Decomposing the Margins of Transfer Pricing

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Abstract

This paper examines the determinants and margins of profit shifting through transfer pricing. We develop a theory model, where transfer pricing patterns are governed by a generalized concealment cost function (CCF). Our empirical analysis draws on micro-level data about transaction-level imports, firm-level characteristics, as well as tax differentials between regions in Switzerland and countries abroad. We find, both theoretically and empirically, that more productive multinational firms trade an increased quantity of goods, while deviating less from the arms' length price. Moreover, the decision of firms to engage in transfer pricing depends negatively on a fixed cost component in the CCF, as well as trade costs. The model allows us to estimate a theory-consistent concealment cost function, which can be used for counterfactual analysis.

JEL classification : F23; H25; H26; H32.

Key Words : Multinational firms; tax avoidance; tax havens; transfer pricing.

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1 Introduction

Tax harmonization and compliance initiatives have been prominent on the international institutional agenda in recent years. Several bilateral and multilateral tax-authority initiatives – in particular the OECD/G20 Base Erosion and Profit Shifting package (BEPS) – aim at collaborating on the matter of tax avoidance, which multinational enterprises (MNE) have been repeatedly accused of.

In this paper, we analyze the forces that govern the pattern of transfer pricing, one widely used methods of profit shifting. In fact, previous literature has found evidence for transfer mis-pricing (see Bernard et al., 2006; Davies et al., 2014; Cristea, 2015). However, the factors that foster transfer mis-pricing are not entirely disentangled to date. Specifically, which factors determine (i) the decision of firms to engage in transfer pricing, i.e., the *extensive* margin, (ii) the extent of profits shifted, i.e., the *intensive* margin, (iii) different transfer pricing strategies, i.e., firms may shift a given amount of profits to locations with lower corporate tax rates by either shipping small volumes at prices vastly different from the competitive arm's length price (ALP), by shipping large quantities at prices very similar to the ALP, or by any combination of the two. We argue that firm heterogeneity is crucial in explaining these different factors. Especially, for the trade-off between quantity and deviation of the transfer price from the ALP, which is involved in a firm's optimization problem. In this regard, we investigate the effect of firm heterogeneity in terms of productivity, transportation costs, the difference in corporate income tax rates on import quantities, prices, and import volumes, utilizing data about the universe of import transactions to a tax haven, Switzerland. We contribute to the literature along four main lines. First, we generalize the concealment cost function by proposing a theory framework in which transfer prices deviate from arm's length prices for a tax avoidance motive.[1] Second, by introducing firm heterogeneity in terms of productivity in our theoretical model we examine the determinants of transfer pricing along *extensive* and *intensive* margins of transfer pricing. Third, the model allows for a theory-consistent estimation of concealment cost function parameters, which can be used for counterfactual analysis within our model framework. Analyzing how variations in tax differentials, trade costs, or trade policy instruments affect tax evasion or limit transfer pricing might be an important policy tool. Fourth, we employ detailed information about the universe of Swiss firm-level manufacturing import transactions between 2006 and 2013 in our empirical analysis. The dataset used for the empirical analysis offers several benefits.

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[1]Concealment costs are the costs that arise due to engaging in transfer pricing, i.e., paying accountants, dealing with tax authorities, etc.

Due to low corporate taxes and a favorable economic and institutional environment with generous tax privileges for certain legal forms, Switzerland is a highly attractive location for foreign-owned MNEs. At the same time, Switzerland is a major location for domestically owned MNEs (for an overview see Egger and Koethenbuerger, 2016). The focus on a single importer country allows us to hold pricing-to-market constant. We are able to use both the variation in corporate income tax rates across local jurisdictions in Switzerland and across exporter countries to determine how tax differentials affect profit shifting under else constant importer conditions. Lastly, we use name matching to identify within firm transactions. Thus, in contrast to the recent literature on transfer pricing we are able to exploit the variation within a firm to clearly identify mis-pricing.

Similar to Davies et al. (2014) we develop a theoretical model in which transfer pricing is explicitly governed by concealment costs, assuming that firms mis-price transfers because they want to avoid taxes. Firms produce differentiated goods and have monopoly power for their variety. They either produce the inputs needed for the differentiated good themselves in the domestic country, or they import them from a foreign affiliate. The latter makes profit shifting possible. Firms face three restrictions to engage in transfer pricing. First, concealment costs have a fixed component and are increasing in the deviation from the competitive price as well as the traded quantity of goods. Second, as inputs have to be used in the production process there is an implicit maximum of inputs that can be used without cannibalizing the domestic monopoly profits. Third, high trade costs might render transfer pricing infeasible, especially for small tax differentials. We find that a certain productivity threshold is necessary for firms to engage in profit shifting, which is due to the fixed cost component in the concealment cost function and varies between countries due to country-pair-specific iceberg trade costs. While higher fixed costs are intuitively associated with decreased entry, the role of trade costs is more subtle. Firms will only shift profits if the gains from profit shifting (in terms of net profits) are sufficiently large to compensate for transportation costs. The net gains from transfer pricing depend on the tax differential: the larger it is the greater are the potential gains. On the other hand the costs of transfer pricing increase with transportation costs because goods need to be traded to be able to exploit the tax differential. This implies that both the tax differential and the trade cost-adjusted tax differential matter. Trade cost can even be so high that they become prohibitive for transfer pricing. Thus, the global decline of transportation costs might play a significant role in the rise of transfer pricing.

The paper is structured as follows. The next section describes the related literature. Section 3

provides an overview of corporate taxation in Switzerland. Section 4 outlines the theoretical model. In section 5 we describe the data and the empirical estimation strategy. Finally, section 6 concludes.

2   Related Literature

A large strand of the public finance literature focuses on profit shifting (see Huizinga and Laeven, 2008; Schindler and Schjelderup, 2013; Dharmapala, 2014), as well as channels through which MNEs reduce their corporate tax payments. In fact, empirical evidence has shown that MNEs avoid taxation by shifting profits to low tax countries (e.g. Clausing, 2009; Dyreng et al., 2012; Dharmapala and Riedel, 2013; Egger et al., 2014). For instance, the results in Egger et al. (2010) suggest that, among European firms, the absolute tax payments of MNEs are lower than those of comparable firms that only operate domestically. The main instruments used for profit shifting are transfer pricing (see Bernard et al., 2006; Davies et al., 2014), debt shifting (see Egger et al., 2014), and royalty payments (see Karkinsky and Riedel, 2012; Griffith et al., 2014 among others). Bernard et al. (2006) and Davies et al. (2014) have shown for the US and France, respectively, that deviations of the transfer price from ALP are related to differences in taxes. The former show that the price wedge depends on product differentiation, firm size, market power, destination-country tax rates, and import tariffs for MNEs in the US, and the latter show that the biggest French MNEs consistently use price transfers.

These findings imply that transfer pricing is an important instrument for multinational firms' tax avoidance practices, and that intensive local multinational activity creates some leeway for profit shifting. The OECD (2010) states the problem underlying the use of transfer prices as a vehicle for profit shifting: *"When independent enterprises deal with each other, the conditions of their commercial and financial relations (e.g., the price of goods transferred or services provided and the conditions of the transfer or provision) ordinarily are determined by market forces. When associated enterprises deal with each other, their commercial and financial relations may not be directly affected by external market forces in the same way."*

Indeed MNEs may use sophisticated methods, for instance, by engaging in manipulation of the arm's length price to conceal deviations in the transfer price (Cristea and Nguyen, 2016) for tax reasons. Even without mis-pricing intent, Bauer and Langenmayr (2013) argue that MNEs are more productive and hence the marginal cost for an intra-firm transaction is lower than that of an independently sourced input. Additionally, the latter involves a bargaining

mark-up, which can render it relatively more expensive. In Keuschnigg and Devereux (2013), financial frictions distort the transfer price. All these factors render the empirical analysis of transfer pricing practices difficult. The next section discusses the institutional setup in Switzerland that fosters profit shifting, in particular transfer pricing.

