border shopping.

(2000) finds that consumers in high sales tax locations are more likely to buy online. A 1%-increase in the sales tax increases the probability of buying online by 0.5%. Ballard and Lee (2007) show that consumers shop online to avoid sales taxes. They also find that consumers who live close to counties with lower sales tax rates are less likely to shop online.<sup>4</sup> Using eBay data, Einav et al. (2014) estimate the impact of sales taxes on online shopping. They find that a one percentage point increase in a state's sales tax increases online purchases by state residents by approximately 2 percent, but decreases their online purchases from home-state retailers by 3-4 percent. Using data from a retailer that sells through the internet and catalogs, Hu & Tang (2014) study the effect of sales tax changes, finding that a tax cut by 4 percentage points has decreased remote sales by about 15%.

The effect of online shopping on tax competition under the origin principle and the destination principle has recently gained some attention in the literature. Bacache Beauvallet (2017) studies the effect of cross border online shopping on tax competition. She shows that online shopping reduces tax competition under the origin principle. In contrast, this paper shows that cross-border online shopping under the origin principle enhances tax competition, while in many cases the destination principle applies. Under the destination principle, however, cross-border online-shopping mitigates tax competition. Although there seems to be a consensus on the effects of both principles for cross-border transactions, some open questions remain for online transactions.

Introducing an online retailer à la Lijesen (2013) into a framework of spatial tax competition, this paper studies the effect of an online retailer on spatial tax competition with mobile consumers. If taxation for online purchases follows the destination principle, the entry of the online retailer mitigates tax competition; if taxation for online purchases follows the origin principle, the entry of the online retailer enhances tax competition. Cooperation between government reverses this effect.

For sufficiently low online shopping costs, welfare in the online retailer's home country is higher under the origin principle, while welfare in the other country is higher under the destination principle. For sufficiently high online shopping costs, this is reversed and welfare in the online retailer's home country is higher under the destination principle, while welfare in the other country is higher under the origin principle. Total welfare is higher under the destination

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<sup>4</sup>Leal, Lopez-Laborda & Rodrigo (2010) interpret these findings as cross-border shopping and Internet shopping being substitutes.

principle.

The rest of the paper is organized as follows. In the next section, the model is presented. The effect of the entry of the online retailer on tax competition and welfare is analyzed in Section 3. Section 4 studies changes in the access to and cost of online shopping. Section 5 explores the role of governments. Section 6 discusses the role of governments, location decisions, and market structure. Section 7 concludes.

## 2 The Model

Consider a Hotelling economy with two countries,  $j = H, F$  (home, foreign) on the line segment  $[0, 1]$ , with country  $H$  extending to the interval  $[0, \frac{1}{2}]$ , country  $F$  to the interval  $[\frac{1}{2}, 1]$ . In each country, there is a brick-and-mortar shop  $i = H, F$  located at the endpoint ( $x_H = 0$ ,  $x_F = 1$ ). An online shop  $i = 0$  is located in country  $H$ . I discuss the case of perfect competition in section 6. Firms sell a single homogeneous product at price  $p_i$ .

### 2.1 Consumers

A unit mass of consumers is uniformly distributed on the line segment. Consumers differ in location  $y \in [0, 1]$ . The utility of a consumer located at  $i$  and buying from the brick-and-mortar store in country  $i$  is given by

$$U_i = v - d|y - x_i| - p_i, \quad (1)$$

where  $v$  denotes the value of the product and  $d$  is transportation cost per unit of distance travelled.<sup>5</sup> The utility of a consumer buying online is given by

$$U_0 = v - \theta - p_0, \quad (2)$$

where  $\theta$  denotes fixed cost of buying online. This can be interpreted as the cost of going online, delivery cost, inconvenience of waiting for the parcel service or the opportunity cost of non-immediate availability of the good purchased online<sup>6</sup>. I discuss the assumption of fixed cost versus location dependent cost of online shopping in section 6. I study the case of not all consumers having access to the internet and thus being able to buy at the online retailer in

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<sup>5</sup> Assume that  $v$  is sufficiently large so that the market is covered.

<sup>6</sup> Country-specific fixed cost, as for example shipping cost depending on the consumer's place of residence, would introduce an asymmetry between countries, but would yield qualitatively similar results.

section 4.

If the online retailer is not active<sup>7</sup>, there is a consumer indifferent between buying at the brick-and-mortar store in country  $H$  and the brick-and-mortar store in country  $F$  located at  $y_{HF}^* = \frac{1}{2} + \frac{p_F^* - p_H^*}{2d}$ .

If the online retailer is active, there is a consumer indifferent between buying from the brick-and-mortar store in country  $H$  and at the online retailer, located at  $y_{H0} = \frac{\theta + p_0 - p_H}{d}$ ; and there is a consumer indifferent between buying from the brick-and-mortar store in country  $F$  and at the online retailer, located at  $y_{0F} = \frac{d - \theta - p_0 + p_F}{d}$ .

## 2.2 Firms

If the online retailer is not active, demand for both firms is

$$q_H^* = y_{HF}^*, q_F^* = 1 - y_{HF}^* \quad (3)$$

and firms' profits are

$$\pi_H^* = (p_H^* - \tau_H^*) q_H^*, \pi_F^* = (p_F^* - \tau_F^*) q_F^*. \quad (4)$$

If the online retailer is active, demand for both firms is given as

$$q_H = y_{H0}, q_F = 1 - y_{0F}, q_0 = y_{0F} - y_{H0}. \quad (5)$$

If taxation follows the destination principle, firms' profits are given by

$$\pi_H^d = (p_H - \tau_H) q_H, \pi_F^d = (p_F - \tau_F) q_F, \pi_0^d = (p_0 - \tau_H) \left( \frac{1}{2} - y_{H0} \right) + (p_0 - \tau_F) \left( y_{0F} - \frac{1}{2} \right). \quad (6)$$

If taxation follows the origin principle, firms' profits are given by

$$\pi_H^o = (p_H - \tau_H) q_H, \pi_F^o = (p_F - \tau_F) q_F, \pi_0^o = (p_0 - \tau_H) q_0. \quad (7)$$

## 2.3 Governments

In each country, there is a single revenue-maximizing government, imposing a unit tax at rate  $\tau_j$ . I discuss the role of governments in section 5.

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<sup>7</sup>An asterisk is used to denote variables associated with the offline equilibrium.

If the online retailer is not active, tax revenue is

$$R_H^* = \tau_H^* q_H^*, R_F^* = \tau_F^* q_F^*.$$

If the online retailer is active and taxation follows the destination principle, tax revenue is

$$R_H^d = \tau_H \left( q_H + \left( \frac{1}{2} - y_{H0} \right) \right), R_F^d = \tau_F \left( q_F + \left( y_{0F} - \frac{1}{2} \right) \right).$$

If taxation follows the origin principle, tax revenue is

$$R_H^o = \tau_H (q_H + q_0), R_F^o = \tau_F (q_F).$$

The structure of the model can be summarized by the following two-stage game: In the first stage, governments set tax rates, in the second stage firms compete in prices.

### 3 The Effect of the Online Retailer On Tax Competition

#### 3.1 Offline Equilibrium

Consider first the case without the online retailer, depicted in Figure 1. Consumers buy from brick-and-mortar stores only. Cross-border shopping takes place. Throughout the paper, it is assumed that cross-border is tax treated according to the origin principle.

Prices and quantities can be found in the Appendix A.1.

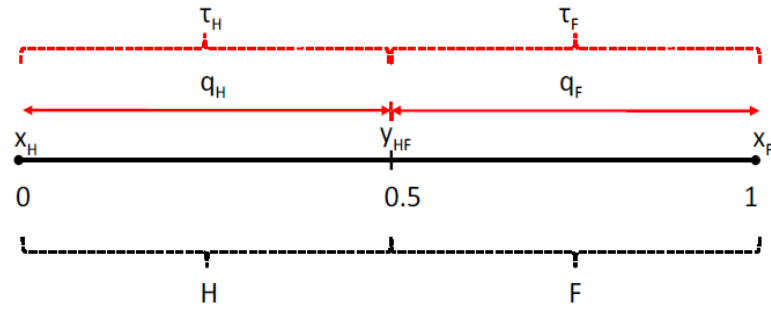


Figure 1: Offline Equilibrium.

