THREE ESSAYS ON TRANSFER PRICING, BASE EROSION AND PROFIT SHIFTING OF U.S. MULTINATIONAL COMPANIES

by

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Abstract of the Dissertation

Three Essays on Transfer Pricing, Base Erosion and Profit Shifting of Multinational Companies

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The dissertation focuses on issues of tax avoidance, base erosion and profit shifting of multinational companies and consists of three essays.

First essay studies multinational's decision making process regarding tax optimization in the global environment with the choice of placing mobile assets in different tax locations and in the presence of possible enforcement from tax authorities. The decision making process is presented as a decision tree, which is used as a tool to evaluate possible payoffs of multinational in regulated environment. Another novelty of the presented approach is inclusion of intermediate destinations (offshores) into existing two ends scheme – home and foreign subsidiary. The model introduces tax authorities in parent and final destinations, which attempt enforce the firm to apply arm-length rules by means of audit and penalties. The results demonstrate that transfer pricing

regulations in high tax countries may compel the firm to move the optimal transfer price close to arm-length, especially if efforts of high tax countries are coordinated.

Second Essay attempts to study tax motivated profit shifting of US companies by constructing structural equation model based on factors that traditionally believed to be associated with income shifting and to investigate the nature of the relationships. Additional advantage of this technique lays in possibility to evaluate the relationships among factors in the presence of multi-co-linearity. Since all variables used in the model are observable, measurement model issues associated with latent indicators are not a concern. Data is constructed by merging Compustat North America Fundamentals and Compustat Execucomp covering the period of 2000-2016. Initial results illustrates that publicly available information can be used to measure income shifting effects. Particularly, application of the simultaneous equations' method in the current analysis confirms that US companies face (i) higher domestic tax obligations and lower abroad tax obligations (ii) book-to-tax difference can be a good sign of tax aggressiveness, (iii) US companies prefers debt financing to equity financing to reduce domestic taxes rather than overseas taxes, and (iv) intangibles are shifted to jurisdictions with low tax rates to reduce taxes in US.

Third essay discusses Luxembourg tax agreements (LTAs, Agreements initiated by the Government of Luxemburg to boost investments), which became a financial scandal first

time leaked to newspapers in November 2014 by the group of journalist from the International Consortium of Investigative Journalists. EU authorities (State Aid) have concerns that those companies involved in LTAs were able to reduce their taxes and these agreements signed by multinationals only for tax avoidance purposes and therefore those taxes to be paid in EU. At the same time multinationals claim that LTA were used by them to pursue other management goals such as expansion of the presence in the EU market and for investment decisions. Current paper evaluates whether US multinational companies from S&P 500, which had been involved in Luxemburg Tax Agreements of 2005-2008, were able to reduce their worldwide tax obligations. By comparing results from various difference-in-difference regressions – traditional, quantile and semiparametric, I have found that these companies may have saved more on taxes then other US companies of the S&P list, what indirectly confirms the arguments of EU authorities about tax aggressiveness of those companies involved in Luxembourg agreements.

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Chapter 1: Profit Shifting Decision Making under Enforceable Uncertainty and Offshore Accounts

1.1. Introduction

Today's global economy is associated with rapid digitalization, removal of trade barriers, free movement of capital and labor, and high level of integration of national and international markets. Multinationals are responding to new challenges through transforming businesses from local operating separate entities into global supply chains. Manufactures are shifted from high-cost countries to low-cost countries and new technologies and communication tools have made it possible to maintain integrated policies and management of the whole group of enterprises under one multinational framework. Such structure provides multinationals with additional advantages of spreading key personnel, manufacture and other valuable assets over different locations to optimize production and minimize costs. Additional advantage is created by the opportunity to move profits from high tax to low tax locations and shift costs in oppose directions. One of such tools is transfer pricing – an important element of the performance measurement of the intra-firm trade and effective tool of tax optimization. Transfer pricing may affect reporting income across the subsidiaries of multinational companies, and thus can be used to manipulate the reporting profit. Whilst the supply chain and managerial accounting study transfer prices under the angle of optimization of production across different subsidiaries, the tax oriented literature consider transfer

pricing as an tax minimization tool, which can be used to deviate from arm-length principle in order to shift income from high tax destinations to low tax domiciles. Current paper focuses on profit shifting policies through transfer pricing mechanisms and takes into account governmental efforts to enforce arm-length principle (OECD, 2013).