3 Corporate Taxes and Profit Shifting in Switzerland

The topic of tax-induced profit shifting of MNEs is a highly debated one, having substantial quantitative implications with respect to the potential losses for national tax authorities. For instance, the Australian Administrative Appeals Tribunal decided in 2008 that Roche Products Pty Limited Australia, a subsidiary of Roche Holdings Ltd of Basel, Switzerland had overpaid 45 million dollar for its ethical pharmaceutical products to Roche Basel (Switzerland) between 1993 and 2003.

Switzerland has a residence-based corporate tax system such that companies are subject to corporate income tax on worldwide income, with the exception of income attributable to foreign permanent establishments or foreign immobile property. Low corporate tax rates in general and privileged taxation of holding companies, administrative companies and mixed companies on a cantonal level (similar to US state level) in Switzerland as well as its reputation as a tax haven, provide an incentive for MNEs to use transfer pricing, among other methods, in order to avoid taxes. Although the privileged taxation is supposed to be abolished through a current corporate tax reform to be put in place by 2018 or 2019, the period under consideration in this paper still falls under current practices.[2]

– Table 1 about here –

Table 1 summarizes the 26 Swiss cantonal corporate profit tax rates for different forms of legal persons. It is evident that the variation in tax rates is large, and the lowest rates apply in central Switzerland, amounting to little more than 12 percent. The highest tax rates apply in Western Switzerland and Basle, amounting to about 24 percent in Geneva. The average tax rate is 17.9 percent.

Profits are supposed to be taxed in the location in which the value added was generated. In general market forces present in transactions between two independent firms should enforce the aforementioned principle. Thus, transactions between two independent firms should be

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[2]Tax privileges for MNEs will be substituted by a decrease in corporate tax rates as well as other benefits more in line with the OECD BEPS package. This includes improved bilateral and multilateral cooperation to diminish profit shifting. In addition, bank secrecy for foreign clients will be abolished at around the same time, hence it is questionable whether Switzerland can be considered a tax haven in the future.

priced at arm's length. In contrast, multinational firms may exploit a lack of market forces (within the firm) to shift profits to low tax countries by pricing this internal transactions different from the ALP. This involves undercharging for inputs sourced from affiliated firms located in high tax countries, and/or overcharging inputs supplied from affiliated firms in low tax countries. The identification of mis-priced transactions is thus empirically challenging. Comparable goods may not be available in the data, especially for specialized industries such as watches and jewelery, and the pharmaceutical industry, which are important sectors for the Swiss economy. Especially the pharmaceutical industry is a highly regulated market, including the regulation of prices.[3] Accordingly it is not peculiar per se, that transfer prices deviate from arm's length prices.

4 Model

In this section we provide a model of transfer pricing between two affiliated firms located in country $i = d, f$, where d indicates the domestic country and f the foreign country. Without loss of generality we write the model from the perspective of a firm in the domestic country that potentially has affiliates in the foreign country. Both countries differ in their corporate tax rates, $\tau_i \in [0, 1]$. Firms are heterogeneous in terms of their productivity, ϕ, which is drawn from a known distribution. Firms produce differentiated goods indexed by ω. For simplicity we assume that the differentiated goods can only be produced and consumed locally in the domestic country, but firms are able to use inputs produced by domestic affiliates and/or import inputs provided from a foreign affiliate. Thus, the foreign affiliate does not produce any differentiated goods and its sole purpose is to decrease the effective tax rate of the domestic firm.[4] We denote the domestic input as x_d and the foreign input as x_f. Both are perfect substitutes in the production process. Profit shifting by transfer pricing arises from the fact that an input can be imported from a foreign affiliated firm and its price can be set differently from the market price.

Concealment costs

If a firm decides to source inputs from a foreign affiliated firm, it may engage in transfer mis-pricing, i.e., shifting profits towards the country with the lower corporate tax rate.

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[3]The Swiss pharmaceutical industry contributes about 6% to the Swiss GDP and accounts for about 30% of exports.

[4]Allowing for foreign production and even trade in differentiated goods, as in Helpman et al. (2004) does not change the analysis, but greatly increases the model complexity as it introduces further entry cutoffs and makes aggregation more difficult.

As in Davies et al. (2014) firms can shift profits towards low tax countries by exporting (importing) intermediate inputs above (below) the market price. As this kind of mis-pricing usually violates tax laws, the firm incurs concealment costs.[5]

Depending on the tax differentials firms either want to import goods below or above the arms' length price. Thus, we specify two generalized concealment cost functions: (i) one in which the foreign firm undercharges their inputs, i.e., the corporate tax rate in the domestic country is lower than in the domestic country, and (ii) one for a foreign firms that overcharges, i.e., the foreign corporate tax rate is lower than the domestic one.

In our model, concealment costs consist of two parts, a variable part and a fixed part. The firm has to pay some fixed cost, F_U and F_O, if the firm uses undercharging or overcharging, respectively. The variable part depends positively on the difference between the transfer price and the competitive price, and the total amount of goods shipped. If the transfer price and the competitive price differ significantly, the firm may be audited by the tax authority and needs to justify this difference, which increases costs. If a firm exports high quantities, this can imply greater profit shifting and tax authorities might demand more documentation, i.e., greater exports/imports might raise the suspicion of tax authorities. The concealment costs for undercharging transfer pricing are

$$(p_A - p_U)^\alpha x_f^\beta + F_U, \tag{1}$$

where p_U is the undercharging price of an internal transaction, which is lower than the competitive price p_A, and $\beta, \alpha \geq 0$. If the firm overcharges, i.e., the transfer price of input p_O is higher than the competitive market price, the concealment costs are

$$(p_O - p_A)^\alpha x_f^\beta + F_O. \tag{2}$$

In contrast to Cristea and Nguyen (2016) firms take the competitive arms' length price as given. Thus, instead of strategically setting p_A and p_U (p_O) to reduce concealment costs, the firm only sets the price wedge between the arms' length price and the internal transfer price p_U or p_O by choosing the optimal p_U and p_O, respectively.[6]

Utility

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[5]These costs might include paying transfer pricing accountants, preparing documentation, and legal fees.

[6]In the Appendix A we show that very similar concealment cost functions can be derived using an optimal acting tax authority that maximizes expected fines.

Individuals (in the domestic country) have linear-quadratic preferences as in Melitz and Ottaviano (2008):

$$U = q_0 + e \int_{\omega \in \Omega} q(\omega) d\omega - \frac{1}{2} b \left(\int_{\omega \in \Omega} q(\omega) d\omega \right)^2 - \frac{1}{2} c \int_{\omega \in \Omega} q(\omega)^2 d\omega, \tag{3}$$

where q_0 is a numeraire, $q(\omega)$ is the quantity of a differentiated good indicated by ω from the set Ω of available goods in the domestic country, and e, b, and c are positive constants. The aggregate market demand is

$$p(\omega) = e - b \int_{\omega \in \Omega} q(\omega) d\omega - cq(\omega), \tag{4}$$

where we assume that the mass of individuals in the economy is normalized to one. We define the aggregate price of all products as

$$P \equiv \int_{\omega \in \Omega} p(\omega) d\omega, \tag{5}$$

and hence

$$P \equiv \left(e - b \int_{\omega \in \Omega} q(\omega) d\omega \right) M - c \int_{\omega \in \Omega} q(\omega) d\omega, \tag{6}$$

where $M \equiv \int_{\omega \in \Omega} d\omega$ is equal to the total number of products in the economy. Then we can write $\int_{\omega \in \Omega} q(\omega) d\omega = \frac{eM - P}{c + bM}$, and the (aggregate) demand for a product ω is linear and given by

$$p(\omega) = E - cq(\omega), \tag{7}$$

where $E \equiv \frac{ec + bP}{c + bM}$. Without loss of generality we normalize c to one.