In equilibrium, tax rates and revenues, respectively, are

$$\tau_H^* = \tau_F^* = 3d \tag{8}$$



and

$$R_H^* = R_F^* = \frac{3}{2}d. \quad (9)$$

Tax rates and revenues increase in transportation cost  $d$ , as higher transportation cost makes consumers less mobile. The tax differential is zero ( $\Delta\tau^* = \tau_F^* - \tau_H^* = 0$ ).

### 3.2 Online Equilibrium under Destination Principle

Consider now the case with the online retailer. Assume first that online purchases are taxed according to the destination principle.<sup>8</sup> Purchases at the brick-and-mortar stores are tax treated according to the origin principle.

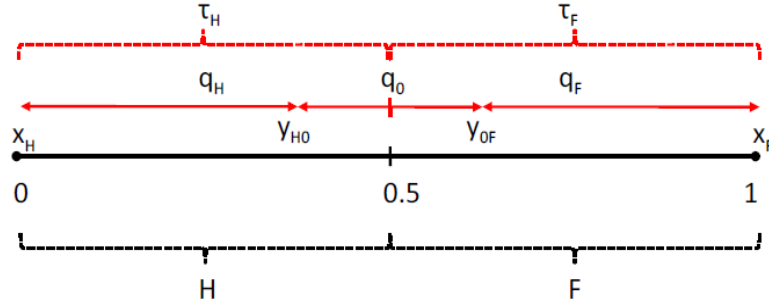


Figure 2: Online Equilibrium, Destination Principle.

For low cost of online shopping i.e.  $\theta < d$ , the online retailer is active. Then cross-border shopping does not take place. This equilibrium is illustrated in Figure 2. For  $\theta > d$ , the online retailer is not active and the equilibrium collapses to the case in 2.1.

Prices and quantities can be found in the Appendix A.1. Tax rates and revenues, respectively, are given as

$$\tau_H^d = \tau_F^d = v - \frac{1}{3}d - \frac{2}{3}\theta \quad (10)$$

and

$$R_H^d = R_F^d = \frac{1}{2} \left( v - \frac{1}{3}d - \frac{2}{3}\theta \right). \quad (11)$$

In this online equilibrium, tax rates and revenues are higher than in the offline equilibrium ( $\tau_H^d = \tau_F^d > \tau_H^* = \tau_F^*$ ,  $R_H^d = R_F^d > R_H^* = R_F^*$ ). The tax differential is zero ( $\Delta\tau^d = \tau_F^d - \tau_H^d = \Delta\tau^* = 0$ ). If online purchases are taxed according to the destination principle, the tax base is determined by geographical size. Thus, governments cannot shift the tax base internationally

<sup>8</sup>This is equivalent to the online retailer in the EU selling to private households and having revenues above the threshold of 100,000 Euros.

and increase tax revenue by lowering the tax rate. Accordingly, the entry of the online retailer eliminates Nash pressures in the first stage and mitigates tax competition. Consumers may choose where to buy, but not where to pay taxes. Hence, they cannot avoid high taxes. This equilibrium is qualitatively equivalent to the closed borders-equilibrium in Kanbur & Keen (1993).

Proposition 1 summarizes the effect of the entry of the online retailer on tax rates under the destination principle.

**Proposition 1** *Suppose that taxation for online purchases follows the destination principle and the online retailer is active ( $\theta < d$ ). Then i) tax rates and tax revenues are higher than in the offline equilibrium, and ii) the tax differential is zero.*

### 3.3 Online Equilibrium Under Origin Principle

Assume now that taxation for online purchases follows the origin principle.<sup>9</sup>

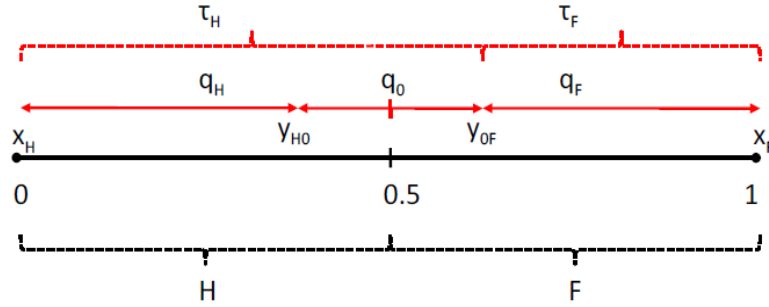


Figure 3: Online Equilibrium, Origin Principle.

For low cost of online shopping ( $\theta < \frac{1}{7}d$ ), the online retailer sells in both countries and cross-border shopping does not take place. This equilibrium is depicted in Figure 3. For intermediate cost of online shopping ( $\frac{1}{7}d < \theta < \frac{11}{23}d$ ), the online retailer sells only in country  $H$  and cross-border shopping takes place. For  $\theta > \frac{11}{23}d$ , the online retailer is not active and the equilibrium collapses to the case in 2.1.

Prices and quantities can be found in the Appendix A.1. Tax rates and revenues, respectively, are given as

$$\tau_H^o = \frac{22(d + 2\theta)}{15}, \tau_F^o = \frac{14(d + 2\theta)}{15} \quad (12)$$

<sup>9</sup>This is equivalent the online retailer in the EU selling to private households and having sales revenues below the threshold of 100.000 Euros.

and

$$R_H^o = \frac{11(11d - 14\theta)(d + 2\theta)}{135d}, R_F^o = \frac{49(d + 2\theta)^2}{135d} \quad (13)$$

Tax rates and revenue increase in gross valuation  $v$  and decrease in traveling cost  $d$  and fixed cost of buying online  $\theta$ . In this online equilibrium, tax rates and revenues are lower than in the offline equilibrium ( $\tau_H^o < \tau_H^*$ ,  $\tau_F^o < \tau_F^*$ ,  $R_H^o < R_H^*$ ,  $R_F^o < R_F^*$ ). The tax differential is negative ( $\Delta\tau^o = \tau_F^o - \tau_H^o < 0 = \Delta\tau^*$ ). This is, the entry of the online retailer enhances tax competition, with the country which does not host the online retailer undercutting the tax rate of the online retailer's home country.

Proposition 2 summarizes the effect of the entry of the online retailer on tax rates under the origin principle.

**Proposition 2** *Suppose that taxation for online purchases follows the origin principle and the online retailer is active ( $\theta < \frac{11}{23}d$ ). Then i) tax rates and tax revenues are lower than in the offline equilibrium, and ii) the tax differential is negative.*

### 3.4 Welfare Analysis

This subsection studies welfare in the two taxation regimes applying to sales of the online retailer. Welfare is defined as the sum of consumer surplus, firms' profits, and tax revenue.

In country  $H$ , the brick-and-mortar stores's and the online retailer's profits are higher under the destination principle ( $\pi_H^o < \pi_H^d$ ,  $\pi_0^o < \pi_0^d$ ). Tax revenues are higher under the destination principle if gross valuation of the product is sufficiently high ( $R_H^o < R_H^d$  if  $v > \widetilde{v}_H$ ). Consumer surplus in country  $H$  is higher under the origin principle if the gross valuation is sufficiently high ( $CS_H^o - CS_H^d < 0$  if  $v > \widetilde{v}_F$ ). This is, in country  $H$ , the brick-and-mortar store and the online retailer would prefer the destination principle, while the government and consumers would prefer the origin principle if gross valuation is sufficiently high, and they would prefer the origin principle otherwise.

In country  $F$ , the brick-and-mortar stores's profit is higher under the origin principle ( $\pi_F^o > \pi_F^d$ ). Tax revenues are higher under the destination principle ( $R_F^o < R_F^d$ ). Consumer surplus in country  $F$  is higher under the origin principle ( $CS_F^o > CS_F^d$ ). In country  $F$ , the brick-and-mortar store and consumers would prefer the origin principle, while the government would prefer the destination principle.

For  $\theta < \frac{173}{2084}d$ , welfare in country  $H$ , given as the sum of consumer surplus, firms' profits,

and tax revenue, is higher under the origin principle, while welfare in country  $F$  is higher under the destination principle. For  $\frac{173}{2084}d < \theta < \frac{19}{148}d$ , in both countries, welfare is higher under the destination principle. For  $\frac{19}{148}d < \theta$ , welfare in country  $H$  is higher under the destination principle, while welfare in country  $F$  is higher under the origin principle ( $W_H^o > W_H^d$  if  $\theta < \widetilde{\theta}_H = \frac{173}{2084}d$ ,  $W_F^o < W_F^d$ , if  $\theta < \widetilde{\theta}_F = \frac{19}{148}d$ ). Global welfare is higher under the destination principle ( $W^o < W^d$ ).