In this paper the decision making principles under uncertainty is combined with transfer pricing theory and global tax minimization practice to build a model of endogenous mobile assets shifting in the presence of unpredictability of tax audit and enforcement on transfer pricing behavior. The model is distinctive in a way it presents the problem faced by multinationals in their efforts to minimize global tax obligations: possible decisions and their expected outcomes are presented in the form of decision tree, the model copies most basic and popular tax avoidance schemes by combining high tax locations, between which the trade takes place, with offshore accounts as well as takes into account the presence of tax regulations with uncertainty of tax audits. Governments are presented through control tools, such as tax audit and penalties for non-compliance with arm's length rules. The essay doesn't discuss the choice of tax rate but has limited discussion on tax cooperation between high tax countries. The model constructs the situation when a multinational reduces its tax liabilities by shifting profit or mobile assets to a subsidiary in a low tax country by the means of transfer prices. The paper attempts to answer to the following question: Given the tax rates as it is, what should be the probability of audit and penalty rate to ensure that a multinational

compiles with the arm's length prices and whether the cooperation in high tax countries increase the chances of transfer price being in line with tax rules. The proposed approach provides alternative view on how to study decision making process of multinationals regarding global tax optimization problem under uncertainty of tax enforcement.

First section presents decision tree with regulated transfer pricing environment and discusses possible outcomes for the company under uncertainty of audit and penalties. Second section solves maximization problem of the company under each option presented earlier.

1.2. Multinational Decision Making Problem

Typical management or tax minimization problem starts with a firm, which has two operation locations: parent company in the home country and the subsidiary in a foreign country. Parent company sends intermediate good to foreign subsidiary, which in its turn produces final good and sells on local market. The subsidiary pays transfer price to the parent company for intermediate good. The transfer pricing regulations are imposed by the authorities in home country. However, the decision making process of the multinational is more complex, includes multiple destinations and involves several interim destinations. To make picture more realistic, I developed a model, which includes the crucial part of tax minimization scheme – intermediary destination; thus

current model tries to solve tax optimization through country A (home), country B (tax heaven, or any other type of intermediate country), and country C, realization of the final product. The multinational develops the product in country A and sells the rights to produce or to sell the product to its subsidiary in country B through property rights, royalty agreements, etc, using transfer pricing rules such as profit split method, sharing the profit between two subsidiaries A and B. Countries A and C levy high taxes, while country B impose zero taxes or offer very low rates, such as $t_A \geq t_c > t_B \approx 0$; in this case country B serves as a tax haven or a country with tax preferential regime. If the split of the profit less than arm length such as $p_{A,tp} < p_{arl}$ than the country' A tax authorities may perform audit and apply taxes and penalties on deviation from the arm-length principal with probability α. At the same time, if transfer price of the product is higher than the arm-length price between subsidiaries in country B and C, $p_{C,tp} > p_{arl}$, then the tax authorities in country C may impose penalties. Thus, the expected profit function of the multinational is a sum of profits of all its subsidiaries and the probability of being audited and penalized.

$$E(\Pi_{tp}) = \underbrace{(1-\alpha)(1-\beta)\Pi_{tp}}_{\text{probability of no audit}} + \underbrace{\alpha[\Pi_{tp} - \Phi_{AB}]}_{\substack{\text{probability of being} \\ \text{audited \& penalized} \\ \text{by country } A}} + \underbrace{\beta[\Pi_{tp} - \Phi_{BC}]}_{\substack{\text{probability of being} \\ \text{audited \& penalized} \\ \text{by county } C}} + \underbrace{\alpha\beta[\Pi_{tp} - \Phi_{ABC}]}_{\substack{\text{probability of being} \\ \text{audited \& penalized} \\ \text{by countries } A \& C}}$$

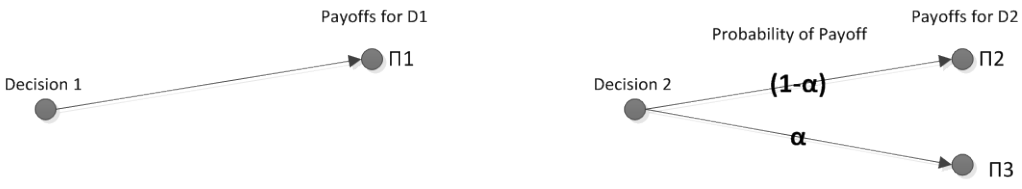
The first expression is the output with probability of avoiding audit and penalties from any country. Second and third expressions show the output with probability of being caught by country A and C respectively, and the last expression is the output if the penalties are imposed by both countries.