Firms

Firms face monopolistic competition in their goods market as in standard Krugman (1980) and Melitz (2003) models. Each differentiated good ω is produced using domestic inputs x_d and/or foreign inputs x_f, which are perfect substitutes in the production process. All domestic parent firms have the same technology to produce the differentiated goods using the two inputs:

$$y(\omega) = x_f + x_d. \tag{8}$$

Firms are heterogeneous in terms of the productivity to produce inputs, x_d and x_f. Their input productivity, ϕ, is drawn from a known distribution with cumulative density function $G(\phi)$. We assume that firms can produce one unit of input x_d and x_f, respectively at costs

$1/\phi$ in both countries. As the productivity of foreign affiliates and the domestic parent firm is the same, there is no reason for firms to source any input from abroad. In this stylized model input sourcing from abroad will be exclusively driven by tax considerations.[7]

In our basic model two types of firms exists. First, a firm that only sources domestically. Second, a firm that sources from a foreign affiliate, but at a price below (above) the arm's length price, i.e., it uses transfer mis-pricing to shift profits to locations with lower tax rates.

Domestic firm

Net profits of a firm that only operates domestically, sources its inputs domestically, and sells its differentiated good in the domestic market, are:

$$\pi^d(\omega) = (1 - \tau_d)\left(p(\omega)y(\omega) - \frac{x_d}{\phi}\right) - F, \tag{9}$$

where we use that for an exclusively domestically sourcing firm, $y(\omega) = x_d$. F denotes fixed entry costs. The (internal) costs of the firm for its inputs is $1/\phi$. Because each firm has a monopoly in its market, the demand for inputs x_d is given by

$$x_d = \frac{E\phi - 1}{2\phi}, \tag{10}$$

which is increasing in ϕ. Then the necessary productivity to cover the fixed cost F and to enter the domestic market is given by

$$\overline{\phi} \geq \left(E - 2\sqrt{\frac{F}{1 - \tau_d}}\right)^{-1}. \tag{11}$$

Undercharging MNE

Assuming that the domestic tax rate is lower than the foreign tax rate, $\tau_d < \tau_f$. In this case firms want to shift profits from the foreign high-tax country towards the domestic low-tax

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[7]We could allow firms to have two independent draws from the $G(\phi)$ distribution, the first one for the domestic productivity, ϕ_d, the second one for the foreign productivity ϕ_f. Thus, $G(\phi_d > \frac{\phi_f}{\epsilon})$ gives the probability of domestic sourcing without the possibility of transfer pricing, where $\epsilon \geq 1$ are iceberg trade costs. Introducing transfer pricing will alter this relationship. The tax differential between the domestic and foreign country might render importing inputs more profitable. Thus, the foreign productivity draw necessary for importing might be lower, and everything else equal more firms will import from foreign affiliates. Or the fixed costs of the concealment cost function are so high that $\frac{\phi}{\epsilon} < \hat{\phi}$, where $\hat{\phi}$ is necessary productivity of a firm to use transfer pricing. In this case we have three types of firm: (i) firms that only source domestically, with the lowest productivity, (ii) firms that source from abroad but at ALP, with intermediate productivity, and (iii) firms that import from the foreign country at a price lower (higher) than the arm's length price. Disregarding the (ii) options simplifies the model.

country. Thus, the firm will import intermediates inputs below the arms' length price, i.e., undercharge. Total consolidated (foreign and domestic) net profits of the firm are:

$$
\begin{aligned}
\pi^U(\omega) =& (1 - \tau_d)\left(p(\omega)y(\omega) - \frac{x_d}{\phi} - p_U\epsilon x_f\right) \\
&+ (1 - \tau_f)\left(p_U - \frac{1}{\phi}\right)x_f - (1 - \tau_f)(p_A - p_U)^\alpha x_f^\beta - F_U - F,
\end{aligned}
\tag{12}
$$

where gross profits generated by the domestic entity are revenues less domestically produced inputs and *undercharged* foreign input costs. The gross profits (losses) of the foreign entity are the revenues from the undercharged exports less the production costs. The term $(p_A - p_U)^\alpha x_f^\beta - F_U$ reflects the concealment costs, which further decrease consolidated profits. Note that the fixed costs, F, are not deductible. Without loss of generality we assume that the concealment costs are paid by the entity with the higher tax rate to even further decrease profits in the high-tax location. Note that if a firm wants to use foreign imports (to make use of transfer pricing), they face iceberg trade costs $\epsilon \geq 1$. These trade costs imply a constraint to shift profits, i.e., the net profit gains of transfer pricing must be sufficiently high to pay for the fixed costs, F_U, and the inefficiency created by the presence of iceberg trade costs. We use the fact that firms have monopoly power and that $y(\omega) = x_d + x_f$, to derive the first order conditions of the firm's maximization problem:

$$
\begin{aligned}
\frac{\partial \pi(\omega)^U}{\partial x_d} =& 0 \quad \rightarrow E - 2(x_d + x_f) - \frac{1}{\phi} = 0, \\
\frac{\partial \pi(\omega)^U}{\partial x_f} =& 0 \quad \rightarrow (1 - \tau_d)\left(E - 2(x_d + x_f) - p_U\epsilon\right) + (1 - \tau_f)\left(p_U - \frac{1}{\phi}\right) - (1 - \tau_f)(p_A - p_U)^\alpha \beta x_f^{\beta-1} = 0, \\
\frac{\partial \pi(\omega)^U}{\partial p_U} =& 0 \quad \rightarrow -(1 - \tau_d)\epsilon x_f + (1 - \tau_f)x_f + (1 - \tau_f)\alpha(p_A - p_U)^{\alpha-1} x_f^\beta = 0.
\end{aligned}
$$

The optimal undercharging price, p_U, is given by

$$
p_U = \frac{\alpha}{\beta - \alpha}\left(\frac{\beta}{\alpha}p_A - \frac{\tau_f - \tau_d}{\phi\zeta}\right),
\tag{13}
$$

where $\zeta = (1 - \tau_d)\epsilon - (1 - \tau_f)$ is the trade costs adjusted tax differential. Note that if $\tau_d < \tau_f$ and $\epsilon \geq 1$, then $\zeta > 0$.

In order to shift profits, the undercharging price needs to satisfy $0 \leq p_U \leq \frac{1}{\phi}$. The first inequality rules out negative prices, the second inequality states that the undercharging price must be smaller than the cost of the affiliate, $\frac{1}{\phi}$, otherwise no profits would been shifted. While the second inequality always holds, given that $p_A = \frac{1}{\phi}$, $\epsilon \geq 1$ and $\alpha > \beta$, the first inequality constrains firms' pricing behavior. If $p_A = \frac{1}{\phi}$ and $\alpha > \beta$, we need $\zeta < \frac{\alpha}{\beta}(\tau_f - \tau_d)$

to ensure that $0 \leq p_U$. Solving the inequality for ϵ yields:

$$\epsilon \leq \frac{\alpha}{\beta} \frac{\tau_f - \tau_d}{1 - \tau_d} + \frac{1 - \tau_f}{1 - \tau_d}, \tag{14}$$

where the right hand side (RHS) is always greater than 1. Notice that the RHS is increasing in τ_d and decreasing in τ_f, i.e., it increases in the tax differential between the two countries. If transportation costs are too high relative to the tax differential, the firm wants to set a negative price to be able to shift profits, i.e., the exporter is actually paying the importer for the intermediate goods. We assume that this case transfer pricing is not feasible. Assuming that ϵ is sufficiently small, such that for a firm with given productivity ϕ the undercharging price is positive, and $\alpha > \beta$, we can show that

$$\partial(p_A - p_U)/\partial\phi < 0, \qquad \partial(p_A - p_U)/\partial\epsilon > 0,$$

$$\partial(p_A - p_U)/\partial\tau_f > 0, \qquad \partial(p_A - p_U)/\partial\tau_d < 0.$$

Thus, more productive firms charge lower prices, but deviate less from the competitive price. On the other hand firm deviate more if the tax differential is greater, holding productivity constant. Last, higher trade costs increase the price wedge.