Proposition 3 summarizes the welfare effect of the two taxation principles.

**Proposition 3** *For  $\theta < \frac{173}{2084}d$  ( $\theta > \frac{173}{2084}d$ ) welfare in country  $H$  is higher under the origin (destination) principle. For  $\theta < \frac{19}{148}d$  ( $\theta > \frac{19}{148}d$ ) welfare in country  $F$  is higher under the destination (origin) principle. Global welfare is higher under the destination principle.*

## 4 Access to and Cost of Online Shopping

This section studies changes in the access to and cost of online shopping.

Competition in the second stage between the brick-and-mortar stores and the online retailer depends on the extent consumers regard the online shop as an alternative to the brick-and-mortar shops. A first precondition for the online retailer to be an alternative is consumers' access to the internet. The larger the share of internet users, the more intense is c.p. competition between brick-and-mortar-shops and the online retailer. A second precondition is reasonable low cost of online shopping compared to the cost of offline-shopping. The lower the cost of online-shopping, also the more intense is competition c.p. between the brick-and-mortar-shops.

Changes on the second stage of competition have an impact on the first stage of competition between governments. If the role of the online-retailer is limited, it has also limited impact on the competition between governments. If, however, competition between the online retailer and the brick-and mortar stores is more intense, it may increase or decrease the impact on competition on the first stage depending on the tax treatment.

The cost of online shopping has decreased over the last years. In the same time, access to the internet has increased. Studying the effect of limited access to the internet and of a decrease in the cost of online shopping allows to show how competition in both stages of the game has evolved in the EU over time.

## 4.1 Limited Access to Online Shopping

Assume that only a fraction  $\lambda \in (0, 1)$  of consumers has access to the internet and may purchase the online retailer. The remaining fraction  $1 - \lambda$  buys from brick-and-mortar stores only. Demand, firms' profits, and tax revenues as well as equilibrium prices, quantities, tax rates, and tax revenues can be found in Appendix A.2. Assume  $\theta < d \frac{\lambda+3}{2(\lambda+1)}$  for the online retailer being active in the market.

Consider first online purchases being tax treated according to the destination principle. Other than in the case with all consumers having access to online shopping (3.2) cross-border shopping takes place, as consumers without internet access may travel abroad for shopping. Tax rates and revenues are higher than in the offline equilibrium ( $\tau_H = \tau_F > \tau_H^* = \tau_F^*$ ,  $R_H = R_F > R_H^* = R_F^*$ ), but lower than in the equivalent equilibrium under full access to online shopping (3.2) ( $\tau_H^{d\lambda} - \tau_H^d < \tau_F^{d\lambda} - \tau_F^d$ ,  $R_H^{d\lambda} - R_H^d < R_F^{d\lambda} - R_F^d$ ). This implies that limited access to online shopping decreases the effect of the online retailer in mitigating tax competition.

Consider now online purchases being tax treated according to the origin principle. Tax rates and revenues are lower than in the offline equilibrium ( $\tau_H^{o,\lambda} < \tau_H^*$ ,  $\tau_F^{o,\lambda} < \tau_F^*$ ,  $R_H^{o,\lambda} < R_H^*$ ,  $R_F^{o,\lambda} < R_F^*$ ). In country  $H$ , tax rates and revenues are higher than in the equivalent equilibrium under full internet access, see 3.3 ( $\tau_H^{o,\lambda} > \tau_H^o$ ,  $R_H^{o,\lambda} > R_H^o$ ). In country  $F$ , tax rates and revenues are higher than in the equivalent equilibrium under full internet access if the cost of online shopping is sufficiently low ( $\tau_F^{o,\lambda} > \tau_F^o$  if  $\theta < \tilde{\theta}_\tau$ ,  $R_F^{o,\lambda} > R_F^o$  if  $\theta < \tilde{\theta}_R$ ). This implies that limited access to online shopping decreases the effect of the online retailer in enhancing tax competition.

Thus, an increase in the number of consumers with access to online shopping may come along with weaker or stronger tax competition depending on the tax treatment of online purchases.

Proposition 4 summarizes the effect of limited access to online shopping.

**Proposition 4** *Under the destination (origin) principle, limited access to online shopping decreases the anti-competitive (pro-competitive) effect of the online retailer on tax rates.*

## 4.2 Decrease in the Cost of Online Shopping

This section studies the effect of a decrease in the cost of online shopping  $\theta$ , e.g. due to improved logistics with faster delivery.

Consider first online purchases being tax treated according to the destination principle.

Lower cost of online shopping increases prices of the brick-and-mortar stores as well as the price of the online retailer ( $\frac{\partial p_H^d}{\partial \theta} = \frac{\partial p_F^d}{\partial \theta} < 0$ ,  $\frac{\partial p_0^d}{\partial \theta} < 0$ ). It shifts market shares from the brick-and-mortar stores to the online retailer ( $\frac{\partial q_H^d}{\partial \theta} = \frac{\partial q_F^d}{\partial \theta} > 0$ ,  $\frac{\partial q_0^d}{\partial \theta} < 0$ ). Lower cost of online shopping increases tax rates and tax revenues ( $\frac{\partial \tau_H^d}{\partial \theta} = \frac{\partial \tau_F^d}{\partial \theta} < 0$ ,  $\frac{\partial R_H^d}{\partial \theta} = \frac{\partial R_F^d}{\partial \theta} < 0$ ). This is, under the destination principle, lower cost of online shopping enhances the anti-competitive effect, which results from the entry of the online retailer.

Consider now online purchases being tax treated according to the origin principle. Lower cost of online shopping decreases prices at the brick-and-mortar stores as well as the price of the online retailer ( $\frac{\partial p_H^o}{\partial \theta} > 0$ ,  $\frac{\partial p_F^o}{\partial \theta} > 0$ ,  $\frac{\partial p_0^o}{\partial \theta} > 0$ ). It shifts market shares from the brick-and-mortar stores to the online retailer ( $\frac{\partial q_H^o}{\partial \theta} > 0$ ,  $\frac{\partial q_F^o}{\partial \theta} > 0$ ,  $\frac{\partial q_0^o}{\partial \theta} < 0$ ). Lower cost of online shopping decreases tax rates ( $\frac{\partial \tau_H^o}{\partial \theta} > 0$ ,  $\frac{\partial \tau_F^o}{\partial \theta} > 0$ ).

In country  $H$ , lower cost of online shopping decreases tax revenue if  $\theta < \frac{1}{7}d$ , i.e. the online retailer is selling in both countries, and increases tax revenues if  $\theta > \frac{1}{7}d$ , i.e. the online retailer is selling in country  $H$  only ( $\frac{\partial R_H^o}{\partial \theta} > 0$ , if  $\theta < \frac{1}{7}d$ ,  $\frac{\partial R_H^o}{\partial \theta} < 0$ , if  $\theta > \frac{1}{7}d$ ). In country  $F$ , lower cost of online shopping decreases tax revenue ( $\frac{\partial R_F^o}{\partial \theta} > 0$ ). This is, under the destination principle, lower cost of online shopping enhances the pro-competitive effect, which is caused by the entry of the online retailer.

This suggests that a decrease in the cost of online shopping may involve weaker or stronger tax competition depending on the tax treatment of online purchases.

Proposition 5 summarizes the effect of a decrease in the cost of online shopping.

**Proposition 5** *Under the destination (origin) principle, lower cost of online shopping enhances the anti-competitive (pro-competitive) effect of the online retailer on tax rates.*

## 5 The Role of Governments

This section discusses alternative role of governments. So far, this paper has assumed revenue-maximizing governments. The opposite case would be benevolent governments, while real-life governments are assumed to behave somewhere in between both extreme scenarios. Instead of competing against each other, governments could also cooperate maximizing joint benefits. In the EU, governments do not cooperate directly on tax rates, but follow harmonized principles and minimum tax rates (see 6.3).

