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# Competition and Welfare Effects of VAT Exemptions*

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## Abstract

Distortions under the value-added tax (VAT) arise partly from the exemption of specific services and sectors. This paper develops an analytical model that is applicable to any sector characterized by asymmetric VAT exemptions of services and activities. We analyze the effects of such asymmetric tax regimes on market shares, optimal prices, tax receipts, and social welfare. The analytical model shows how asymmetric VAT exemptions distort competition by strengthening the competitive position of non-rated firms. The net effect of such tax exemptions depends on the fraction of VAT-rated inputs versus the fraction of non-rated customers. We further elucidate main competitive impacts of VAT policies, while showing their consequences on overall welfare by presenting simulation results based on a calibrated quantitative model of a selected sector. Our paper provides guidance on how to resolve the policy trade-off between a level playing field in the market, consumer surplus, and government tax revenue.

**KEYWORDS:** value-added tax, indirect taxes, regulation, tax exemption, social welfare, competitive effects

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# 1 Introduction

The value-added tax (VAT) has been adopted in more than 130 countries over the last half-century. In particular, all OECD countries with the exception of the United States have introduced VAT. Proponents of VAT claim that it is a particularly effective tax that reduces the welfare costs of raising revenue. However, the tax should be raised such that it does not lead to significant distortions in competition (Keen and Lockwood 2006). Unfortunately, this is not always the case.

According to Aujean et al. (1999), distortions under VAT arise mainly from exemptions for specified services and sectors. As Cnossen (2003) argues, the rationale for most exemptions lies in the history of their adoption and not in "their underlying economic or administrative logic". For instance, countries that have adopted VAT only recently (e.g., Australia, Canada or New Zealand) follow "best practices" by taxing most of the services that are exempt in countries with a long history of VAT (e.g., member states of the European Union).

The postal sector is a good example of such a distortion because most member states of the European Union (EU) exempt universal postal services provided by the incumbent operator from VAT on the grounds that they are the "public postal service." At the same time, competing postal service providers must charge VAT at the standard rate. Recently, the European Court of Justice (ECJ) essentially confirmed this interpretation of the current VAT Directive.[1] According to the ECJ, universal service tariffs are VAT exempt unless prices are individually negotiated with customers. The decision of the ECJ is binding on all member states. The postal sector is therefore a good candidate to illustrate comprehensively the competitive effects of VAT regimes.

Our paper focuses on the competitive and welfare effects of different VAT regimes in sectors with asymmetric VAT exemptions. Where such exemptions exist, the competitive effects are ambiguous a priori. While an exempt firm cannot reclaim VAT paid on inputs (which is relevant for non-labor inputs only) and therefore faces higher costs, ceteris paribus, an important fraction of the customers of non-exempt firms will not be able to deduct VAT themselves. Therefore, the exempt firm has a cost disadvantage on the one hand and a price advantage on the other. The net effect will depend on the fraction of non-labor inputs relative to the fraction of non-rated customers.

[1] Council Directive 77/388/EEC of 17 May 1977 on the harmonization of the laws of the EU member states relating to turnover taxes.

To analyze the effects of different VAT scenarios, we develop an analytical model that is applicable to any sector characterized by asymmetric VAT exemptions of services and activities or differentiated tax rates. In a second step, we calibrate the model for a specific sector: the postal market. This approach enables us to quantify the competitive and welfare effects of the selected tax regimes. The various scenarios differ regarding the firms' fraction of labor input and their rating status. We also take into account the fraction of non-rated customers that cannot deduct VAT themselves. Thus, our paper provides a well-founded basis for assessing the main competitive impact of VAT policies while showing the consequences on overall welfare. Finally, we assess the policy trade-off between a level playing field, consumer surplus and government tax revenue.

The structure of the paper is as follows. Section 2 briefly reviews the related literature. Section 3 introduces the model framework and presents the analytical results. Section 4 describes the calibration of the model for the postal sector. Section 5 reports the simulation results. Finally, Section 6 summarizes the main findings and concludes our study.

# 2 Literature Review

Before proceeding with the model, we present a short literature review. Cnossen (1998) examines various VAT structures and argues that the application of VAT on public-sector bodies has the advantage of confronting policymakers more directly with the full cost of public intervention. Competitive conditions are distorted if the government's services bear a lower tax or no tax while competing private-sector services are taxed in full. He concedes, however, that the prices of government services are often regulated or subsidized, which makes the levy of VAT little more than a bookkeeping exercise, as the effect of the VAT can be exactly replicated by the exemption. Keen and Lockwood (2006) use panel data for the OECD and empirically test whether VAT is a "money machine." They find that countries with VAT raise more revenue than those without. However, the effect may not be large. Keen (2007) examines in detail the criticisms that VAT faces today. Giesecke and Tran (2010) analyze the VAT characteristics of multiproduction, legislated differences in exemption status, and industry-specific differences in the refundability of VAT paid on inputs to production and investment in a general equilibrium framework. Finally, PWC (2007) discuss various forms of market distortions resulting from VAT exemptions for financial and insurance services.

In the postal sector, VAT exemptions have been addressed in recent years. Dieke and Elixmann (2005) quantify the effects of such exemptions for postal operators on government tax revenue. De Donder et al. (2009) focus on the pricing and welfare implications of changing a postal operator's VAT status. Crew et al. (2009) discuss the importance of VAT exemptions in the framework of the prospective study by PwC (2006). Dietl et al. (2011) base their study on our framework and utilize the results to derive further insights and implications for the postal market. Contrary to our general setting that is applicable to any sector characterized by asymmetric VAT exemptions of services and activities or differentiated tax rates, Dietl et al. (2011) specifically tailor their analysis to relevant policy issues in the postal industry resulting from the distortion created through the VAT exemption of the incumbent postal operator.

Relative to the work of De Donder et al. (2009), who assume that entrants act as a competitive fringe, we model profits of both the incumbent and new market entrants. This allows us to provide a more comprehensive treatment of the competitive effects of VAT policies. We also provide a relevant sensitivity analysis with regards to the fraction of labor inputs and the fraction of non-rated customers. We show that the results are very sensitive to the operators' labor policies. Consequently, VAT exemptions have a different impact in countries with different labor regulations. Secondly, the sensitivity analysis highlights that the competitive effects will vary strongly between different customer segments. Therefore, there is a second important regulatory link between VAT exemptions and uniform pricing constraints. The comprehensive treatment of competition and welfare enables us to provide guidance on how to resolve the policy trade-off between consumer surplus, government tax revenue, and a level playing field markets with VAT exemptions.

# 3 The Analytical Model

## 3.1 Notation and Assumptions

Two firms (operators), denoted by *I* and *E,* offer differentiated products or services in the same market.[2] The before-tax price of firm $i \in \{E, I\}$ is given by $p_i$, whereas $(1+t_i)p_i$ denotes the after-tax price of firm *i*, with $t_i \in [0,1]$ being the VAT rate of firm *i*. Moreover, each firm pays VAT given by $t \in [0,1]$ on non-

[2] The firms are denoted by *I* and *E* because we calibrate the model with market data from a selected sector (postal market) in Section 4. As mentioned, in postal markets, the (historical) incumbent operator *I* is usually VAT exempt, whereas the entrant operator *E* is VAT rated.

labor inputs. Depending on their VAT status, firms are able to deduct the input VAT from their output VAT billed to their customers.