Similarly we derive the optimal traded quantity is

$$x_f^U = \left(\frac{(1 - \tau_d)\epsilon - (1 - \tau_f)}{(1 - \tau_f)\alpha(p_A - p_U)^{\alpha - 1}} \right)^{\frac{1}{\beta - 1}}. \tag{15}$$

Substituting the optimal undercharging price, p_U, from equation (13) yields

$$x_f^U = \left(\frac{(1 - \tau_d)\epsilon - (1 - \tau_f)}{(1 - \tau_f)\alpha \left(\frac{\alpha}{\alpha - \beta} \left(p_A - \frac{\tau_f - \tau_d}{\phi\zeta} \right) \right)^{\alpha - 1}} \right)^{\frac{1}{\beta - 1}}. \tag{16}$$

Assuming that $p_A = \frac{1}{\phi}$, an interior solution, $(x_f, X_d > 0)$, and $1 < \beta < \alpha$, it can be shown that $\partial x_f^U/\partial\phi > 0$. Thus, bigger (more productive) firms trade more goods. Moreover, we find that

$$\partial x_f^U/\partial\tau_f > 0, \qquad \partial x_f^U/\partial\tau_d < 0, \qquad \partial x_f^U/\partial\epsilon < 0.$$

Every thing else equal, a higher foreign tax rate (higher tax differential) incentivizes a firm trade more goods to shift profits. Moreover firm deviate more from the competitive price, thus total profits shifted increase with the tax differential. Given that $\alpha > \beta$ and an interior solution, more productive firms will deviate less from the arms' length price and instead

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use more quantity. With increasing productivity firms substitute price deviation for quantity.

In the Appendix B we explicitly derive the analogous expression for an overcharging MNE. The overcharging price is given by

$$p_O = \frac{\beta}{\beta - \alpha} \left(p_A + \frac{\alpha}{\beta} \frac{\tau_d - \tau_f}{\phi \zeta} \right). \tag{17}$$

Note that the overcharging price has to be higher than the arms' length price, which is the case if $\zeta \leq 0$. Solving for ϵ we get an analogous condition to equation (14) for the feasibility of profit shifting in the presence of iceberg trade costs:

$$\epsilon < \frac{1 - \tau_f}{1 - \tau_d}, \tag{18}$$

where the RHS is greater than one as $\tau_d > \tau_f$. Similarly to the undercharging case transportation costs limit transfer pricing if the tax differential is too small. The optimal quantity is

$$x_f^O = \left(\frac{(1 - \tau_f) - \epsilon(1 - \tau_d)}{(1 - \tau_d)\alpha(p_O - p_A)^{\alpha-1}} \right)^{\frac{1}{\beta-1}}. \tag{19}$$

Binding non-negativity constraint

Also the assumption that E is sufficiently large to ensure that $x_d, x_f > 0$ might seem trivial, yet it has important implications for the model. If the domestic demand for the differentiated good of a firm is small, only limited amounts of inputs can be used in the production. This limits the profit shifting capabilities of a firm. If profit shifting is optimal and E is not sufficiently large, we are in a corner solution with $x_d = 0$. In this case the firm will source all its inputs from abroad, still maximizing local profits, i.e., the firm behaves like a monopolist in the domestic market. Thus, the optimal inputs with a binding non-negativity constraint on x_d are given by

$$\tilde{x}_f = \left(\frac{\phi E - \epsilon}{2\phi} \right). \tag{20}$$

The first order condition becomes

$$\frac{\partial \pi(\omega)^U}{\partial p_U} = 0 \quad \rightarrow \quad -(1 - \tau_d)\epsilon + (1 - \tau_f) + (1 - \tau_f)\alpha(p_A - p_U)^{\alpha-1}\hat{x}_f^{\beta-1} = 0,$$

which implies that $\frac{\partial(p_A - p_U)}{\partial \phi} > 0$. More productive firms deviate more from the arms' length price. The only possibility to shift more profits is to change the price wedge, e.g., lower p_U.

Moreover, for constraint firms we will not observe any quantity adjustments, as they always use the maximum amounts of inputs. Thus, firm's with a binding non-negativity constraint will introduce a downward bias in the price difference estimation and in the quantity estimation.

Extensive margin

Firms face two constraints when using transfer pricing for reasons of tax avoidance. First, the transfer price has to satisfy the two conditions given by equations (14) and (18). These relate the tax differential to the iceberg trade costs, ϵ. Figure 1 depicts the relationship given by equations (14) and (18) graphically. Only if the iceberg trade costs are below the line, transfer pricing (over- or undercharging) will be feasible. The part to the left of the kink corresponds to the overcharging case, i.e., $\tau_f \leq \tau_d$, while the right-hand side gives the undercharging condition. The depicted relationship is independent of ϕ, as we assume the arm's length price to be equal to $\frac{1}{\phi}$. Clearly, transfer mis-pricing is more feasible the greater tax differential, as the upper limit of trade cost increases in the right and left tail.

– Figure 1 about here –

Second, firms have to recover the fixed costs. Specifically, in the case of undercharging the additional profits of transfer pricing less concealment costs and total trade costs must exceed the fixed costs, F_U. Equation (21) states this relationship:

$$(\tau_f - \tau_d)x_f^U(p_A - P_U) - (1 - \tau_f)(p_A - p_U)^\alpha (x_U^U)^\beta - (1 - \tau_f)(\epsilon - 1)x_f^U p_U \geq F_U, \qquad (21)$$

where the first part of the left-hand side (LHS) gives the additional (net) profits due to profit shifting, the middle part represents the reduction of (net) profits due to the variable costs of undercharging, and the last part are the (net) additional iceberg transportation costs a firm faces. Moreover, the LHS increases with ϕ, thus there is a cutoff value $\hat{\phi}$ for which firms will start to use transfer pricing. i.e., the above inequality holds with equality. We substitute the optimal undercharging price and import quantities from equation (13) and (16), respectively. Equation (21) cannot be solved explicitly for $\hat{\phi}$. Using the implicit function theorem, we find that $\hat{\phi}$, decreases with the tax differential and increases with transportation costs, as well as fixed costs of transfer pricing.

We use a simple calibration of the model to show how the transfer pricing cutoff productivity, $\hat{\phi}$, varies with the tax differential, $\tau_d - \tau_f$, the iceberg trade costs, ϵ, and the fixed costs of

transfer pricing, F_U. Table 2 shows the calibration used. As we want to analyze the extensive margin, we need to parameterize the productivity distribution. We assume that productivity is Pareto distributed with $G(\phi) = 1 - \left(\frac{1}{\phi}\right)^k$ with shape parameter $k = 1.75$, which is the estimate of Eaton et al. (2011). We set the entry costs F and the market size E such that in the baseline calibration the necessary productivity to enter the market $\hat{\phi} = 100$. The cutoff for transfer pricing is around 172, which implies that around 38% of the firms that have entered the market are using transfer pricing.

– Table 2 about here –

Figure 2 shows a numerical responses of the transfer pricing cutoff $\hat{\phi}$ and changes of the extensive margin in terms of percentage of firms that use undercharging conditional on being in the market. We hold all variables constant using the baseline calibration, and only vary the variable indicated on the x-axis.