## 5.1 Cooperative Leviathan Governments

Consider the case of governments cooperating in setting tax rates and maximizing joint revenue. Prices and quantities can be found in the Appendix A.3.

In the offline equilibrium, cooperatively set tax rates are given as

$$\tau_H^{*,C} = \tau_F^{*,C} = v - \frac{3}{2}d, \quad (14)$$

which are higher than under no cooperation ( $\tau_H^{*,C} = \tau_F^{*,C} > \tau_H^* = \tau_F^*$ ). Tax revenue is

$$R_H^{*,C} = R_F^{*,C} = \frac{1}{2} \left( v - \frac{3}{2}d \right), \quad (15)$$

which are higher than under no cooperation ( $R_H^{*,C} = R_F^{*,C} > R_H^* = R_F^*$ ).

Consider first the online retailer being active and online purchases being tax treated according to the destination principle. The equilibrium under the destination principle and cooperation is equivalent to the equilibrium under no cooperation described in 3.2. This is, there is no benefit of cooperation among governments if online purchases are taxed according to the destination principle.

Consider now the online retailer being active and online purchases being tax treated according to the origin principle. Cooperatively set tax rates are given as

$$\tau_H^{o,C} = \tau_F^{o,C} = v - \frac{1}{3}d - \frac{2}{3}\theta, \quad (16)$$

which are higher than under no cooperation ( $\tau_H^{o,C} = \tau_F^{o,C} > \tau_H^o = \tau_F^o$ ). Tax revenue is

$$R_H^{o,C} = R_F^{o,C} = \frac{1}{2} \left( v - \frac{1}{3}d - \frac{2}{3}\theta \right), \quad (17)$$

which is higher than under no cooperation ( $R_H^{o,C} > R_H^o, R_F^{o,C} > R_F^o$ ).

Under cooperation, the effect of the online retailer on tax competition is reversed: If online purchases are taxed according to the destination principle, the online retailer enhances tax competition; if online purchases are taxed according to the origin principle, the online retailer weakens tax competition.

Proposition 6 summarizes the effect of the cooperation between governments.

**Proposition 6** *Suppose that governments cooperate and maximize joint tax revenue. Under*

the destination (origin) principle, the online retailer enhances (weakens) tax competition.

## 5.2 Benevolent Governments

Consider now the case of non-cooperative governments setting tax rates to maximize welfare, given as the sum of consumer surplus, firms' profits, and tax revenue. Welfare as well as prices and quantities can be found in Appendix A.3.

In the offline equilibrium, welfare in country  $j$  is decreasing in the tax rate of country  $j$  and increasing in the tax rate in the tax of the other country ( $\frac{\partial W_j}{\partial \tau_j} < 0$ ,  $\frac{\partial W_j}{\partial \tau_{-j}} > 0$ ). This is, increasing the tax rate decreases welfare in the respective country and increases welfare in the other country. Equilibrium tax rates are

$$\tau_H^{*W} = \tau_F^{*W} = 0, \quad (18)$$

which are lower than revenue maximizing tax rates ( $\tau_H^{*W} = \tau_F^{*W} < \tau_H^* = \tau_F^*$ ).

Consider first the online retailer being active and online purchases being tax treated according to the destination principle. Welfare in country  $j$  is decreasing in the tax rate of country  $j$  and increasing in the tax rate in the tax of the other country ( $\frac{\partial W_j^d}{\partial \tau_j} < 0$ ,  $\frac{\partial W_j^d}{\partial \tau_{-j}} > 0$ ). In equilibrium, tax rates are

$$\tau_H^{W,d} = \tau_F^{W,d} = 0, \quad (19)$$

which are lower than revenue maximizing tax rates ( $\tau_H^{W,d} = \tau_F^{W,d} < \tau_H^d = \tau_F^d$ ).

Consider now the online retailer being active and online purchases being tax treated according to the origin principle. Equilibrium non-negative tax rates are

$$\tau_H^{W,o} = \frac{2(11d - 14\theta)}{101}, \tau_F^{W,o} = 0, \quad (20)$$

which are lower than under revenue-maximizing governments ( $\tau_H^{W,o} < \tau_H^o$ ,  $\tau_F^{W,o} < \tau_F^o$ ).

If governments maximize welfare (instead of tax revenue), the online retailer has no effect on tax competition.

Proposition 7 summarizes the effect of benevolent governments.

**Proposition 7** *Suppose that governments maximize welfare non-cooperatively. Then the online retailer has no effect on tax competition.*



## 6 Discussion

This section addresses assumptions of the model and their implications for the analysis.

### 6.1 Market Structure

So far, the model has assumed that the brick-and-mortar stores are local monopolies and that all three retailers have pricing power. This allows us to study the strategic interaction of firms. Assuming the opposite extreme, perfect competition would result in marginal cost pricing and effective consumer prices amounting to the (respective) tax rate. Under destination based taxation, this would imply that the online retailer charges an average price of the two tax rates or sets country-specific (and tax rate-specific) prices.

In the offline equilibrium, assuming perfect competition among brick-and-mortar stores yields tax rates

$$\tau_H^{*,comp} = \tau_F^{*,comp} = d, \quad (21)$$

which are lower than under market power.

In the online equilibrium under the destination principle, assuming perfect competition among online retailers and/or brick-and-mortar stores yields the same tax rates, i.e.

$$\tau_H^{d,comp} = \tau_F^{d,comp} = \tau_H^d = \tau_F^d = v - \frac{1}{3}d - \frac{2}{3}\theta. \quad (22)$$

In the online equilibrium under the origin principle, assuming perfect competition among online retailers and/or brick-and-mortar stores yields lower tax rates than under market power, i.e.

$$\tau_H^{o,comp,0} = \frac{(4d - \theta)}{3}, \tau_F^{o,comp,0} = \frac{(2d + \theta)}{3} \quad (23)$$

for competition among online retailers and

$$\tau_H^{o,comp,HF0} = \frac{2}{3}d - \frac{1}{3}\theta, \tau_F^{o,comp,HF0} = \frac{1}{3}d + \frac{1}{3}\theta \quad (24)$$

for competition among online retailers and brick-and-mortar stores. This is, assuming perfect competition yields qualitatively similar results. Under the destination principle, the entry of the online retailer mitigates tax competition and results in higher tax rates in the online equilibrium ( $\tau_H^{d,comp} > \tau_H^{*,comp} = \tau_F^{d,comp} > \tau_F^{*,comp}$ ). Under the origin principle, the entry of the

online retailer enforces tax competition and results in lower tax rates in the online equilibrium ( $\tau_H^{o,comp,HF0} < \tau_H^{*,comp}$ ,  $\tau_F^{o,comp,HF0} < \tau_F^{*,comp}$ ).

## 6.2 Location

This subsection discusses alternative assumptions with regard to the location of the online retailer and the brick-and-mortar stores.

Under the destination principle, taxation of the online-retailer is independent of its location. Thus, the location of the online retailer is irrelevant for tax competition. Under the origin principle, the online retailer can choose where to be taxed by locating in one country or the other. Therefore, tax competition arises. But for symmetric countries the equilibrium is also symmetric with one country hosting the online retailer. . If countries would strategically compete for the location of the online retailer, this could affect the results, but normally countries do not compete for the location of firms by the VAT but by profit taxes.

In the Hotelling economy, both stores have an incentive to move to the center to lower competitive pressure. The reduced competitive pressure would result higher tax rates in both countries.

## 6.3 Tax Policy

As in Kanbur & Keen (1993), consider two tax policies, tax harmonization and the implementation of a minimum tax rate. The latter can also be found in Directive 2006/112/EG.

In the offline equilibrium, tax rates are symmetric. This is, there is actually no scope for tax harmonization. If governments choose a common tax rate, they choose

$$\tau_H^{*,h} = \tau_F^{*,h} = \tau^{*,h} = v - \frac{3}{2}d, \quad (25)$$

which is higher than the tax rates in the offline equilibrium without tax harmonization ( $\tau^{*,h} > \tau_H^* = \tau_F^*$ ). In the online equilibrium under the destination principle, the harmonized tax rate is

$$\tau^{d,h} = v - \frac{1}{3}d - \frac{2}{3}\theta, \quad (26)$$

which is equivalent to the tax rates without tax harmonization ( $\tau^{d,h} = \tau_H^d = \tau_F^d$ ). In the online

equilibrium under the origin principle, the harmonized tax rate is

$$\tau^{o,h} = v - \frac{1}{3}d - \frac{2}{3}\theta, \quad (27)$$

which is higher than the tax rates without tax harmonization ( $\tau^{o,h} > \tau_H^o$ ,  $\tau^{o,h} > \tau_F^d$ ).