Following De Donder et al. (2001), we define the total utility of a representative customer quasi-linear as[3]

$$u(x_I, x_E) = m + \alpha_I x_I - \frac{\beta}{2}\left(x_I\right)^2 + \alpha_E x_E - \frac{\beta}{2}\left(x_E\right)^2 - \varepsilon\beta x_I x_E, \qquad (1)$$

where $\alpha_I, \alpha_E, \beta > 0$ and $\varepsilon \in (0,1)$. The parameter $m>0$ characterizes the amount of money spent on other goods; $x_I$ and $x_E$ represent the demands faced by firms *I* and *E*, respectively. The last term in Equation (1) reflects the fact that the products or services offered by the two firms are differentiated products or services. A smaller parameter $\varepsilon$ indicates a higher degree of differentiation. The parameters $\alpha_I$ and $\alpha_E$ determine the market shares of firms *I* and *E*, respectively, whereas $\beta$ determines the slope of the demand functions. In our model, there are two types of customers: VAT rated and VAT exempt customers. For simplicity, we aggregate these to one representative customer. Her/his budget constraint is given by

$$y = m + x_I\left[\gamma p_I(1+t_I) + (1-\gamma)p_I\right] + x_E\left[\gamma p_E(1+t_E) + (1-\gamma)p_E\right], \qquad (2)$$

where $\gamma \in [0,1]$ denotes the fraction of exempt, "non-rated" customers and $(1-\gamma)$ is the proportion of customers that are rated.[4] The latter type of customers can reclaim the VAT they paid on their products because these products are an input in their own production processes (e.g., most companies and businesses). Reclaiming VAT is not possible for exempt customers (e.g., banks, insurances and private customers). Therefore, for rated customers, the before-tax price $p_i$ is relevant, whereas for exempt customers, the after-tax price $(1+t_i)p_i$ from firm *i* is relevant. The model specification presumes that the fraction of non-exempt letters is the same for both firms.

From Equations (1) and (2), we determine the demand faced by firm *i* as follows.

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[3] Similar to and as justified by De Donder et al. (2001), we treat firms and households in the same manner (see also De Donder et al. 2002). For notational simplicity, we then utilize the term "utility function" even when it relates to firms. Moreover, the quasi-linearity of the utility specification enables us to compute monetary welfare measures.

[4] More precisely, $\gamma$ represents the fraction of demand from its VAT exempt business (e.g., banking), while $(1-\gamma)$ represents ordinary commercial business activities that are rated.

**Lemma 1**

*The linear demand function for the product or service of firm i yields*

$$x_i = \frac{1}{\beta(1-\varepsilon^2)}\Big[\alpha_i - \varepsilon\alpha_j - p_i(1+\gamma t_i) + \varepsilon p_j(1+\gamma t_j)\Big], \tag{3}$$

*with* $i, j \in \{E, I\}$ *and* $i \neq j$.

**Proof:** See Appendix A1.

It should be noted that the slopes of the linear demand functions are equal for both firms. We further see that the demand of firm *i* decreases in its own price $p_i$ but increases in the price $p_j$ of the other firm *j*. Demand is also positively related to a higher degree of product differentiation (a smaller $\varepsilon$); that is, $\partial x_i / \partial \varepsilon < 0$.

If firm $i$ is VAT exempt (i.e., $t_i = 0$), it does not charge VAT to its customers, but it does charge VAT to its customers if it is rated (i.e., $t_i > 0$). The effect of different VAT regimes $t_i, t_j$ on $x_i$, that is

$$dx_i / dt_i = \partial x_i / \partial t_i + (\partial x_i / \partial p_i \; \partial p_i / \partial t_i)_i + (\partial x_i / \partial p_j \; \partial p_j / \partial t_i),$$

will depend on the second-order effects of a change in the tax rate $t_i$. However, these second-order effects are ambiguous, as we will see below.

On the cost side, firm *i* is assumed to face three types of costs: (i) fixed costs $F_i$, (ii) constant marginal upstream costs $u_i$ (e.g., collection and sorting in the postal sector), and (iii) constant marginal downstream costs $d_i$ (e.g., mail delivery in the postal sector). The fraction of the fixed costs that is non-labor is denoted by $\mu_i^F \in (0,1)$, whereas $\mu_i \in (0,1)$ stands for the fraction of marginal upstream and downstream costs that are non-labor costs. It should be noted that firm *i* has to pay VAT, given by *t*, on the fraction of non-labor costs derived from fixed costs, upstream and downstream costs independent of its VAT status.

We thus specify total costs faced by firm (operator) $i \in \{E, I\}$ as

$$C_i = \Big[1 + \mu_i^F (t - t_i)\Big] F_i + \Big[1 + \mu_i (t - t_i)\Big](u_i + d_i) \cdot x_i, \tag{4}$$

with $t \geq t_i$ and demand $x_i$ given by Equation (3). For notational simplicity, we denote the sum $u_i + d_i$ of marginal upstream and downstream costs with $c_i$ in the subsequent analysis: that is, $c_i = u_i + d_i$.

The cost function shows that the VAT status crucially determines the costs faced by firm *i*. For example, if firm *i* is VAT rated with $t_i = t$, it can reclaim the VAT it has paid on inputs such that $C_i^r = F_i + c_i x_i$. Conversely, if firm *i* is non-rated, that is, VAT exempt with $t_i = 0$, it cannot reclaim the VAT it has paid on inputs such that $C_i^{nr} = (1+\mu_i^F t)F_i + (1+\mu_i t)c_i x_i$.

The (net of tax) profit of firm (operator) $i$ thus amounts to

$$\pi_i = p_i x_i - \left[1+\mu_i(t-t_i)\right]c_i \cdot x_i - \left[1+\mu_i^F(t-t_i)\right]F_i$$
$$= \frac{p_i - \left[1+\mu_i(t-t_i)\right]c_i}{\beta(1-\varepsilon^2)}\left[\alpha_i - \varepsilon\alpha_j - p_i(1+\gamma t_i) + \varepsilon p_j(1+\gamma t_j)\right] - \left[1+\mu_i^F(t-t_i)\right]F_i,$$

with $i, j \in \{E, I\}$ and $i \neq j$.

The timing is as follows: First, the regulator sets the VAT regime, i.e., it decides whether one firm is VAT exempt and the other is rated (Scenario A) or whether both firms are rated (Scenario B). Given the VAT regime, the firms simultaneously maximize their profits and set prices $p_i^*,\ i \in \{I, E\}$ correspondingly. Then, the customers decide how much to buy at the given price, yielding demands $x_i^*,\ i \in \{I, E\}$ for the product or service of firm *i*. Finally, profits are realized.

## 3.2 Optimality Conditions

To derive its optimal pricing, firm *i* solves the maximization problem $\max_{p_i \geq 0} \pi_i$. The corresponding first-order conditions are computed as[5]

$$\frac{\partial \pi_i}{\partial p_i} = \frac{1}{\beta(1-\varepsilon^2)}\left[\alpha_i - (1+\gamma t_i)\left[2p_i - (1+\mu_i(t-t_i))c_i\right] - \varepsilon(\alpha_j - p_j(1+\gamma t_j))\right] = 0.$$

From the first-order conditions, we obtain the reaction function $p_i(p_j)$ for firm *i* as

[5] Note that the second-order conditions for a maximum are satisfied because $\partial^2 \pi_i / \partial p_i^2 = -2(1+t_i\gamma)/(\beta(1-\varepsilon^2)) < 0.$

$$p_i(p_j) = \frac{1}{2}\left[\left(1+\mu_i(t-t_i)\right)c_i + \frac{\alpha_i - \varepsilon\alpha_j}{1+\gamma t_i} + \varepsilon\frac{1+\gamma t_j}{1+\gamma t_i}p_j\right],$$

with $i, j \in \{E, I\}$ and $i \neq j$. Prices are strategic complements, i.e., $\partial p_i / \partial p_j > 0$. The effect of $t_j$ on $p_i$ is strictly positive, i.e., an increase of the competitors VAT rate will shift the reaction function upwards. However, the effect of $t_i$ is ambiguous and will be analyzed later on.