– Figure 2 about here –

The top two graphs show the how the domestic and foreign tax rates change $\hat{\phi}$. As τ_d increases, i.e., the tax differential decreases, $\hat{\phi}$ increases. Although we use τ_d up to 0.5, the transportation costs constraint shown in Figure 1 becomes binding before. Moreover, the share of firms that engage in transfer pricing increases with τ_d. This seems counter-intuitive, but recall that the market entry cutoff, $\overline{\phi}$, increases with τ_d, and at a much quicker rate than $\hat{\phi}$.[8] As the domestic tax rate raises, less firms enter the market, but more and more firms use transfer pricing. In the top right graph of Figure 2 we find the relationship that we expect. As the tax differential increases, τ_f raises relative to τ_d, undercharging becomes more and more profitable, and a lower productivity is needed to engage in it. The bottom left panel shows the response due to changing iceberg trade costs, holding all other variables constant at the baseline calibration value. Again, higher transportation costs make transfer pricing less profitable and the necessary productivity increases. Note that for values $\epsilon > 1.54$, the constraint depicted in Figure 1 becomes binding and no firm (independent of its productivity) will be able to use transfer pricing. The last graph relates $\hat{\phi}$ to the fixed undercharging costs to higher fixed costs, F_U,

Corollary

The specific concealment cost function in the model yields some interesting and testable

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[8]Recall that we assume that F is not deductible.

14

predictions. Given an interior solution, $\alpha > \beta > 1$, and trade costs sufficiently low the following model predictions arise:

1. The necessary productivity of firms to engage in transfer mis-pricing increases with the fixed costs of transfer mis-pricing and per piece trade costs, and decreases with the tax differential.

2. The optimal quantity shipped of transfer mis-priced goods depends negatively on the iceberg trade costs, and positively on the tax differential.

3. The optimal price wedge is inversely related to the quantity traded, thus more goods are traded at prices more similar to the arm's-length price.

5 Empirical analysis

5.1 Data

We combine several micro-level datasets for Switzerland. First, we use the universe of Swiss import transactions in the manufacturing sector between 2006 and 2013, provided by the *Swiss Customs Administration*. These contain information about the CIF (including cost, insurance and freight) transaction volumes and quantities, the 8-digit product category, the country of origin, and the name of both the importer and the exporter. The availability of volumes and quantities allows us to construct CIF unit values which serve as the proxy for the transaction-specific mark-up. Note that firms are not identified by a unique identification number but only based on name and location characteristics, hence a string search algorithm was applied in order to identify firms. We treated firms with several locations in Switzerland as separate entities in a first step. The search process was complicated by an undefined number of firm and location spellings, and it was computationally expensive because of the large sample size. We have reduced the burden by conditioning on the canton for Swiss firms and on the country of origin for foreign firms, and by matching strings that shared the same first character. Next, Stata's *reclink2* command was used to identify pair-relationships, i.e., affiliates or parent companies based on the name and country of origin of the importer or exporter, respectively. As not all affiliated or holding companies carry the same name as the Swiss firm, this results in conservative estimates throughout the next section. Second, we have matched these data to information about firm-level characteristics such as the number of employees, the NACE affiliation, operating revenue and capital stock from Bureau van

Dijk's *Amadeus* database.[9] These data are used to calculate log productivity based on Petrin et al. (2004). The free variables are log wage and log age, the proxy we use is the import volume, capital is taken from the balance sheet, and we use gross operating turnover as the dependent variable.[10] As the information about Swiss firms is relatively scarce, we use this match to analyze the response to the tax wedge in terms of extensive and intensive margins of interest. We use the universe of our import dataset for further counterfactual analysis later on. Third, we use the cantonal corporate profit tax rates summarized in section 3, which are matched to the canton the importer is located in. Fourth, we use comprehensive data for corporate profit tax rates in 79 countries between 1996 and 2013 as described in Egger et al. (2015). For the corporate profit tax rate we use the maximum corporate profit tax rate in a country and year.

– Figure 3 about here –

Figure 3 shows the distribution of the aforementioned tax rate for each year in the data, using whisker-plots. The area around the median (a horizontal bar) indicated by a box refers to the interquartile range (IQR), whereas the extended lines, the *whiskers*, indicate values within a maximum of 1.5 times the IQR. The corporate profit tax rates in Figure 3 show a relatively high degree of variability over time, even at the median.

– Table 3 about here –

Next, we provide summary statistics about the data used for empirical analysis in Table 3. We have collapsed the data at the level of the firm, the exporter firm, the country of origin, product code (by HS 8-digit industry), as well as year for a preliminary analysis. This also reduces the noise inherent in an analysis based on the use of every single import transaction as recorded by the customs office. The resulting number of observations amounts to nearly 10 million. We observe slightly more than 100 thousand firms, importing more than 8 thousand products from more than 750 thousand exporter firms located in 143 countries, in 8 years. Moments of the data are summarized in the upper panel of the table. More than 6 percent of observations refer to intra-firm imports. Finally, the (absolute) average tax differential amounts to 10 percent, with a minimum of zero and a maximum of 40 percent. Note that

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[9]Alternatively, we have tried to match this sample with information about firm ownership from Bureau van Dijk's *Orbis* database, however this resulted in a very small number of matches (around 50).

[10]We have calculated productivities differently (according to the Ackerberg et al. (2015) and Gandhi et al. (2016) methods) to check the sensitivity of the results later on. The corresponding results were unchanged.

we have disregarded observations where the country of origin offers a lower tax rate, as the number of countries is negligible.[11]

5.2 Estimation

5.3 Reduced form estimation

The first part of the empirical strategy is related to Davies et al. (2014) and Cristea and Nguyen (2016). Precisely, we are interested in testing the predictions obtained in section 4 by way of reduced form regressions. As described in the previous section, the unit of observation is an import transaction, specific to the import of a good in product category g by importer firm i (located in canton d) from exporting firm j (located in origin country f) in year t.[12] The notation illustrates that the data used is novel in its degree of detail, as we can observe import pair-relationships at the product level, and exploit variation in regional taxes in addition to the one in countries of origin. The price baseline regression is estimated as follows:

$$ p_{ijgt} = \gamma_1 \text{MNE}_{ijgt} + \theta_{ipfdt} + \tag{22} $$

where p_{ijpt} is the log import price for each transaction of good p between firm i located in a Swiss canton d, and a foreign firm j located in a country f, MNE_{ijpt} is a binary variable which equals one if the transaction is intra-firm and zero if it is an arm's length transaction, , and ν_{ijgt} is the disturbance term. The fixed effect θ_{ipfdt}, η_{ipj}, λ_{fd}, κ_{ft}, and π_{pt} remove the bias from unobserved firm-product-origin-canton-time factors that affect prices (e.g., productivity, or average, time-invariant product-origin prices paid by a firm). Essentially we are using the variation of different transactions within a firm for a given product, origin country and year. Thus, we compare the prices of product p between a firm in canton d with a foreign firm in country f, where the firm is either affiliate or not.

The equation for log import quantities and volumes can be written analogously to (22).

Next we can adapt estimation of equation (22) to be based on the data containing firm-level information from Amadeus. This leads to an equation which differs from (22) in the inclusion

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[11]Nevertheless, it is perfectly feasible to include those observations, see also Cristea (2015).

[12]Because i is specific to d, and j to f, we simplify the notation accordingly.

of log productivity and takes the following form:

$$p_{ijpt} = \delta_1 \text{MNE}_{ijpt} \times \Delta\tau_{fdt} + \delta_2 \text{MNE}_{ijt} \times \phi_{it} + \delta_3 \Delta\tau_{fdt} \times \text{MNE}_{ijt}\tau_{fdt} \times \phi_{it}$$
$$+ \mu_i + \chi_{ft} + \psi_{pt} + \sigma_{fd} + \varepsilon_{ijpt}, \tag{23}$$

where ϕ_{it} is log productivity, and ε_{ijpt} is the disturbance term. This equation includes two interaction terms. In order to remove endogeneity bias, we further control for firm, canton-origin, origin-time and product-time fixed effects, but need to neglect firm-time specific general factors in order to be able to identify the effect of productivity. With these data at hand we can verify the predictions derived in section 4, about firm-level factors that determine intensive and extensive margin transfer-pricing patterns. The equations for log quantity and log volume can be stated analogously.