A (binding) minimum tax rate in the offline equilibrium would increase tax rates. It would raise prices, but not affect market shares. In the online equilibrium under the destination principle, a higher tax rate would increase tax rates and result in incomplete market coverage. In the equilibrium without the minimum tax rate the marginal consumer has a consumer surplus of zero and an increase in the tax rate and accordingly, a higher price would result in the marginal consumer not buying. In the online equilibrium under the origin principle, a minimum tax rate would raise both tax rates, no matter whether it is binding for one tax rate or both tax rates, since tax rates are strategic substitutes. A minimum tax rate would decrease the tax differential, with a higher minimum tax rate resulting in a lower tax differential.

## 7 Conclusion

This paper has studied the effect of an online retailer on spatial tax competition with mobile consumers.

If taxation for online purchases follows the destination principle, in many cases, the entry of the online retailer mitigates tax competition. If taxation for online purchases follows the origin principle, the entry of the online retailer typically enhances tax competition. This is, the choice of the taxation principle may shape the effect of the online retailer on tax competition. In the European Union, the destination principle applies to online retailers with sales to private households and with sales above the threshold of 100,000 Euros, suggesting that the entry of online retailers has mitigated tax competition. Under cooperation, when governments maximize joint tax revenue, the effect of the online retailer on tax competition is the same as under non-cooperative governments: Under the destination principle, it mitigates tax competition; under the origin principle, it enhances tax competition.

Lower cost of online shopping enhances the effect of the online retailer on tax competition, limited internet access decreases the effect of the online retailer on tax competition. This suggests that with increasing access to the internet in the European Union and decreasing cost of online shopping due to improved technology – and as a result of the Digital Agenda for Europe

– one can expect that the tax competition-mitigating impact of online retailers increases over time.

For sufficiently low cost of online shopping, welfare in the country where the online retailer is located is higher under the origin principle and welfare in the other country is higher under the destination principle. Global welfare is higher under the destination principle. For sufficiently high shopping costs, this is reversed and welfare in the online retailer’s home country is higher under the destination principle, while welfare in the other country is higher under the origin principle. This does not imply that there is a conflict between both countries with respect to the choice of the taxation regime if side payments are feasible, because global welfare is higher under the destination principle. The member states of the European Union have agreed on the destination principle, which this model may explain with welfare maximizing governments or tax revenue maximizing, but tax competition avoiding governments.

This model has considered commodity tax competition so far. An issue of increasing relevance in the European Union is the taxation of profits of online retailers, especially with respect to the question which member states may tax online retailers. This question is left for further research.

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# Appendix

## A. 1 The Effect of the Online Retailer

### Offline Equilibrium

Equilibrium prices:  $p_H^* = p_F^* = 4d$ .

Equilibrium quantities:  $q_H^* = q_F^* = \frac{1}{2}$ .

Equilibrium profits:  $\pi_H^* = \pi_F^* = \frac{1-6d}{4}$ .

Consumer surplus:  $CS_H^* = \int_0^{y_{HF}^*} (v - p_H^* - dx) dx = CS_F^* = \int_{y_{HF}^*}^1 (v - p_F^* - d(1-x)) dx$   
 $= \frac{1}{2}v - \frac{17}{8}d$ .

### Online Equilibrium under Destination Principle

Equilibrium prices:  $p_H^d = p_F^d = v - \frac{1}{6}d - \frac{1}{3}\theta$ ,  $p_0^d = v - \theta$ .

Equilibrium quantities:  $q_H^d = q_F^d = \frac{d+2\theta}{6d}$ ,  $q_0^d = \frac{2(dd-\theta)}{3d}$ .

Equilibrium profits:  $\pi_H^d = \pi_F^d = \frac{(d+2\theta)^2}{36d}$ ,

$\pi_0^d = \frac{2(d-\theta)^2}{9d}$ .

Consumer surplus:  $CS_H^d = \int_0^{y_{H0}} (v - p_H - dx) dx + \int_{y_{H0}}^{\frac{1}{2}} (v - p_0 - \theta) dx$   
 $= CS_F^d = \int_{\frac{1}{2}}^{y_{0F}} (v - p_0 - \theta) dx + \int_{y_{0F}}^1 (v - p_F - d(1-x)) dx = \frac{1}{72d} (d+2\theta)^2$ .

Welfare:  $W_H^d = \frac{36vd-44d\theta+28\theta^2+7d^2}{72d}$ ,  $W_F^d = \frac{12vd-3d^2-4d\theta+4\theta^2}{24d}$ ,  $W^d = \frac{36vd-d^2-28d\theta+20\theta^2}{36d}$ .

Price differences:  $p_H^d - p_H^* = p_F^d - p_F^* = v - \frac{25}{6}d - \frac{1}{3}\theta > 0$ .

Quantity differences:  $q_H^d - q_H^* = q_F^d - q_F^* = -\frac{(d-\theta)}{3d} < 0$ .

Tax rate differences:  $\tau_H^d - \tau_H^* = \tau_F^d - \tau_F^* = v - \frac{10}{3}d - \frac{2}{3}\theta > 0$ .

Revenue differences:  $R_H^d - R_H^* = R_F^d - R_F^* = \frac{1}{2}v - \frac{5}{3}d - \frac{1}{3}\theta > 0$ .

### Online Equilibrium under Origin Principle

Equilibrium prices:  $p_H^o = \frac{143(d+2\theta)}{90}$ ,  $p_F^o = \frac{119(d+2\theta)}{90}$ ,  $p_0^o = \frac{77d+109\theta}{45}$ .

Equilibrium quantities:  $q_H^o = \frac{11(d+2\theta)}{90d}$ ,  $q_F^o = \frac{7(d+2\theta)}{18d}$ ,  $q_0^o = \frac{2(11d-23\theta)}{45d}$ .

Equilibrium profits:  $\pi_H^o = \frac{121(d+2\theta)^2}{8100d}$ ,  $\pi_F^o = \frac{49(d+2\theta)^2}{324d}$ ,  $\pi_0^o = \frac{2(11d-23\theta)^2}{2025d}$ .

Consumer surplus:  $CS_H^o = \int_0^{y_{H0}} (v - p_H - dx) dx + \int_{y_{H0}}^{\frac{1}{2}} (v - p_0 - \theta) dx = \frac{8100vd-11(1249d-22\theta)(d+2\theta)}{16200d}$ ,

$CS_F^o = \int_{\frac{1}{2}}^{y_{0F}} (v - p_0 - \theta) dx + \int_{y_{0F}}^1 (v - p_F - d(1-x)) dx = \frac{1620vd-7(361d-70\theta)(d+2\theta)}{3240d}$ .



$$\text{Welfare: } W_H^o = \frac{8100vd+2959d^2-23804d\theta-27044\theta^2}{16200d}, W_F^o = \frac{540vd-287d^2+700d\theta+2548\theta^2}{1080d},$$

$$W^o = \frac{8100vd-673d^2-6652d\theta+5588\theta^2}{8100d}.$$

$$\text{Price differences: } p_H^o - p_H^* = -\frac{(217d-286\theta)}{90} < 0, p_F^o - p_F^* = -\frac{(241d-238\theta)}{90} < 0.$$

$$\text{Quantity differences: } q_H^o - q_H^* = -\frac{(17d-11\theta)}{45d} < 0, q_F^o - q_F^* = -\frac{(d-7\theta)}{9d} < 0 \text{ if } \theta < \frac{1}{7}d.$$

$$\text{Tax rate differences: } \tau_H^o - \tau_H^* = -\frac{(23d-44\theta)}{15} < 0, \tau_F^o - \tau_F^* = -\frac{(31d-28\theta)}{15} < 0.$$

$$\text{Revenue differences: } R_H^o - R_H^* = -\frac{(163d^2-176d\theta+616\theta^2)}{270d} < 0,$$