Solving the system of reaction functions yields the equilibrium before-tax price $p_i^*$ of firm (operator) *i* as

$$p_i^* = \frac{1}{4-\varepsilon^2}\left[2\left(1+\mu_i(t-t_i)\right)c_i + \varepsilon\frac{1+\gamma t_j}{1+\gamma t_i}\left(1+\mu_j(t-t_j)\right)c_j + \frac{\alpha_i(2-\varepsilon^2) - \alpha_j\varepsilon}{1+\gamma t_i}\right] \tag{5}$$

with $i, j \in \{E, I\}$ and $i \neq j$.

It is intuitive that the before-tax price $p_i^*$ of firm $i$ increases with higher marginal upstream and downstream costs $c_i$. Similarly, it is straightforward that $p_i^*$ also increases with higher marginal costs $c_j$ of the competitor *j*.

We further derive that a higher tax rate $t_j$ of competitor *j* induces a higher before-tax price $p_i^*$ of firm $i$ if the proportion $\gamma$ of VAT exempt customers is sufficiently large with $\gamma > \frac{\mu_j}{1+\mu_j(t-2t_j)}$. It should be noted that firm *j*'s amount of input tax (measured by $\mu_j$) plays a crucial role. As $\gamma$ is usually significantly larger than zero (see calibration section), the condition will be satisfied if $\mu_j$ is sufficiently close to zero (e.g., an operator mainly employing labor directly instead of via subcontractors). In such a case, an increase of firm *j*'s tax $t_j$ will degrade its competitive position, as non-rated customers face higher prices that cannot be compensated for by input tax deductions. Therefore, firm *i* will be able to increase its price profitably.

On the other hand, a higher own tax rate $t_i$ induces a decrease in the before-tax price $p_i^*$ if the ratio of market sizes $\alpha_I / \alpha_E$ is larger than $\varepsilon / (2-\varepsilon^2)$ because then the last term in equation (5) is positive and it decreases similar to the other terms with a higher tax $t_i$. Otherwise, the last term is negative and hence it

increases in $t_i$ such that the effect of a higher $t_i$ on the before-tax price is ambiguous.

To derive further insights, we analyze two scenarios: in Scenario A, firm *I* is VAT exempt, while firm *E* is VAT rated. In Scenario B, both firms are VAT rated.[6]

## 3.3 Scenario A: Firm *I* is VAT exempt and Firm *E* is VAT rated

In Scenario A, we assume that firm *I* is VAT exempt, that is, $t_I = 0$, whereas firm $E$ is VAT rated, that is, $t_E = t > 0$. Because firm *E* is rated, it can reclaim the VAT it has paid on inputs, while this is not possible for the exempt firm *I*.

From Equation (5), we compute the before-tax price $p_I^A$ of firm (operator) *I* in Scenario A by setting $t_I = 0$ and $t_E = t$.

$$p_I^A = \frac{1}{4-\varepsilon^2}\left[2\left(1+\mu_I t\right)c_I + \varepsilon\left(1+\gamma t\right)c_E + \alpha_I(2-\varepsilon^2) - \alpha_E\varepsilon\right].$$

Similarly, the before-tax price $p_E^A$ of firm (operator) $E$ is computed as

$$p_E^A = \frac{1}{4-\varepsilon^2}\left[2c_E + \varepsilon\frac{1}{1+\gamma t}\left(1+\mu_I t\right)c_I + \frac{\alpha_E(2-\varepsilon^2) - \alpha_I\varepsilon}{1+\gamma t}\right].$$

Substituting equilibrium prices $(p_I^A, p_E^A)$ in the demand functions given by Equation (3) produces equilibrium demands $(x_I^A, x_E^A)$ in Scenario A as

$$x_I^A = \frac{(2-\varepsilon^2)(\alpha_I - c_I(1+\mu_I t)) + \varepsilon(c_E(1+\gamma t) - \alpha_E)}{\beta(4-\varepsilon^2)(1-\varepsilon^2)},$$

$$x_E^A = \frac{(2-\varepsilon^2)(\alpha_E - c_E(1+\gamma t)) + \varepsilon(c_I(1+\mu_I t) - \alpha_I)}{\beta(4-\varepsilon^2)(1-\varepsilon^2)}.$$

The functions illustrate the trade-off that we have discussed: input tax disadvantage vs. output tax advantage. With symmetric costs and demands, firm *I* will have a larger market share whenever $\gamma > \mu_I$. It should be noted that the parameter $\mu_I$ depends on the outsourcing decisions of the firm. Ceteris paribus,

[6] Note that we introduce the scenario with asymmetric VAT treatment of firms first because this scenario represents the status quo in many real-world markets as explained in the introduction.

being VAT exempt will make it more profitable for the firm to employ workers directly than via subcontracting as compared to being VAT rated.

In the next proposition, we analyze the effect of a higher tax rate $t$ on equilibrium prices and demands in Scenario A.

**Proposition 1**

*(i) A higher tax rate $t$ always yields an increase in the before-tax price $p_I^A$ of the VAT exempt firm I, while the before-tax price $p_E^A$ of the VAT rated firm E decreases if the market size of firm I is not too large. Formally,* $\frac{\partial p_E^A}{\partial t} < 0 \Leftrightarrow \alpha_I < \frac{\gamma - \mu_I}{\gamma} c_I + \frac{2-\varepsilon^2}{\varepsilon} \alpha_E$.

*(ii) A higher tax rate $t$ induces a decrease in the equilibrium demands $(x_I^A, x_E^A)$ of the VAT exempt firm and the VAT rated firm if $\frac{c_E}{c_I}\frac{\gamma}{\mu_I}$ is within the interval* $\eta(\varepsilon) = \left(\frac{\varepsilon}{2-\varepsilon^2}, \frac{2-\varepsilon^2}{\varepsilon}\right)$. *Formally,* $\left(\frac{\partial x_I^A(t)}{\partial t} < 0 \text{ and } \frac{\partial x_E^A(t)}{\partial t} < 0\right) \Leftrightarrow \frac{c_E}{c_I}\frac{\gamma}{\mu_I} \in \eta(\varepsilon)$.

**Proof:** See Appendix A.2.

Part (i) of the proposition shows that the before-tax price of the exempt firm *I* always increases in the tax rate. If the market size of firm *I* is sufficiently small, then the before-tax price of the rated firm *E* decreases in the tax rate. This result can be explained by two effects: (a) because firm *I* cannot deduct VAT, higher taxes will directly lead to higher production costs, and (b) a higher tax rate will increase firm *I*'s output tax advantage as the increased VAT rate is directly price relevant for firm *E*'s non-rated customers. Under reasonable calibration assumptions (i.e., a minimal number of non-rated customers relative to the size of $\mu_E$), firm *E* will be forced to reduce prices to offset the increase in taxes without gaining market shares in return. Marginally, firm *I* is able to increase prices. Therefore, the two effects always have the same direction for the VAT exempt firm, whereas they are ambiguous for the VAT rated firm.

Under reasonable calibration assumptions, both effects will negatively affect demand. Analytically, part (ii) of Proposition 2 explains this result. If the two firms offer sufficiently differentiated products or services (i.e., the parameter $\varepsilon$ is sufficiently low), then the term $(c_E\gamma)/(c_I\mu_I)$ will be in the interval $\eta(\varepsilon)$ and

both types of firms will respond to a higher tax rate by offering lower quantities in equilibrium.[7]

## 3.4 Scenario B: Both Firms are VAT rated

In Scenario B, we assume that firms $I$ and $E$ are VAT rated; that is, $t_I = t_E \equiv t > 0$. It follows that both firms can reclaim the VAT they have paid on inputs.