5.4 Structural estimation

As a final step, we are interested in the parameters α and β of the concealment cost function, which allows us to perform counter-factual analysis. The theoretical model allows us to identify relationships that pin down these parameters, i.e., equations (15) and (19). We take logs of the aforementioned equations which yields

$$log(x_f^U) = \frac{1}{\beta - 1}log\left(\frac{1 - \tau_f - \epsilon(1 - \tau_d)}{1 - \tau_f}\right) - \frac{\alpha - 1}{\beta - 1}log(p_A - p_U) + u, \tag{24}$$

which can be used to identify α and β. Note that we need the deviation from the competitive price, $1/\phi - p_U$, to estimate the parameters. We construct the price wedge from the reduced form regression using the MNE_{ijpt} interaction to compute the firm-specific price wedge. We use iceberg trade costs from Egger (2014).

5.5 Results

We report estimates from the estimation of equation (23) in Table 4. The first three columns report estimates for first-order effects, while columns 4–6 allow for both the first- and second-order effects that we have derived in Section 4 by including interaction effects between the intra-firm dummy, the tax differential, and log productivity variables. The results may be summarized as follows: Using the extensive fixed effects in columns 1–3, we find that within firm transactions are under-priced on average by about 12%, but firms trade significantly more in terms of quantity and volume. Columns 4–6 square with the theory predictions. The

sign of the coefficient on the tax differential (for intra-firm imports) is negative regarding prices, and positive regarding quantities and volumes. This implies that firms mis-price their transfers by undercharging, and they do so more intensively, as the tax differential becomes larger. They also ship larger quantities and volumes as the tax wedge increases.

Next, the coefficient on productivity carries a positive sign regarding price and volume and is insignificant for quantity. Thus, more productive firms deviate less from the arms' length price put use more volume to shift profits, which is consistent with out theory. As productivity increases, the firm can also import larger amounts of foreign inputs without cannibalizing the monopoly mark-up, such that p_A falls. Consequently, $p_A - p_U$ raises as the firm faces a price wedge-quantity trade-off. If many firms are at a corner solution, i.e., they cannot shift more profits without decreasing their profits at home, the quantity is given by equation (20) and would expect insiginificant effects for the quantity regression.

Thus over all our results imply that more productive firms deviate less from the ALP while shipping higher volumes, which is in line with concealment costs (and also trade costs), making profit shifting costly.

An estimation of the universe of import transactions will allow us to estimate (24) in a next step.

6   Conclusion

In this paper we have developed a theoretical model of transfer pricing. Firms that shift profits to low tax destinations face concealment costs and trade costs. The fixed part of the concealment cost function as well as the trade costs limit the number of firms (or possible location of firms) that are able to use transfer pricing. The specific functional form of the concealment cost function drives the intensive margin, i.e., the elasticity of the price wedge and the quantity of goods shipped. We find that the profits shifted increase with firm productivity, i.e., more productive firms deviate less from the arms' length price and ship a larger quantity of goods. Our theoretical model is consistent with empirical findings from reduced form estimations using Swiss transaction-level import data, as well as data about firm-level productivity. Finally, the theoretical model allows to estimate a theory-consistent concealment cost function which can be used for counterfactual analysis. Our findings are consistent with compliance (Jost et al., 2010; Bauer and Langenmayr, 2013; Becker and Davies, 2014; Rathke, 2015) or managerial incentives frameworks (Baldenius et al., 2004; Koethenbuerger and Stimmelmayr, 2015).

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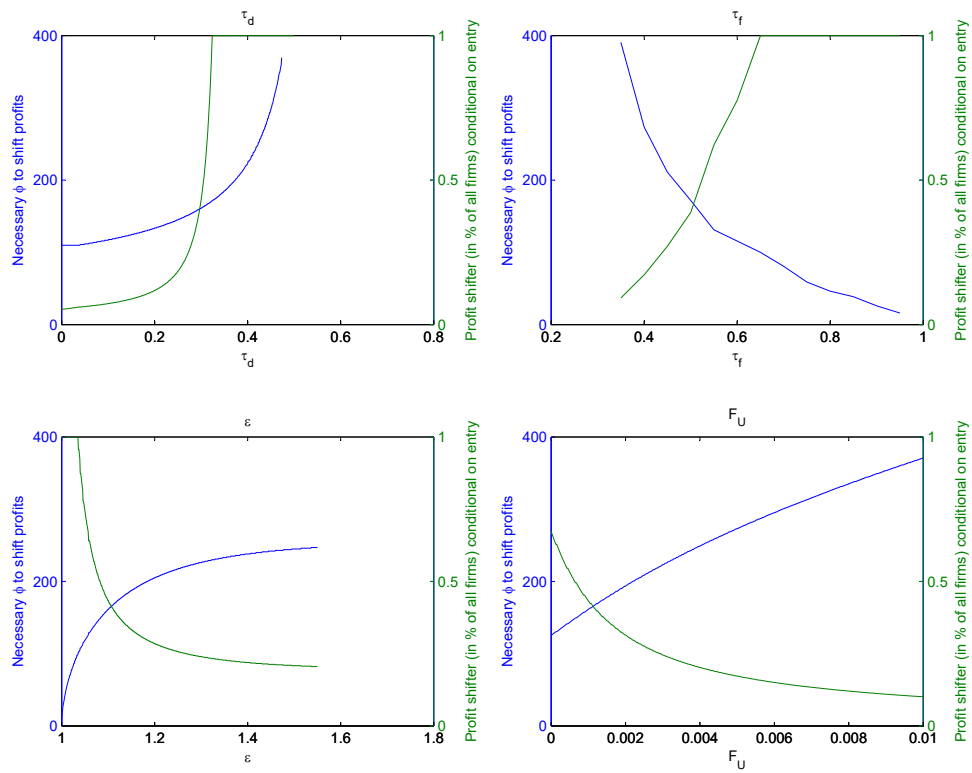
Tables and figures

Figure 1: CONDITION FOR ϵ TO ENSURE TRANSFER PRICING.
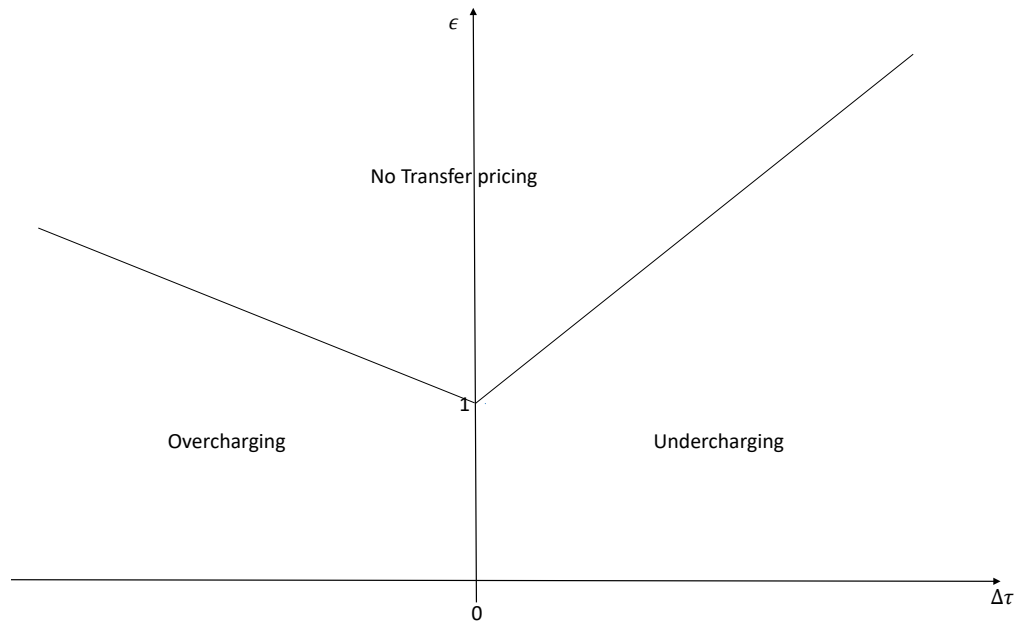
Note: We fix $\tau_d = 0.5$ and only vary τ_f. We assume that $\alpha = 0.75$ and $\beta = 0.25$. For ϵ above the line, transfer pricing is not feasible for firms, independent of their productivity.