$$R_F^o - R_F^* = \frac{(-307d^2+392d\theta+392\theta^2)}{270d} < 0.$$

## Welfare Analysis

$$\text{Profit differences: } \pi_H^o - \pi_H^d = -\frac{26(d+2\theta)^2}{2025d} < 0, \pi_0^o - \pi_0^d = -\frac{16(13d-19\theta)(d+2\theta)}{2025d} < 0,$$

$$\pi_F^o - \pi_F^d = \frac{10(d+2\theta)^2}{81d} > 0.$$

$$\text{Revenue differences: } R_H^o - R_H^d = \frac{7(41d^2+38d\theta-88\theta^2)}{270d} - \frac{1}{2}v < 0 \text{ if } v > \widetilde{v}_H = \frac{287d^2+266d\theta-616\theta^2}{135d},$$

$$\text{Market coverage under origin principle if } U = v - d(y - x_H) - p_H > 0$$

$$\text{if } v > \widehat{v} = \frac{(143d+376\theta)}{90}$$

$$\widetilde{v}_H - \widehat{v} = \frac{-596d\theta-1232\theta^2+145d^2}{270d} > 0 \text{ if } \theta < \left(\frac{3}{616}\sqrt{7429} - \frac{149}{616}\right)d.$$

$$R_F^o - R_F^d = \frac{(143d^2+482d\theta+392\theta^2)}{270d} - \frac{1}{2}v < 0.$$

$$\text{Consumer surplus differences: } CS_H^o - CS_H^d = \frac{2025vd-(3491d+52\theta)(d+2\theta)}{4050d} > 0,$$

$$\text{if } v > \widetilde{v}_F = \frac{(3491d+52\theta)(d+2\theta)}{2025d}.$$

$$\widetilde{v}_F - \widehat{v} = \frac{(547d^2-2852d\theta+208\theta^2)}{4050d} > 0, \text{ if } \theta < \left(\frac{713}{104} - \frac{45}{104}\sqrt{237}\right)d,$$

$$CS_F^o - CS_F^d = \frac{1620vd-7(361d-70\theta)(d+2\theta)}{3240d} - \frac{1}{72d}(d+2\theta)^2 = \frac{405vd-(643d-100\theta)(d+2\theta)}{810d} > 0.$$

$$\text{Welfare differences: } W_H^o - W_H^d = \frac{173d^2-1738d\theta-4168\theta^2}{2025d} > 0 \text{ if } \theta < \widetilde{\theta}_H = \frac{173}{2084}d,$$

$$W_F^o - W_F^d = -\frac{19d^2-110d\theta-296\theta^2}{135d} < 0, \text{ if } \theta < \widetilde{\theta}_F = \frac{19}{148}d,$$

$$W^o - W^d = -\frac{8(14d^2+11d\theta-34\theta^2)}{2025d} < 0.$$

## A. 2 Access to and Cost of Online Shopping

### Limited Access to Online Shopping

#### Online Equilibrium under Destination Principle

$$\text{Demand: } q_H^{d\lambda} = (1-\lambda)(y_{HF}) + \lambda y_{H0}, q_F^{d\lambda} = (1-\lambda)(1-y_{HF}) + \lambda(1-y_{0F}), q_0^{d\lambda} = \lambda(y_{0F} - y_{H0}).$$

$$\text{Profits: } \pi_H^{d\lambda} = (p_H - \tau_H)q_H, \pi_F^{d\lambda} = (p_F - \tau_F)q_F,$$

$$\pi_0^{d\lambda} = (p_0 - \tau_H)\lambda\left(\frac{1}{2} - y_{H0}\right) + (p_0 - \tau_F)\lambda\left(y_{0F} - \frac{1}{2}\right).$$

$$\text{Revenues: } R_H^{d\lambda} = \tau_H\left(q_H + \lambda\left(\frac{1}{2} - y_{H0}\right)\right), R_F^{d\lambda} = \tau_F\left(q_F + \lambda\left(y_{0F} - \frac{1}{2}\right)\right).$$

Equilibrium prices:  $p_H^{d\lambda} = p_F^{d\lambda} = \frac{d(13\lambda+2\lambda^2+\lambda^3+8)+2\theta\lambda(1-\lambda^2)}{2(2\lambda+1)(1-\lambda^2)}$ ,  $p_0^{d\lambda} = \frac{d(\lambda+3)(8\lambda-\lambda^2+5)-2\theta(1-\lambda)(\lambda+1)^2}{4(2\lambda+1)(1-\lambda^2)}$ .

Equilibrium quantities:  $q_H^{d\lambda} = q_F^{d\lambda} = (\lambda+1) \frac{d(2-\lambda)+2\theta\lambda}{4d(2\lambda+1)}$ ,  $q_0^{d\lambda} = \lambda \frac{d(\lambda+3)-2\theta(\lambda+1)}{2d(2\lambda+1)}$

Equilibrium tax rates:  $\tau_H^{d\lambda} = \tau_F^{d\lambda} = d \frac{\lambda+3}{1-\lambda^2}$ .

Equilibrium revenues:  $R_H^{d\lambda} = R_F^{d\lambda} = d \frac{\lambda+3}{2(1-\lambda^2)}$ .

Tax rate differences:  $\tau_H^{d\lambda} - \tau_H^* = \tau_F^{d\lambda} - \tau_F^* = d\lambda \frac{3\lambda+1}{1-\lambda^2} > 0$ .

Revenue differences:  $R_H^{d\lambda} - R_H^* = R_F^{d\lambda} - R_F^* = \frac{1}{2}d\lambda \frac{3\lambda+1}{1-\lambda^2} > 0$ .

Price differences:  $p_H^{d\lambda} - p_H^d = p_F^{d\lambda} - p_F^d =$   
 $-\frac{6v(1-\lambda^2)(2\lambda+1)-d(41\lambda+5\lambda^2+\lambda^3+25)-2\theta(1-\lambda^2)(5\lambda+1)}{6(1-\lambda^2)(2\lambda+1)} < 0$ ,

$p_0^{d\lambda} - p_0^d = -\frac{4v(1-\lambda^2)(2\lambda+1)+d(\lambda+3)(-8\lambda+\lambda^2-5)-2\theta(1-\lambda^2)(3\lambda+1)}{4(1-\lambda^2)(2\lambda+1)} < 0$ .

Quantity differences:  $q_H^{d\lambda} - q_H^d = q_F^{d\lambda} - q_F^d = (1-\lambda) \frac{d(3\lambda+4)-2\theta(3\lambda+2)}{12d(2\lambda+1)} > 0$ ,

$q_0^{d\lambda} - q_0^d = -\frac{(1-\lambda)(d(3\lambda+4)-2\theta(3\lambda+2))}{6d(2\lambda+1)} < 0$ .

Tax rate differences:  $\tau_H^{d\lambda} - \tau_H^d = \tau_F^{d\lambda} - \tau_F^d =$   
 $-\frac{3v(1-\lambda^2)-d(\lambda+2)(5-\lambda)-2\theta(1-\lambda^2)}{3(1-\lambda^2)} < 0$

Revenue differences:  $R_H^{d\lambda} - R_H^d = R_F^{d\lambda} - R_F^d =$   
 $-\frac{3v(1-\lambda^2)-d(\lambda+2)(5-\lambda)-2\theta(1-\lambda^2)}{6(1-\lambda^2)} < 0$

## Online Equilibrium under Origin Principle

Demand:  $q_H^{o,\lambda} = (1-\lambda)(y_{HF}) + \lambda y_{H0}$ ,  $q_F^{o,\lambda} = (1-\lambda)(1-y_{HF}) + \lambda(1-y_{0F})$ ,  $q_0^{o,\lambda} = \lambda(y_{0F} - y_{H0})$ .

Profits:  $\pi_H^{o,\lambda} = (p_H - \tau_H)q_H$ ,  $\pi_F^{o,\lambda} = (p_F - \tau_F)q_F$ ,  $\pi_0^{o,\lambda} = (p_0 - \tau_H)q_0$ .

Revenues:  $R_H^{o,\lambda} = \tau_H(q_H + q_0)$ ,  $R_F^{o,\lambda} = \tau_F q_F$ .