From Equation (5), we compute the before-tax price $p_I^B$ of firm (operator) $I$ in Scenario B by setting $t_I = t_E \equiv t$:

$$p_I^B = \frac{1}{4-\varepsilon^2}\left[2c_I + \varepsilon c_E + \frac{\alpha_I(2-\varepsilon^2) - \alpha_E\varepsilon}{1+\gamma t}\right].$$

Similarly, the before-tax price $p_E^B$ of firm $E$ is given by

$$p_E^B = \frac{1}{4-\varepsilon^2}\left[2c_E + \varepsilon c_I + \frac{\alpha_E(2-\varepsilon^2) - \alpha_I\varepsilon}{1+\gamma t}\right].$$

Substituting equilibrium prices $(p_I^B, p_E^B)$ in the demand functions given by Equation (3) produces equilibrium demands $(x_I^B, x_E^B)$ in Scenario B as

$$x_I^B = \frac{(2-\varepsilon^2)(\alpha_I - c_I(1+\gamma t)) + \varepsilon(c_E(1+\gamma t) - \alpha_E)}{\beta(4-\varepsilon^2)(1-\varepsilon^2)},$$

$$x_E^B = \frac{(2-\varepsilon^2)(\alpha_E - c_E(1+\gamma t)) + \varepsilon(c_I(1+\gamma t) - \alpha_I)}{\beta(4-\varepsilon^2)(1-\varepsilon^2)}.$$

Except for the cost structure and the market sizes, the two equilibrium demands are now equal and independent of the fraction of VAT rated inputs. Therefore, this VAT regime does not distort competition between the two firms (operators); consequently, Scenario B can be seen as the benchmark case for Scenario A's market distortions driven by firm *I*'s VAT exemption.

In the next proposition, we analyze the effect of a higher tax rate $t$ on the equilibrium prices and demands in Scenario B.

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[7] The interval $\eta(\varepsilon)$ describes the sufficient conditions under which a higher tax rate induces a decrease in equilibrium quantities for both firms. Note that the lower the differentiation parameter $\varepsilon$ the larger is the interval $\eta(\varepsilon)$. In the limiting case where $\varepsilon$ is zero the interval goes to infinity, i.e., $\lim_{\varepsilon\to 0}\eta(\varepsilon) = (0,\infty)$.

**Proposition 2**

*(i) A higher tax rate* $t$ *yields a decrease in the before-tax prices* $(p_I^B, p_E^B)$ *of firms I and E if the ratio of market sizes* $\alpha_I / \alpha_E$ *is within the interval* $\eta(\varepsilon)$*. Formally,* $\left( \frac{\partial p_I^B(t)}{\partial t} < 0 \text{ and } \frac{\partial p_E^B(t)}{\partial t} < 0 \right) \Leftrightarrow \frac{\alpha_I}{\alpha_E} \in \eta(\varepsilon).$

*(ii) A higher tax rate* $t$ *yields a decrease in the equilibrium demands* $(x_I^B, x_E^B)$ *of firms I and E if the ratio of cost parameters* $c_I / c_E$ *is within the interval* $\eta(\varepsilon)$*.*

*Formally,* $\left( \frac{\partial x_I^B(t)}{\partial t} < 0 \text{ and } \frac{\partial x_E^B(t)}{\partial t} < 0 \right) \Leftrightarrow \frac{c_I}{c_E} \in \eta(\varepsilon).$

**Proof:** See Appendix A.3.

A higher VAT tax rate will decrease before-tax prices for both firms in Scenario B under reasonable market conditions, i.e., if firms offer reasonably differentiated products or services. Even though the fraction of firm *I*'s non-labor inputs $\mu_I$ is no longer relevant, as the firm can now deduct input taxes as well, a tax increase will lead to higher prices for the non-rated customer segment. To offset some of the resulting volume reductions, the firm will be forced to reduce their before-tax prices, ceteris paribus.

In equilibrium, total demand will decrease for both firms because the increase in VAT introduces a new cost for non-rated customers. Moreover, a higher parameter $\gamma$ reinforces the negative effect of *t* on the equilibrium demands for both firms. It should be noted that if $\gamma = 0$, then the tax rate *t* has no effect on the equilibrium demands.

Scenario B with symmetric taxation of both firms' profits is comparable to the situation usually studied in the literature on tax incidence. Our findings are in line with these analyses. In perfectly competitive industries, commodity taxes induce producer prices (before-tax prices) to either fall or remain unchanged. In imperfectly competitive markets, taxes may be over-shifted, which results in an increase in producer prices due to taxation. Seade (1985) provides criteria for assessing the effects of taxes on prices and profits in Cournot competition. Anderson et al (2001) argue that the extent of tax over-shifting depends on the market characteristics (see also Stern, 1987): For constant elasticity demand and under Bertrand Competition, an ad valorem tax can be either over- or under-shifted. With homogeneous products and linear demand, taxes are under-shifted.

Kenkel (2005) realized a micro econometric study on alcohol beverages based on survey data. He finds that an increase in indirect taxes was over-shifted. Baker and Brechling (1992) conducted analyses of tax pass-through for a number of consumption products, and they generally find the relation to be one-to-one.

## 3.5 Comparison of Scenarios A and B

Comparing Scenarios A and B, we can establish Proposition 3 which summarizes the main results.

**Proposition 3**

*(i) The before-tax price of the entrant is lower in Scenario A than in Scenario B if and only if the proportion* $\gamma$ *of VAT exempt customers is lower than firm I's fraction* $\mu_I$ *of upstream and downstream costs that is non-labor. Formally,* $p_E^A < p_E^B \Leftrightarrow \gamma < \mu_I$.

*(ii) The before-tax price of firm I is higher in Scenario A than in Scenario B if the fraction* $\mu_I$ *of its upstream and downstream costs that is non-labor is sufficiently large. Formally,* $p_I^A > p_I^B \Leftrightarrow \mu_I > \gamma \frac{\varepsilon(\alpha_E - c_E(1+\gamma t)) - (2-\varepsilon^2)\alpha_I}{2c_I(1+\gamma t)}$.

**Proof:** See Appendix A.4.

Part (i) of Proposition 3 shows that the relation between the fraction of non-labor upstream and downstream costs of firm *I* and the proportion of VAT exempt customers crucially determines whether the before-tax price of firm *E* is higher in Scenario A or B. We derive that if $\gamma$ is smaller than $\mu_I$, firm *I*'s VAT exemption will translate into a disadvantage from firm *E*'s point of view and force firm *E* to reduce prices, ceteris paribus.[8]

Part (ii) of Proposition 3 mirrors the results of Part (i). While firm *E* will be forced to decrease prices, ceteris paribus, firm *I* will be able to increase its price if the fraction $\mu_I$ of its upstream and downstream costs that is non-labor is sufficiently large. In this case, VAT exemptions are likely to strengthen the competitive position of firm *I*.

[8] Note that with regard to postal markets, this is the likely scenario, as incumbents (firm *I*) often have a high percentage of labor costs (i.e., $\mu_I$>0.5), whereas the fraction of non-rated customers does not usually exceed 50% (i.e., $\gamma \leq 0.5$ ).