Figure 2: CONDITION FOR ϵ TO ENSURE TRANSFER PRICING.

Note: Numerical responses of $\hat{\phi}$, due to changes in model parameters.

Figure 3: CORPORATE PROFIT TAX. 79 COUNTRIES, 1996 - 2011
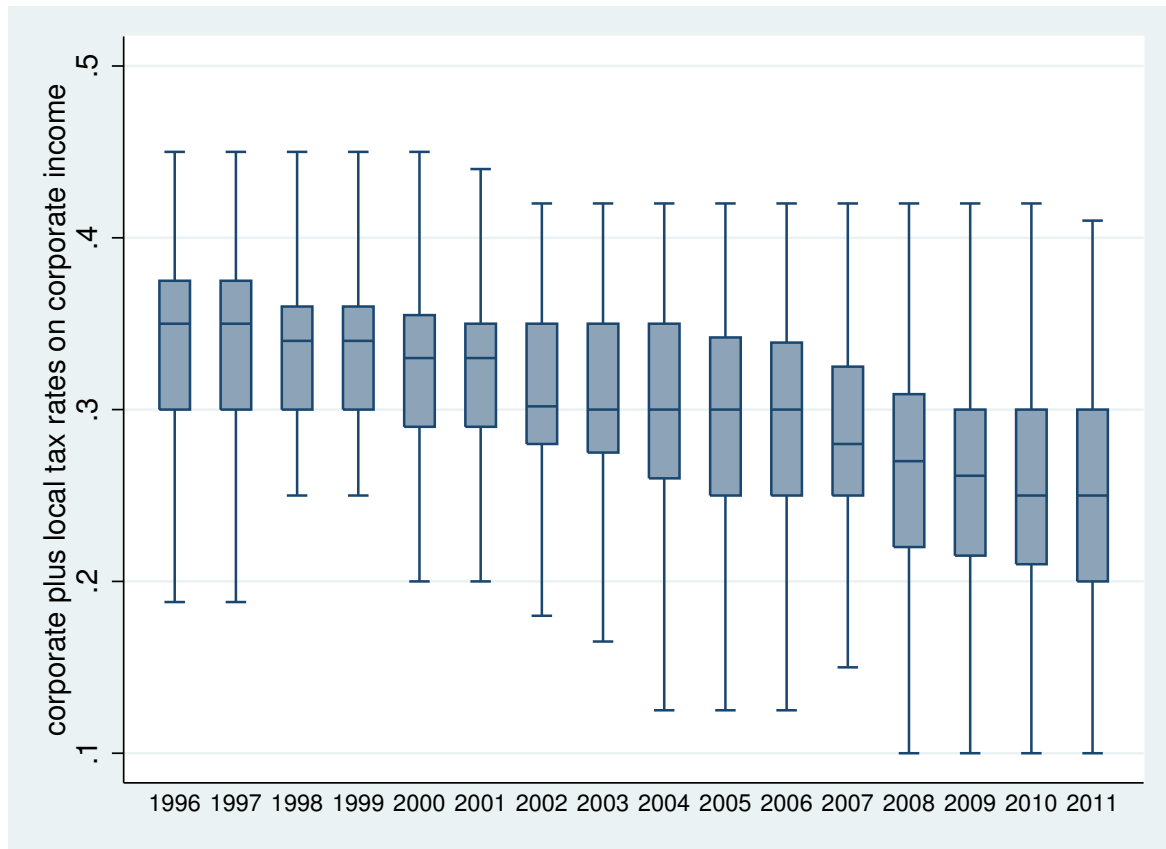
Note: For corporate profit taxes, we utilize the maximum tax rate levied at the national level on corporate profit in a country of residence. In federal states, the total corporate tax rate is calculated as the weighted average of the local (sub-national) taxes combined with federal tax rates (e.g., for Germany or Canada as reported by the OECD) or the tax rate prevailing in the economic center (e.g. for Switzerland, where the rates of the canton of Zurich are taken). The primary sources for corporate profit tax rates are the following: Ernest and Young *Worldwide Corporate Tax Guide* 1998-2012; Coopers and Lybrand *International Tax Summaries* 1996-1997; International Bureau of Fiscal Documentation *Global Corporate Tax Handbook* 2007-2012; Price Waterhouse Coopers *Corporate Taxes - Worldwide Summaries* 1999-2000, 2001-2003, 2012-2013; OECD *www.taxfoundation.org*.

Table 1: Corporate tax rates in Switzerland

Lucerne	12.32	St. Gallen	17.40
Nidwalden	12.66	Aargau	19.17
Obwalden	12.66	Fribourg	19.86
Appenzell A.	13.04	Ticino	20.67
Appenzell I.	14.16	Basle-Land	20.70
Zug	14.60	Jura	20.77
Schwyz	14.86	Zurich	21.15
Uri	15.12	Valais	21.57
Glarus	15.71	Berne	21.64
Schaffhausen	16.04	Solothurn	21.85
Thurgau	16.43	Basle	22.18
Grisons	16.68	Vaud	22.79
Neuchâtel	17.01	Geneva	24.16

Notes: Maximum effective federal/cantonal/municipal pre-tax rate at the cantonal capital in % in Switzerland. Corporate tax rates 2015 (2014 for Berne, Fribourg, Geneva, Lucerne, Thurgau, Uri), Source: Clarity on Swiss Taxes 2015, KPMG Switzerland.

Table 2: Calibration

Variable		Baseline	Variation
Domestic tax rate	τ_d	0.3	[0,0.3]
Foreign tax rate	τ_f	0.5	[0.3,1]
Price wedge elasticity	α	0.75	
Quantity elasticity	β	0.25	
Iceberg trade costs	ϵ	1.1	[1,1.6]
Fixed entry costs	F	0.01	
Fixed undercharging costs	F_U	0.001	[0,0.01]
Market size	E	0.249	
Pareto parameter	k	1.75	

Notes: Parameters used in the baseline simulation and the responses. We assume that the productivity is Pareto distributed with c.d.f.: $G(\phi) = 1 - \left(\frac{1}{\phi}\right)^k$. F and E were chosen such that in the baseline calibration $\overline{\phi} = 100$.

Table 3: Summary statistics

	Mean	SD	Min	Max
Log price	3.676	1.991	-11.225	22.225
Log quantity	3.434	3.023	-6.908	20.572
Log volume	7.109	2.599	0	21.904
ϕ_{it}	7.337	1.419	-0.062	15.773
$\Delta\tau_{fdt}$	10.297	4.431	0.026	39.750
MNE_{ijt}	0.063	0.243	0	1
No Firms				102,668
No Products				8,141
No Exporter				753,274
No Origins				143
No Years				8
Observations				9,654,916

Notes: The summary statistics correspond to data pooled over the period 2006-2015 for import transactions obtained from the Swiss Customs Administration. Log price was calculated as the log of volume divided by quantity. The data correspond to a match of trade transactions data with Amadeus firm-level data from Bureau van Dijk. Log ϕ_{it} is calculated according to Petrin et al. (2004).