Equilibrium prices:  $p_H^{o,\lambda} = \frac{d(15\lambda+3\lambda^2+8)(15\lambda+\lambda^2+6)+2\theta\lambda(\lambda+1)(-3\lambda^2+9\lambda+4)}{6(2\lambda+1)(\lambda+1)(7\lambda+\lambda^2+2)}$ ,

$p_F^{o,\lambda} = \frac{(21\lambda+5\lambda^2+8)(d(9\lambda-\lambda^2+6)+2\theta\lambda(\lambda+1))}{6(2\lambda+1)(\lambda+1)(7\lambda+\lambda^2+2)}$ ,

$p_0^{o,\lambda} = \frac{d(9\lambda+5)(\lambda+3)(15\lambda+\lambda^2+6)-2\theta(\lambda+1)(33\lambda+44\lambda^2+9\lambda^3+6)}{12(2\lambda+1)(\lambda+1)(7\lambda+\lambda^2+2)}$ .

Equilibrium quantities:  $q_H^{o,\lambda} = \frac{(\lambda+1)(d(2-\lambda)(15\lambda+\lambda^2+6)+2\theta\lambda(23\lambda+\lambda^2+10))}{12d(2\lambda+1)(7\lambda+\lambda^2+2)}$ ,

$q_F^{o,\lambda} = \frac{d(9\lambda-\lambda^2+6)+2\theta\lambda(\lambda+1)}{12d(2\lambda+1)}$ ,

$q_0^{o,\lambda} = \frac{\lambda(15\lambda+\lambda^2+6)(d(\lambda+3)-2\theta(\lambda+1))}{6d(2\lambda+1)(7\lambda+\lambda^2+2)}$ .

Equilibrium tax rates:  $\tau_H^{o,\lambda} = (\lambda+3) \frac{d(15\lambda+\lambda^2+6)-2\theta\lambda(\lambda+1)}{3(\lambda+1)(7\lambda+\lambda^2+2)}$ ,  $\tau_F^{o,\lambda} = (\lambda+3) \frac{d(9\lambda-\lambda^2+6)+2\theta\lambda(\lambda+1)}{3(\lambda+1)(7\lambda+\lambda^2+2)}$ .

Equilibrium revenues:  $R_H^{o,\lambda} = \frac{(\lambda+3)(d(15\lambda+\lambda^2+6)-2\theta\lambda(\lambda+1))^2}{36d(2\lambda+1)(\lambda+1)(7\lambda+\lambda^2+2)}$ ,  $R_F^{o,\lambda} = \frac{(\lambda+3)(d(9\lambda-\lambda^2+6)+2\theta\lambda(\lambda+1))^2}{36d(\lambda+1)(2\lambda+1)(7\lambda+\lambda^2+2)}$

Tax rate differences:  $\tau_H^{o,\lambda} - \tau_H^* = -\lambda \frac{2(d(27\lambda+4\lambda^2+15)+\theta(\lambda+3)(\lambda+1))}{3(\lambda+1)(7\lambda+\lambda^2+2)} < 0$ ,

$\tau_F^{o,\lambda} - \tau_F^* = -\frac{2\lambda(d(33\lambda+5\lambda^2+24)-\theta(\lambda+3)(\lambda+1))}{3(\lambda+1)(7\lambda+\lambda^2+2)} < 0$ .

Revenue differences:  $R_H^{o,\lambda} - R_H^* =$

$$-\lambda \frac{d^2(-\lambda^4+75\lambda^3+591\lambda^2+513\lambda+126)+4\theta(\lambda+3)(\lambda+1)(6d+15d\lambda-\theta\lambda+d\lambda^2-\theta\lambda^2)}{36d(2\lambda+1)(\lambda+1)(7\lambda+\lambda^2+2)} < 0,$$

$$R_F^{o,\lambda} - R_F^* =$$

$$-\lambda \frac{d^2(1089\lambda+903\lambda^2+123\lambda^3-\lambda^4+342)+4\theta(\lambda+3)(\lambda+1)(-6d-9d\lambda-\theta\lambda+d\lambda^2-\theta\lambda^2)}{36d(2\lambda+1)(\lambda+1)(7\lambda+\lambda^2+2)} < 0.$$

$$\text{Price differences: } p_H^{o,\lambda} - p_H^o =$$

$$\frac{d(1-\lambda)(1725\lambda+1772\lambda^2+241\lambda^3+434)-2\theta(\lambda+1)(1513\lambda+2010\lambda^2+331\lambda^3+286)}{90(2\lambda+1)(\lambda+1)(7\lambda+\lambda^2+2)} > 0,$$

$$\text{if } \theta < \tilde{\theta}_{p_H} = \frac{d(1-\lambda)(1725\lambda+1772\lambda^2+241\lambda^3+434)}{2(\lambda+1)(1513\lambda+2010\lambda^2+331\lambda^3+286)}.$$

$$p_F^{o,\lambda} - p_F^o = \frac{d(1-\lambda)(1905\lambda+1976\lambda^2+313\lambda^3+482)-2\theta(\lambda+1)(1189\lambda+1470\lambda^2+163\lambda^3+238)}{90(2\lambda+1)(\lambda+1)(7\lambda+\lambda^2+2)} > 0,$$

$$\text{if } \theta < \tilde{\theta}_{p_F} = \frac{d(1-\lambda)(1905\lambda+1976\lambda^2+313\lambda^3+482)}{2(\lambda+1)(1189\lambda+1470\lambda^2+163\lambda^3+238)}.$$

$$p_0^{o,\lambda} - p_0^o = \frac{d(1-\lambda)(2985\lambda+3212\lambda^2+481\lambda^3+734)-2\theta(\lambda+1)(2893\lambda+3930\lambda^2+571\lambda^3+526)}{180(2\lambda+1)(\lambda+1)(7\lambda+\lambda^2+2)} > 0,$$

$$\text{if } \theta < \tilde{\theta}_{p_0} = \frac{d(1-\lambda)(2985\lambda+3212\lambda^2+481\lambda^3+734)}{2(\lambda+1)(2893\lambda+3930\lambda^2+571\lambda^3+526)}.$$

$$\text{Quantity differences: } q_H^{o,\lambda} - q_H^o$$

$$= \frac{d(1-\lambda)(3\lambda+4)(83\lambda+5\lambda^2+34)-2\theta(3\lambda+2)(-5\lambda^3-102\lambda^2+13\lambda+22)}{180d(2\lambda+1)(7\lambda+\lambda^2+2)} > 0,$$

$$q_F^{o,\lambda} - q_F^o = \frac{d(3\lambda+4)(1-\lambda)-2\theta(-3\lambda^2+25\lambda+14)}{36d(2\lambda+1)} > 0, \text{ if } \theta < \tilde{\theta}_{q_F} = \frac{d(3\lambda+4)(1-\lambda)}{2(-3\lambda^2+25\lambda+14)}.$$

$$q_0^{o,\lambda} - q_0^o = -\frac{d(1-\lambda)(3\lambda+4)(59\lambda+5\lambda^2+22)-2\theta(-15\lambda^4-148\lambda^3+375\lambda^2+416\lambda+92)}{90d(2\lambda+1)(7\lambda+\lambda^2+2)} < 0,$$

$$\text{if } \theta < \tilde{\theta}_{q_0} = \frac{d(1-\lambda)(3\lambda+4)(59\lambda+5\lambda^2+22)}{2(-15\lambda^4-148\lambda^3+375\lambda^2+416\lambda+92)}.$$

$$\text{Tax rate differences: } \tau_H^{o,\lambda} - \tau_H^o =$$

$$\frac{d(1-\lambda)(103\lambda+17\lambda^2+46)-2\theta(\lambda+1)(169\lambda+27\lambda^2+44)}{15(\lambda+1)(7\lambda+\lambda^2+2)} > 0,$$

$$\tau_F^{o,\lambda} - \tau_F^o = \frac{d(1-\lambda)(101\lambda+19\lambda^2+62)-2\theta(\lambda+1)(83\lambda+9\lambda^2+28)}{15(\lambda+1)(7\lambda+\lambda^2+2)} > 0, \text{ if } \theta < \tilde{\theta}_\tau = \frac{d(1-\lambda)(101\lambda+19\lambda^2+62)}{2(\lambda+1)(83\lambda+9\lambda^2+28)}.$$