# 4 Calibration

To predict competitive and welfare effects more precisely, we simulate the analytical model presented in Section 3 by using stylized market data for a selected sector with asymmetric VAT exemptions. There are various services and sectors with asymmetric exemptions such as the postal sector, medical and hospital care, welfare and social security work, university education, certain cultural services and so forth. Our model is applicable to all of these sectors. We have chosen the postal sector because it provides a prototypical example of such a VAT distortion as we have laid out in the introduction. We calibrate the model to reflect the B2C bulk mail market because this is the mail segment in which competition is most likely to take place in a fully liberalized postal market.[9] Firm *I* represents the incumbent operator (universal service provider), whereas firm *E* is the entrant operator. Scenario A represents the standard situation in the EU postal markets in which only the historical (incumbent) operator is VAT exempt, whereas the entrant operator has to charge VAT at the standard rate. In Scenario B, both the incumbent and the entrant operator are VAT rated.

To calibrate parameters $\alpha_I$ and $\beta$, we assume that incumbent *I* as a monopolistic operator in the market would deliver one billion bulk mail items at an average price of 0.35 units of money per item with a point-price elasticity of -0.5. It should be noted that the demand function given in Equation (3) is linear, which results in the price elasticity decreasing in quantity.

Parameters $\alpha_i$ influence the size of the market of the two operators' services. By setting $\alpha_I > \alpha_E$, we can include effects such as customer inertia, reputation effects, switching costs, or even quality differences in favor of the incumbent (universal service provider). Formally, we define $\phi$ as the percentage of total demand the incumbent serves if the entrant offers the very same price for its services ("incumbent advantage"). For the calibration, we evaluate demand given in Equation (3) with a price of 0.35 for both operators and solve the resulting equation system. We obtain

$$\phi = \frac{x_I}{x_I + x_E}; \quad p_I = p_E = p = 0.35; \quad \alpha_E = \frac{1}{1-\varepsilon(1-1/\phi)}\left(\alpha_I(\varepsilon - 1 + \tfrac{1}{\phi}) + p(1-\varepsilon)(2 - \tfrac{1}{\phi})\right).$$

[9] For more calibration details, see Dietl et al. (2005, 2011).

In the simulation, we set $\phi = 0.8$; that is, the entrant would get 20% of the market if it were to offer the very same services as the incumbent. A value of 50% would mean that customers have symmetric preferences for the two operators.[10]

As mentioned, parameter $\varepsilon$ measures how different the two products of the two operators are; a value close to one would mean that the products are very close substitutes. Consistent with previous model calibrations (e.g., Dietl et al. 2005), we set $\varepsilon = 0.75$.

The parameter $\gamma$ represents the fraction of exempt, non-rated customers and varies across mail segments. For the base case, we assume $\gamma = 0.5$ to reflect the bulk mail market. The value is in line with the current situation, such as the German letters market, where DPWN reported a 50% fraction of non-rated customers in 2009.

On the supply side, cost needs to be differentiated in the three dimensions: variable/fixed, upstream/downstream and labor/non-labor costs. The latter is relevant for the deduction of input VAT because non-labor costs are VAT rated. In the monopolistic calibration benchmark, we assume costs of 250 million units of money excluding input taxes. In line with the demand calibration, the cost structure of the incumbent is calibrated for a hypothetical monopolistic situation. We thus assume a reasonable rate of return such that the initial price of 0.35 represents a rate-of-return regulated monopoly.[11]

Table 1 shows the major cost assumptions. With these, we are able to compute the necessary parameters to calibrate the two cost functions as introduced in Equation (4).

We assume that the entrant pursues a different business model with only a few delivery days per week, digital pre-sorting and with a lower quality of service. On the one hand, this business model leads to both lower fixed and variable costs. On the other hand, it induces a higher incumbent advantage $\phi$. The lead example of such a business model is the Dutch company Sandd. Similar models can be found in other liberalized postal markets. To illustrate the distortive effects of VAT with regard to outsourcing, we assume that both players pay equal wage rates. In the base case, we assume that the entrant – as observed in practice – applies a much larger fraction of outsourced labor.[12]

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[10] See Jaag (2007) for a discussion of consumers' switching behavior in the mail market.

[11] By doing so, we are able to report the results for the monopoly benchmark. Because we are mainly interested in competitive effects, we will not report these results.

[12] We will see below that this different structure can be explained by the different VAT treatments.

**Table 1: Major Cost Assumptions Base Case**

| | Incumbent | Entrant |
|---|---|---|
| Fraction of fixed costs | 50% | 20% |
| $\mu^F$ (fraction of VAT rated fixed costs) | $=\mu_I$ | $=\mu_E$ |
| $\mu$ (fraction of VAT rated variable costs) | 30% | 70% |
| Efficiency premium upstream | - | 10% |
| Efficiency premium downstream | - | 30% |
| Wage premium | - | - |

The quasi-linear model framework allows for a computation of overall welfare by adding up consumer surplus, operators' profits and governmental tax revenues. The effect of changing postal VAT regimes on governmental tax revenues can be computed as follows. In the case that the USP is exempt, the total VAT tax base is the value of the USP's input goods plus the product value of the USP's customers' output that is rated. If the USP is rated, the tax base is the value of the USP's output to exempt customers in addition to the product value of the USP's customers' output that is VAT rated. Whether the difference in the two cases is positive thus depends on the USP's value added and the fraction of rated customers. It is positive if the fraction of exempt customers is larger than the inverse of the USP's relative value added. In the next section, we will compute the relevant overall welfare measures.

# 5 Numerical Results

The calibrated model allows for some insight into the overall competitive and welfare consequences of various tax regimes using the example of the postal sector. In addition, we perform sensitivity analysis and derive recommendations for regulators, market players, and VAT authorities. It should be noted that the quantitative results presented in this section serve as rough guidelines only.[13]

We report simulation results for the two Scenarios A (incumbent is VAT exempt, $t_I = 0$) and B (both operators fully rated at $t_i = t = 20\%$). We are interested in (i) competitive effects measured by market shares, prices, and profits; (ii) welfare effects; and (iii) changes in collected VAT. We compute the latter against a benchmark scenario where both operators are VAT exempt ($t_I = t_E = 0$).

[13] More detailed simulation results are provided in Dietl et al. (2011).

## 5.1 Base Case

Table 2 reports the results for the base case as introduced in Section 4. The base case includes three different VAT scenarios. In Scenario 0, both operators are VAT exempt. Scenario A is the standard case in the European postal markets, where only the historical (incumbent) operator is VAT exempt. In Scenario B, both operators are fully rated. The results that illustrate the competitive effects are shown in the upper part of the table, whereas those that show the welfare effects are reported in the lower part.