Table 4: Price, quantity and volume regressions

	(1)	(2)	(3)	(4)	(5)	(6)
	Price	Quantity	Volume	Price	Quantity	Volume
MNE	-0.118***	0.527***	0.411***	-0.361***	0.147***	-0.112***
	(0.003)	(0.005)	(0.005)	(0.019)	(0.032)	(0.029)
1.ltau_fd				0.000	0.001	0.000
				(0.001)	(0.005)	(0.001)
1.omega				-0.024***	-0.070***	-0.046**
				(0.001)	(0.002)	(0.002)
1.mneXltau_fd				-0.002***	0.008***	0.005***
				(0.001)	(0.009)	(0.001)
1.mneXlnomega				0.032***	-0.005	0.027***
				(0.002)	(0.004)	(0.003)
Obs.	4,749,672	4,749,672	4,749,672	3,576,624	3,576,624	3,576,624
No. ipfdt	1,449,636	1,449,636	1,449,636			
No. i				44,224	44,224	44,224
No. ft				799	799	799
No. pt				39,517	39,517	39,517
No. fd				1,523	1,523	1,523
R^2	0.825	0.793	0.767	0.638	0.554	0.485

Notes: ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively. All equations are estimated by OLS with robust standard errors and dependent variables in logs.

A   Expected fines of tax evasion

In this section we derive the proposed concealment cost functions in equations (1) and (2) from the optimal behavior of a tax authority that maximizes expected tax revenues. Without loss of generality we focus only on the undercharging case. Deriving the concealment cost function for the overcharging case follows analogously. The tax authority decides how many revenue officers it wants to employ to audit a parent firm given some ex-ante observable variables. The detection probability of illegal transfer pricing increases with the price wedge between the competitive arm's length price and the undercharging price. Both taken as given from the perspective of the tax authority. Moreover, the probability increases (for a given price wedge) with the number of revenue officers are employed at the audit of the firm. We assume that the tax authority randomly audit firms, but a firm is selected for an audit the tax authority can costlessly observe the price wedge and the traded quantity. Still the tax authority has to confirm that the firm indeed applies illegal transfer pricing. Thus, the expected tax revenues, E_T, from an audit are

$$E_T = \left(\frac{L(p_A - p_U)^\varsigma}{L(p_A - p_U)^\varsigma + 1} \right) (\tau_f (p_A - p_U) x_f \varphi) - wL, \tag{25}$$

where the first parenthesis gives the detection probability as a function of revenue officers employed, the price wedge, and an elasticity parameter $\varsigma > 0$. The second parenthesis corresponds to the evaded tax revenues multiplied by a fine markup, $\varphi > 1$, and wL are the wage costs of revenue officers.

The optimal amount of tax officers is given by

$$L(p_A - p_U)^\varsigma + 1 = \left(\frac{\tau_f x \varphi (p_A - p_U)^{\varsigma+1}}{w} \right)^{\frac{1}{2}}. \tag{26}$$

Assume that the probability of a firm to get audited is $\frac{\overline{L}}{ML}$, where $\overline{L}$ is the (inelastic) total number of tax officers at the tax authority and M is the total number of firms in the economy that the tax authority could audit. Then the expected fine from the perspective can be written as

$$E_\Pi = \frac{\overline{L}}{ML} \frac{L(p_A - p_U)^\varsigma}{L(p_A - p_U)^\varsigma + 1} \tau_f (p_A - p_U) x_f \varphi = \frac{\overline{L}}{M} (x \varphi \tau_f)^{\frac{1}{2}} (p_A - p_U)^{\frac{\varsigma+1}{2}}, \tag{27}$$

where we substituted the optimal number of tax officers from equation (26). This is equivalent to the concealment costs function in equation (1), scaled by $\frac{\overline{L}}{M} (\varphi \tau_f)^{\frac{1}{2}}$, and $\beta = \frac{\varsigma+1}{2}$,

and $\alpha = \frac{1}{2}$.

B Overcharging MNE

If the tax rate in the domestic country is higher than in the foreign country $\tau_d > \tau_f$, firms have incentives to shift profits to the foreign country and thus the foreign affiliate overcharges the domestic firm, $p_O > 1/\phi$. Total net profits are

$$
\begin{aligned}
\pi^O(\omega) =& (1 - \tau_d) \left(p(\omega)y(\omega) - \frac{x_d}{\phi} - p_O\epsilon x_f \right) + (1 - \tau_f) \left(p_O - \frac{1}{\phi} \right) x_f \\
& - (1 - \tau_d)(p_O - p_A)^\alpha x_f^\beta) - F_O - F.
\end{aligned}
\tag{28}
$$

The first order conditions of the firm's maximization problem are:

$$
\frac{\partial \pi^O(\omega)}{\partial x_d} = E - 2(x_d + x_f) - \frac{1}{\phi} = 0,
$$

$$
\frac{\partial \pi^O(\omega)}{\partial x_f} = (1 - \tau_d)(E - 2(x_d + x_f) - p_O\epsilon) + (1 - \tau_f) \left(p_O - \frac{1}{\phi} \right) - (1 - \tau_d)\beta x_f^{\beta-1}(p_O - p_A)^\alpha = 0,
$$

$$
\frac{\partial \pi^O(\omega)}{\partial p_O} = -(1 - \tau_d)\epsilon x_f + (1 - \tau_f)x_f - (1 - \tau_d)\alpha(p_O - p_A)^{\alpha-1}x_f^\beta = 0
$$

Solving for the optimal p_O yields

$$
p_O = \frac{\beta}{\beta - \alpha} \left(p_A + \frac{\alpha}{\beta} \frac{\tau_d - \tau_f}{\phi\zeta} \right).
\tag{29}
$$

Note that the overcharging price is higher than the arms' length price if $\zeta \leq 0$. This is the case if

$$
\epsilon < \frac{1 - \tau_f}{1 - \tau_d},
\tag{30}
$$

where the RHS is greater than one as $\tau_d > \tau_f$. Similarly to the undercharging case transportation costs limit transfer pricing if the tax differential is too small.

Similar to the undercharging case we derive the comparative statics for overcharging:

$$
\partial p_O/\partial \phi < 0, \qquad \partial p_O/\partial \epsilon < 0,
$$

$$
\partial p_O/\partial \tau_f < 0, \qquad \partial p_O/\partial \tau_d > 0, \qquad \partial^2 p_U/\partial \tau_f \partial \phi > 0,
$$

where we use that for $p_A = \frac{1}{\phi}$, $\alpha > \beta$ and $\zeta < 0$ to ensure that $p_O > \frac{1}{\phi}$. In the overcharging case high-productivity firms increase the transfer price less than low-productivity firms.

Solving for x_f yields

$$x_f^O = \left(\frac{(1 - \tau_f) - \epsilon(1 - \tau_d)}{(1 - \tau_d)\alpha(p_O - p_A)^{\alpha - 1}} \right)^{\frac{1}{\beta - 1}}. \tag{31}$$

Again substituting p_O from equation (17) yields the equilibrium traded quantity:

$$x_f^O = \left(\frac{-\zeta}{(1 - \tau_f)\alpha \left(\frac{\alpha}{\alpha - \beta} \left(p_A + \frac{\tau_d - \tau_f}{\phi \zeta} \right) \right)^{\alpha - 1}} \right)^{\frac{1}{\beta - 1}}. \tag{32}$$

Again, bigger firms trade more goods at a smaller price differential relative to the competitive price. Moreover, $\partial x_f^O / \partial \tau_d > 0$ and $\partial x_f^O / \partial \tau_f < 0$, which implies that a higher tax difference leads to increased imports of the over-priced foreign inputs. The cutoff productivity can be determined analogously to the undercharging case.

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