$$\text{Revenue differences: } R_H^{o,\lambda} - R_H^o = \frac{-4\theta(\lambda+1)(176d-616\theta+1238d\lambda-3388\theta\lambda+2085d\lambda^2+446d\lambda^3+15d\lambda^4-4665\theta\lambda^2-676\theta\lambda^3-15\theta\lambda^4)}{540d(2\lambda+1)(\lambda+1)(7\lambda+\lambda^2+2)}$$

$$+ \frac{d^2(1-\lambda)(-15\lambda^4+458\lambda^3+3781\lambda^2+3000\lambda+652)}{540d(2\lambda+1)(\lambda+1)(7\lambda+\lambda^2+2)} > 0,$$

$$R_F^{o,\lambda} - R_F^o = \frac{-4\theta(\lambda+1)(392d+392\theta+1886d\lambda+2156\theta\lambda+2445d\lambda^2+302d\lambda^3+15d\lambda^4+2895\theta\lambda^2+332\theta\lambda^3-15\theta\lambda^4)}{540d(2\lambda+1)(\lambda+1)(7\lambda+\lambda^2+2)} +$$

$$\frac{d^2(1-\lambda)(-15\lambda^4+602\lambda^3+3709\lambda^2+4080\lambda+1228)}{540d(2\lambda+1)(\lambda+1)(7\lambda+\lambda^2+2)} > 0,$$

$$\text{if } \theta < \tilde{\theta}_R = \frac{d^2(1-\lambda)(-15\lambda^4+602\lambda^3+3709\lambda^2+4080\lambda+1228)}{4(\lambda+1)(392d+392\theta+1886d\lambda+2156\theta\lambda+2445d\lambda^2+302d\lambda^3+15d\lambda^4+2895\theta\lambda^2+332\theta\lambda^3-15\theta\lambda^4)}.$$

## Decrease in the Cost of Online Shopping

$$\text{Prices: } \frac{\partial p_H^d}{\partial \theta} = \frac{\partial p_F^d}{\partial \theta} = -\frac{1}{3} < 0, \quad \frac{\partial p_0^d}{\partial \theta} = -1 < 0.$$

$$\text{Quantities: } \frac{\partial q_H^d}{\partial \theta} = \frac{\partial q_F^d}{\partial \theta} = \frac{1}{3d} > 0, \quad \frac{\partial q_0^d}{\partial \theta} = -\frac{2}{3d} < 0.$$

$$\text{Tax rates: } \frac{\partial \tau_H^d}{\partial \theta} = \frac{\partial \tau_F^d}{\partial \theta} = -\frac{2}{3} < 0.$$

$$\text{Revenues: } \frac{\partial R_H^d}{\partial \theta} = \frac{\partial R_F^d}{\partial \theta} = -\frac{1}{3} < 0.$$

$$\text{Prices: } \frac{\partial p_H^o}{\partial \theta} = \frac{143}{45} > 0, \quad \frac{\partial p_F^o}{\partial \theta} = \frac{119}{45} > 0, \quad \frac{\partial p_0^o}{\partial \theta} = \frac{109}{45} > 0.$$

Quantities:  $\frac{\partial q_H^o}{\partial \theta} = \frac{11}{45d} > 0$ ,  $\frac{\partial q_F^o}{\partial \theta} = \frac{7}{9d} > 0$ ,  $\frac{\partial q_0^o}{\partial \theta} = -\frac{46}{45d} < 0$ .

Tax rates:  $\frac{\partial \tau_H^o}{\partial \theta} = \frac{44}{15} > 0$ ,  $\frac{\partial \tau_F^o}{\partial \theta} = \frac{28}{15} > 0$ .

Revenues:  $\frac{\partial R_H^o}{\partial \theta} = \frac{88(d-7\theta)}{135d} > 0$ , if  $\theta < \frac{1}{7}d$ ,  $\frac{\partial R_F^o}{\partial \theta} = \frac{49(4d+8\theta)}{135d} > 0$ .

### A.3 Role of Governments

#### Cooperative Leviathan Governments

##### Offline Equilibrium

Equilibrium prices:  $p_H^{*C} = p_F^{*C} = v - \frac{1}{2}d$ .

Equilibrium quantities:  $q_H^{*C} = q_F^{*C} = \frac{1}{2}$ .

Revenue differences:  $R_H^{*C} - R_H^* = R_F^{*C} - R_F^* = \frac{1}{2}v - \frac{9}{4}d > 0$ .

##### Online Equilibrium under Origin Principle

Equilibrium prices:  $p_H^{o,C} = p_F^{o,C} = v - \frac{1}{6}d - \frac{1}{3}\theta$ ,  $p_0^{o,C} = v - \theta$ .

Equilibrium quantities:  $q_H^{o,C} = q_F^{o,C} = \frac{d+2\theta}{6d}$ ,  $q_0^{o,C} = \frac{2(d-\theta)}{3d}$ .

Revenue differences:  $R_H^{o,C} - R_H^o = \frac{1}{2}v - \frac{7(41d-44\theta)(d+2\theta)}{270d} > 0$ ,

$R_F^{o,C} - R_F^o = \frac{1}{2}v - \frac{(143d+196\theta)(d+2\theta)}{270d} > 0$ .

Tax rate differences:  $\tau_H^{o,C} - \tau^{*C} = \frac{7}{6}d - \frac{2}{3}\theta > 0$ .

#### Benevolent Governments

##### Offline Equilibrium

Equilibrium prices:  $p_H^W = p_F^W = d$ .

Equilibrium quantities:  $q_H^W = q_F^W = \frac{1}{2}$ .

Welfare:  $W_H^* = \frac{(3d+\tau_F-\tau_H)(12v-3d-\tau_F+\tau_H)}{72d}$ ,  $W_F^* = \frac{(3d-\tau_F+\tau_H)(12v-3d+\tau_F-\tau_H)}{72d}$ .

##### Online Equilibrium under Destination Principle

Equilibrium prices:  $p_H^{W,d} = p_F^{W,d} = \frac{1}{6}d + \frac{1}{3}\theta$ ,  $p_0 = \frac{1}{3}d - \frac{1}{3}\theta$ .

Equilibrium quantities:  $q_H^{W,d} = q_F^{W,d} = \frac{(d+2\theta)}{6d}$ ,  $q_0^{W,d} = \frac{2(d-\theta)}{3d}$ .

Welfare:  $W_H^d = \frac{144vd+4(-44d\theta+28\theta^2+7d^2)-9(\tau_F-\tau_H)(4d-8\theta+5\tau_F-5\tau_H)}{288d}$ ,

$W_F^d = \frac{48vd-4(3d-2\theta)(d+2\theta)+3(\tau_F-\tau_H)(4d-8\theta+3\tau_F-3\tau_H)}{96d}$ .

##### Online Equilibrium under Origin Principle

Equilibrium prices:  $p_H^{W,o} = \frac{(37d+8\theta)}{101}$ ,  $p_F^{W,o} = \frac{2(13d+11\theta)}{101}$ ,  $p_0^{W,o} = \frac{(52d-57\theta)}{101}$ .

Equilibrium quantities:  $q_H^{W,o} = \frac{3(5d+12\theta)}{101d}$ ,  $q_F^{W,o} = \frac{2(13d+11\theta)}{101d}$ ,  $q_0^{W,o} = \frac{2(30d-29\theta)}{101d}$ .

Welfare:  $W_H^o = \frac{144vd+4(-44d\theta+28\theta^2+7d^2)+52d\tau_F+44d\tau_H+19\tau_F^2-101\tau_H^2-40\theta\tau_F-56\theta\tau_H+82\tau_F\tau_H}{288d}$ ,

$W_F^o = \frac{48vd-4(3d-2\theta)(d+2\theta)-12d\tau_F-20d\tau_H-8\theta\tau_F+40\theta\tau_H-15\tau_F^2-10\tau_F\tau_H+25\tau_H^2}{96d}$ .

## A. 4 Discussion

Tax rate differences:  $\tau_H^{d,comp} - \tau_H^{*,comp} = \tau_F^{d,comp} - \tau_F^{*,comp} =$

$$\frac{1}{3}(3v - 4d - 2\theta) > 0,$$

$$\tau_H^{o,comp,HF0} - \tau_H^{*,comp} = -\frac{1}{3}(d + \theta) < 0,$$

$$\tau_F^{o,comp,HF0} - \tau_F^{*,comp} = -\frac{1}{3}(2d - \theta) < 0.$$