**Table 2: Simulation Results Base Case** $(\mu_I = 0.3, \mu_E = 0.7)$

| | Scenario 0 | Scenario A | Scenario B |
|---|---|---|---|
| Individual VAT rate I ($t_I$) | 0% | 0% | 20% |
| Individual VAT rate E ($t_E$) | 0% | 20% | 20% |
| **Competitive Effects** | | | |
| Incumbent Market Share | 64.8% | 64.1% | 63.7% |
| Price Ratio (I/E) excl. VAT | 118% | 131% | 120% |
| Price Ratio (I/E) incl. VAT | 118% | 109% | 120% |
| Profit Ratio (I/E) | 1755% | 455% | 212% |
| Profit I | 21,979,609 | 20,051,777 | 11,013,273 |
| Profit E | 1,252,698 | 4,410,232 | 5,196,978 |
| **Welfare Effects** | | | |
| Overall Price Level excl. VAT | 0.33 | 0.32 | 0.30 |
| Overall Price Level incl. VAT | 0.33 | 0.34 | 0.36 |
| Operator Profits | 23,232,307 | 24,462,009 | 16,210,251 |
| Consumer Surplus | 372,849,153 | 375,231,196 | 372,755,232 |
| Incremental Government Tax Revenue | - | -3,582,967 | 6,069,580 |
| Overall Welfare | 396,081,460 | 396,110,238 | 395,035,064 |

The comparison of Scenario A and B illustrates the competitive distortions of asymmetric VAT exemptions. In the base case, Scenario A is more favorable for the incumbent. Compared to Scenario B in which both operators are fully rated, the incumbent's profit increases substantially, whereas the entrant's profit decreases slightly. Both price and profit ratios are substantially higher for the incumbent in Scenario A, meaning that the incumbent can charge higher prices in Scenario A in relative terms and earn a higher profit at the same time. Despite its

higher price level in Scenario A, the incumbent achieves a higher market share. The figures show that the tax exemption is distorting competition significantly.[14]

Nevertheless, Scenario A exhibits a slightly higher overall welfare level than Scenario B.[15] There are two opposite welfare effects at work; as a result of the incumbent's VAT rating, the average marginal tax rate in the industry increases. This lowers welfare. However, as the two operators are equally rated, there is a level playing field, and competition is more intense, which increases welfare. Whereas incremental profits are roughly compensated for by opposite incremental tax effects (the profit decrease of the incumbent in Scenario B equals roughly the tax increase of the tax authority), customers are slightly better off in Scenario A. The positive effect comes from the 50% non-rated customers who face lower net prices than they do in Scenario B.[16]

The comparison of Scenario 0 and Scenario B illustrates the distortive impact of VAT on the firms' outsourcing decisions. If both operators are exempt from VAT (Scenario 0), there is a strong incentive to use internal workforce because input VAT on outsourced labor cannot be deducted and hence outsourcing is less attractive, ceteris paribus. Consequently, the entrant's competitive position is much stronger in Scenario B, where the input VAT can be deducted. It should be noted that the operators' cost structures are exogenous in both scenarios, results in a suboptimal labor policy in Scenario 0. The increased costs (because the VAT deduction is not possible in Scenario 0) translate into higher incumbent pricing and profits. In practice, operators would be likely to optimize their labor policy and increase the share of internal workforce in Scenario 0, whereas Scenario B will be competitively neutral in this regard. To sum up, abolishing the incum-

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[14] With the following exception, the results are in line with recent decisions of Deutsche Post DHL to reduce its letter prices for business customers significantly in light of the new VAT regime in Germany as of July 1, 2010. Deutsche Post announced net price decreases equal to the VAT rate itself, which is significantly more than we predict in our simulation.

[15] Our welfare results differ from those reported by De Donder et al. (2009), which yield higher welfare in Scenario B. Whereas the authors also report higher consumer surplus in Scenario A, they multiply government tax revenues by 1.3 to reflect the shadow cost of public funds and therefore find higher overall welfare in Scenario B. As we are interested in the relative effects of the postal sector, we weigh all three components of welfare equally and generally do not account for second-order effects in other parts of the economy.

[16] Note that this effect stems from the fact that we do not allow for price differentiation between customers segments. Therefore, the operators are forced to balance over the two customer segments yielding lower net prices for the rated customers. While we could extend the model to capture the relevant effects, regulations in many countries (e.g., Germany) will not allow differentiated prices for the incumbent.

bent's VAT exemption levels the playing field (in the market itself and in the outsourcing market) while it slightly decreases overall welfare in the base case.

## 5.2 Effect of Different Cost Structures $\mu_I$ and $\mu_E$

Our analytical results presented in Section 3 indicate that the effects crucially depend upon the relative magnitude of the parameters $\mu_i$ and $\gamma$. Whereas $\gamma$ is exogenously given, the cost structure $\mu_i$ can be optimized by the operators. The fraction of rated inputs for the entrant, $\mu_E$, is not relevant for the entrant's decision making if it is fully rated (i.e., in Scenarios A and B); a higher value of $\mu_E$ indicates larger VAT expenses, which, however, can be fully deducted from the VAT billed to the customers. For the tax authority, the net effect matters, as we report the difference in a scenario with both operators being exempt. Therefore, a higher $\mu_E$ increases the input tax deduction that the entrant can reclaim.

In contrast to $\mu_E$, changes in $\mu_I$ are of great importance for the market equilibrium in Scenario A in which the incumbent is exempt. Here, changes in $\mu_I$ are directly cost relevant; outsourcing to equally efficient partners will increase costs by the VAT rate times the amount of the outsourced input goods. In Scenario B, $\mu_I$ is irrelevant for the market equilibrium (in analogy to $\mu_E$ above).

Table 3 reports the competitive effects of different cost structures.[17] Scenario A1 and A2 differ in $\mu_I$ but not in $\mu_E$ (i.e., we obtain the same results for all $\mu_E \in [0,1]$). Scenario A1 represents an incumbent that uses employees mainly. Scenario A2 indicates an incumbent business model with subcontractors in delivery.

Whereas the share of non-rated inputs is generally irrelevant in Scenario B, it is of great importance in Scenario A for the operator that is exempt. In contrast to the relative prices, the operators' profits change substantially when comparing Scenarios A1 and A2. The incumbent's VAT exemption is an advantage in Scenario A1 and a disadvantage in Scenario A2, where incumbent profits are lower. The results are in line with our analytical findings. It should be noted that in Scenario A1, $\mu_I < \gamma$, while we have $\mu_I > \gamma$ in Scenario A2. We conclude that the net competitive effect of an asymmetric VAT exemption crucially depends on the fraction of VAT rated inputs versus the fraction of non-rated customers. In the

[17] Remember that the fraction of VAT exempt (non-rated) customers is set to $\gamma = 0.5$.

base case, the latter effect compensates for the former and the exempt incumbent has a competitive advantage.

**Table 3: Simulation Results for Different Combinations of $\mu_I$ and $\mu_E$**

| | Scenario A1 | Secnario A2 | Scenario B |
|---|---|---|---|
| $\mu_I$ (fraction of non-rated inputs I) | 0.30 | 0.70 | [0,1] |
| $\mu_E$ | [0,1] | [0,1] | [0,1] |
| **Competitive Effects** | | | |
| Incumbent Market Share | 64.1% | 63.3% | 63.7% |
| Price Ratio (I/E) excl. VAT | 131% | 132% | 120% |
| Price Ratio (I/E) incl. VAT | 109% | 110% | 120% |
| Profit Ratio (I/E) | 455% | 70% | 212% |
| Profit I | 20,051,777 | 4,205,975 | 11,013,273 |
| Profit E | 4,410,232 | 5,990,790 | 5,196,978 |
| **Welfare Effects** | | | |
| Overall Price Level excl. VAT | 0.32 | 0.32 | 0.30 |
| Overall Price Level incl. VAT | 0.34 | 0.34 | 0.36 |
| Operator Profits | 24,462,009 | 10,196,765 | 16,210,251 |
| Consumer Surplus | 375,231,196 | 370,295,244 | 372,755,232 |
| Incremental Government Tax Revenue | -3,582,967 | -3,469,367 | 6,069,580 |
| Overall Welfare | 396,110,238 | 377,022,643 | 395,035,064 |

In terms of overall welfare, a higher $\mu_I$ decreases welfare in Scenario A, as the higher perceived costs of the incumbent reduce its profits and slightly increase average prices in the market (lower consumer surplus). In Scenario B, operator and consumer surplus remain unaffected. Abolishing the incumbent's VAT exemption decreases welfare in Scenario A1 ($\mu_I < \gamma$), whereas it increases welfare in Scenario A2 ($\mu_I > \gamma$). Therefore, from a public policy point of view, the incumbent's VAT exemption is desirable in a scenario in which the incumbent's fraction of non-labor costs is relatively low. Conversely, if the fraction is relatively high, the VAT exemption reduces welfare because it induces higher prices.[18]

In most European countries, incumbent operators do not predominantly make use of outsourced labor (i.e., $\mu_I$ is relatively low). Therefore, VAT exemptions for bulk mail can be justified from a welfare perspective in countries with a substantial fraction of non-rated customers, even though such exemptions distort competition clearly in the incumbent's favor.

[18] Note that this differentiation is not captured in the simulation results reported by De Donder et al. (2009).

## 5.3 Effects of Different Combinations of $\gamma$ and $\mu_I$

Our analytical results in Section 3 have shown that the competitive effects of VAT exemptions are crucially driven by the relative size of $\gamma$ and $\mu_I$. The results provided in Table 3 have confirmed the analytics.

Figure 2 provides a series of 3D-plots to provide a more comprehensive understanding of the competitive effects of the two VAT regimes in Scenarios A and B. The 3D-plots depict the operators' profits in the two-dimensional space defined by $\mu_I \in [0,1]$ and $\gamma \in [0,1]$, i.e., all feasible combinations of $\mu_I$ and $\gamma$.[19] Figures 2-1 and 2-2 depict the profits of the incumbent and entrant for Scenarios A and B, respectively. Figure 2-3 illustrates the profits of the two operators in Scenario A, while Figure 2-4 displays the differences in the operators' profits between Scenario A and the undistorted Scenario B.[20]

The figures confirm the analytical findings from Section 3, and they also replicate the results presented in Section 5.2 regarding the impact of the operators' cost structure. In addition, they highlight the importance of market segmentation and provide a more differentiated view on the competitive effects of VAT exemptions.

Figure 2-1 illustrates the ambiguous effect of VAT exemptions for non-rated (incumbent) operators. Such operators will be strengthened in market segments with a relatively high fraction $\gamma$ of non-rated customers (e.g., industrial customers), whereas they will be worse off in segments with a relatively high fraction of rated customers (e.g., banks and private customers). Because exempt operators will optimize their capital structure toward a low value of $\mu_I$, they are likely to be better off in Scenario A and opt for a VAT exemption.

Figure 2-2 shows the entrant's perspective. The profits of the VAT rated entrants are strictly decreasing in $\gamma$ independently of the Scenario. It will prefer Scenario B whenever $\mu_I > \gamma$.[21] As the incumbent is likely to choose a low value of $\mu_I$ in Scenario A, the entrant is likely to opt for Scenario B in policy discussions.

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[19] Apart from that we use in Figure 2 the same parameter constellations as in Scenarios A and B in Section 4.2.

[20] In Figure 2, the operators' profits appear as planes. Nevertheless, profits are not linear in $\mu_I$ and $\gamma$; the curvature is only very weak for $\mu_I \in [0,1]$ and $\gamma \in [0,1]$.

[21] Recall $p_E^A < p_E^B \Leftrightarrow \gamma < \mu_I$ from Proposition 3(i).

Figure 2-4 confirms these findings. It further shows that in the relevant parameter range (i.e., low $\mu_I$), the competitive advantage of exempt operators in non-rated market segments is more important than their disadvantage in rated market segments.

## Figure 2: Competitive Effects of Scenario A and B

**Figure 2-1: Incumbent profits in Scenarios A vs. B**

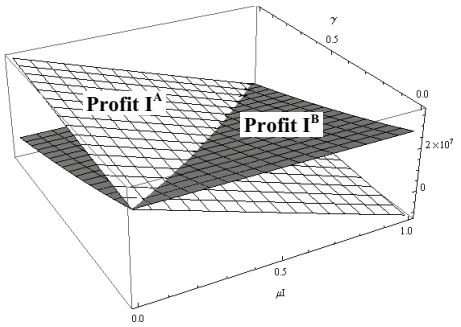



**Figure 2-2: Entrant profits in Scenarios A vs. B**

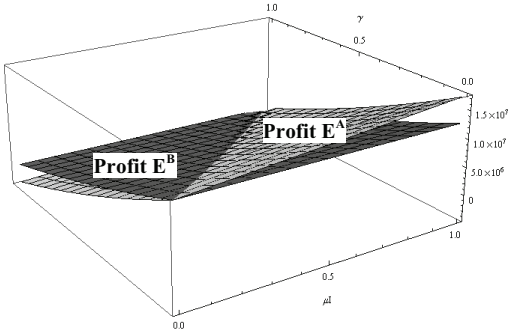



**Figure 2-3: Operators' profits in Scenario A**

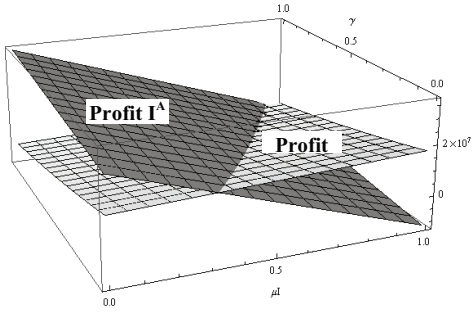
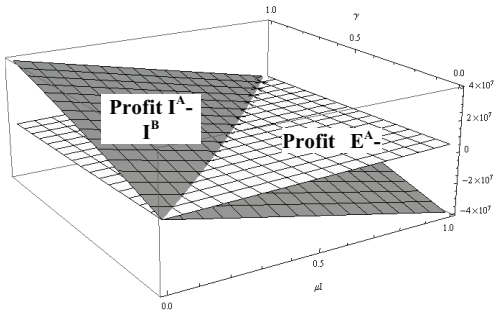



**Figure 2-4: Operators' change in profits**




As a result, in practice, the competitive effects of VAT exemptions will crucially depend on the distribution of customer segments in an industry, which vary significantly with $\gamma$. Thereby, entrant operators will be able to influence ("de-average") $\gamma$ by segmenting the market appropriately. For example, they might choose not to enter the market for non-rated banks and insurances and instead focus and tailor their pricing decisions on market segments, in which customers are rated (in fact most businesses).

# 6 Conclusion

Distortions under the value-added tax (VAT) arise partly from the exemption for specified services and sectors or from differentiated rates within an industry sector. The list of these exempt services and sectors include activities undertaken by public sector bodies, such as medical and hospital care, welfare and social security work, the provision of education and university education and the supply of certain cultural services. Furthermore, non-commercial activities carried out by public radio and television stations are also exempt from VAT. Another example is the postal sector where the universal service providers are usually exempt on the grounds that they are the "public postal service". Other postal service providers are VAT rated at the standard rate (cf. Trinkner 2009 for a recent overview).

In this paper, we have developed a general model framework that can be applied to any sector in which firms competing in the market face asymmetric VAT rates. The model framework enables us to analyze the effects of such asymmetric tax regimes on market shares, optimal prices, tax receipts and welfare. The analytical model shows how asymmetric VAT exemptions distort competition by strengthening the competitive position of non-rated firms. The net effect of such tax exemptions depends on the fraction of rated inputs versus the fraction of non-rated customers. We further elucidate the main competitive impact of VAT policies while showing the consequences on overall welfare by presenting simulation results based on a calibrated quantitative model of the postal sector.

With a reasonable model calibration, the VAT exemption positively affects profits of exempt operators and degrades profits of rated operators. Therefore, it strengthens the exempt operators' relative competitive position and results in an unlevel playing field. In the postal sector, this implies that tax exemptions for universal service providers may reduce their burden represented by the net cost of universal service obligations.[22] Our simulation results further show that the exemption has a positive effect on consumer surplus. Compared to the scenario without VAT exemption, it has a small but positive welfare effect in that the marginal tax rate is lower on average.

The different VAT regimes also have an effect on the make-or-buy decisions of operators because VAT exempt operators have a higher incentive to employ their own workers instead of subcontractors. VAT exemptions thus raise a

[22] Jaag and Trinkner (2011) discuss the effect of market distortions on the calculation of the net cost of postal universal service obligations. See Jaag (2010, 2011) for a discussion of the unfair burden resulting from universal service obligations in the postal sector.

second set of market distortions because they worsen the competitive position of external suppliers.

Our paper may help policy makers assess the main competitive effects of VAT policies in sectors that are characterized by asymmetric VAT exemptions. Moreover, it can provide guidance on how to resolve the policy trade-off between a level playing field in the market, consumer surplus and government tax revenue.

# Appendix A

## A.1 Proof of Lemma 1

The representative customer maximizes utility $u$ under her/his budget constraint $y$ and thus solves

$$\max\left\{u(x_I,x_E)=m+\alpha_I x_I-\frac{\beta}{2}\left(x_I\right)^2+\alpha_E x_E-\frac{\beta}{2}\left(x_E\right)^2-\varepsilon\beta x_I x_E\right\}$$

$$\text{s.t. } (x_I,x_E)\in B \text{ with } B=\left\{(x_I,x_E)\in \mathrm{R}_+^2 \mid y=m+p_I\left[x_I(1+\gamma t_I)\right]+p_E\left[x_E(1+\gamma t_E)\right]\right\}.$$

The Lagrange function is given by

$$L(x_I,x_E,\lambda)=u(x_I,x_E)-\lambda(m+p_I\left[x_I(1+\gamma t_I)\right]+p_E\left[x_E(1+\gamma t_E)\right]-y).$$

By computing the first-order conditions of the Lagrange function and solving the resulting equation systems, we derive

$$x_I=\frac{1}{\beta(1-\varepsilon^2)}\left[\alpha_I-\varepsilon\alpha_E-p_I(1+\gamma t_I)+\varepsilon p_E(1+\gamma t_E)\right],$$

$$x_E=\frac{1}{\beta(1-\varepsilon^2)}\left[\alpha_E-\varepsilon\alpha_I-p_E(1+\gamma t_E)+\varepsilon p_I(1+\gamma t_I)\right].$$

## A.2 Proof of Proposition 1

To prove part (i), we compute the partial derivative of $p_I^A(t)$ and $p_E^A(t)$ with respect to $t$ as

$$\frac{\partial p_I^A(t)}{\partial t}=\frac{1}{4-\varepsilon^2}\left[2\mu_I c_I+\varepsilon\gamma c_E\right]>0,$$

$$\frac{\partial p_E^A(t)}{\partial t}=\frac{1}{4-\varepsilon^2}\left[\frac{(\mu_I-\gamma)c_I}{(1+\gamma t)^2}-\gamma\frac{\alpha_E(2-\varepsilon^2)-\alpha_I\varepsilon}{(1+\gamma t)^2}\right].$$

We further derive $\frac{\partial p_E^A(t)}{\partial t} > 0 \Leftrightarrow \alpha_I > \alpha_I' \equiv \frac{\gamma - \mu_I}{\gamma} c_I + \frac{2-\varepsilon^2}{\varepsilon} \alpha_E$.

To prove part (ii), we compute the partial derivative of $x_I^A(t)$ and $x_E^A(t)$ with respect to $t$ and further derive

$$\frac{\partial x_I^A(t)}{\partial t} = \frac{\varepsilon\gamma c_E - \mu_I(2-\varepsilon^2)c_I}{\beta(4-\varepsilon^2)(1-\varepsilon^2)} < 0 \Leftrightarrow \frac{c_E}{c_I}\frac{\gamma}{\mu_I} < \frac{2-\varepsilon^2}{\varepsilon},$$

$$\frac{\partial x_E^A(t)}{\partial t} = \frac{\varepsilon\mu_I c_I - \gamma(2-\varepsilon^2)c_E}{\beta(4-\varepsilon^2)(1-\varepsilon^2)} < 0 \Leftrightarrow \frac{c_E}{c_I}\frac{\gamma}{\mu_I} > \frac{\varepsilon}{2-\varepsilon^2}.$$

## A.3 Proof of Proposition 2

To prove part (i), we compute the partial derivative of $p_I^B(t)$ and $p_E^B(t)$ with respect to $t$ and further derive

$$\frac{\partial p_I^B(t)}{\partial t} = -\frac{1}{4-\varepsilon^2}\left[\gamma\frac{\alpha_I(2-\varepsilon^2)-\alpha_E\varepsilon}{(1+\gamma t)^2}\right] > 0 \Leftrightarrow \frac{\alpha_I}{\alpha_E} < \frac{\varepsilon}{2-\varepsilon^2} \quad \forall \gamma > 0,$$

$$\frac{\partial p_E^B(t)}{\partial t} = -\frac{1}{4-\varepsilon^2}\left[\gamma\frac{\alpha_E(2-\varepsilon^2)-\alpha_I\varepsilon}{(1+\gamma t)^2}\right] > 0 \Leftrightarrow \frac{\alpha_I}{\alpha_E} > \frac{2-\varepsilon^2}{\varepsilon} \quad \forall \gamma > 0.$$

Note that if $\gamma = 0$, then the tax rate $t$ has no effect on the equilibrium prices for both firms.

To prove part (ii), we compute the partial derivative of $x_I^B(t)$ and $x_E^B(t)$ with respect to $t$ and further derive

$$\frac{\partial x_I^B(t)}{\partial t} = \frac{\gamma(\varepsilon c_E - (2-\varepsilon^2)c_I)}{\beta(4-\varepsilon^2)(1-\varepsilon^2)} < 0 \Leftrightarrow \frac{c_I}{c_E} > \frac{\varepsilon}{2-\varepsilon^2} \quad \forall \gamma > 0,$$

$$\frac{\partial x_E^B(t)}{\partial t} = \frac{\gamma(\varepsilon c_I - (2-\varepsilon^2)c_E)}{\beta(4-\varepsilon^2)(1-\varepsilon^2)} < 0 \Leftrightarrow \frac{c_I}{c_E} < \frac{2-\varepsilon^2}{\varepsilon} \quad \forall \gamma > 0.$$

Note that if $\gamma = 0$, then the tax rate $t$ has no effect on the equilibrium demands for both firms.

## A.4 Proof of Proposition 3

To prove part (i), we compute the difference of firm *E*'s before-tax price in Scenarios A and B and derive

$$p_E^A - p_E^B = t\frac{\varepsilon(\mu_I - \gamma)c_I}{(4-\varepsilon^2)\left(1+\gamma t\right)} > 0 \Leftrightarrow \mu_I > \gamma.$$

To prove part (ii), we compute the difference of firm *I*'s before-tax price in Scenarios A and B as

$$p_I^A - p_I^B = t\frac{\left(1+\gamma t\right)(\varepsilon\gamma c_E + 2\mu_I c_I) - \gamma(\alpha_E\varepsilon - \alpha_I(2-\varepsilon^2))}{(4-\varepsilon^2)\left(1+\gamma t\right)} > 0.$$

We further derive

$$p_I^A > p_I^B \Leftrightarrow \mu_I > \gamma\frac{\varepsilon(\alpha_E - c_E(1+\gamma t)) + (2-\varepsilon^2)\alpha_I}{2c_I(1+\gamma t)}.$$

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