As it has been mentioned, the above expression exhibits the expected payoff of the company when the multinational chooses to deviate from the arm-length principle in all tax jurisdictions. However the corporation doesn't need to select this path. It can decide to follow the arm-length principle in any stage or in all stages; it may also not to use intermediate destination B and delivery the product directly from the country A to the country C. All possible decisions of the company are presented through a decision tree (see Appendices A&B). As it is shown on the decision tree, there are six possible decisions and twelve outputs corresponding to these decisions.

If the company chooses to operate through subsidiary A and C, then it has two options: (i) comply with, or (ii) not to comply with the arm-length principle. The decisions noted as (D1) and (D2). These decisions result in three payoffs **П1** – the company complies with the arm-length. If it doesn't obey the rules then there are two possible outputs **П2** and **П3** with probabilities α and (1-α). If payoff **П3** occurs, then the company pays additional taxes and penalties on the amount which was mismatched due to transfer pricing being not equal to arm's length: penalties due (Φ_A) are equal to unpaid taxes in country A plus additional penalties due to mismatches.

$$\Phi_A = t_A(p_{arl} - p_{tp})x(p) + \phi_A\{t_A(p_{arl} - p_{tp})x(p)\} = (1+\phi)t_A(p_{arl} - p_{tp})x(p)$$

Figure 1: Chapter 1. Payoffs for Decisions 1 and 2



П2 is the highest profit between three possible payoffs and therefore the company might choose transfer price not equal to arm-length if the probability of being caught with combination of the penalty rates are low enough.

If П1<(1-α)П2+(α)П3, company chooses TP to be less then arm-length $p^{tp} < p^{arl}$; since П3 is equal П2 minus penalty payments {$П3=П2-Φ_A$}, we can re-write inequality as П2>П1+αΦ confirming that outcome from not complying with rules should be higher than profit from obeying rule and penalties to be paid in case of rules are not obeyed and audit conducted.

In the next case a company chooses to operate through three subsidiaries, A,B and C, where subsidiary B located in tax haven, and two other subsidiaries are in high tax domiciles. In this case, there are four options to choose from:

Decision 3. (D3) Use arm-length between A and B, and arm-length between B and C

Decision 4. (D4) Use arm-length between A and B, and TP between B and C

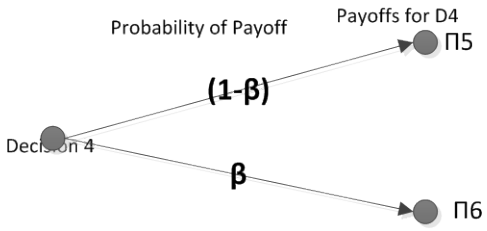
Decision 5. (D5) Use TP between A and B, and arm length between B and C

Decision 6. (D6) Use TP between A and B, and TP between B and C

If company selects D3, i.e. company opts not to cheat in all tax destinations, then the after-tax profit comprises $\Pi 4 = \Pi^{arl} = (1-t_A)\pi_A^{arl} + \pi_B + (1-t_C)\pi_C^{arl}$. At D4, transfer price applied in destination C and company gets the payoff of $\Pi 5 = (1-t_A)\pi_A^{arl} + \pi_B^C + (1-t_C)\pi_C^{TP}$

with probability 1-β and $\Pi 6 = (1-t_A)\pi_A^{arl} + \pi_B^c + (1-t_C)\pi_C^{TP} - \Phi_C$ [1] with probability β, where Φ_C is compensation to country C and it consists of unpaid taxes plus penalties. If payoff **П4** less than payoff **П6** then company would be attracted to choose D4, therefore penalty rate Φ_C and the probability of audit (β) should be high enough to ensure that **П4** is bigger than expected payoffs **П5** and **П6**. Thus, only combination of penalty rate and the probability of audit can convince the company to obey arm-length principle.

Figure 2: Chapter 1. Payoffs for Decision 4



To illustrate this, consider the expected outcome of the company in decision 4:

$E(D4) = (1-\beta)\Pi_C^{TP} + \beta(\Pi_C^{TP} - \Phi_C)$; simplifying the equation we obtain that $E(D4) = \Pi_C^{TP} - \beta\Phi_C$.

Comparison of decisions 3 and 4 brings are to the following conclusions – in order to cheat profit by obeying arm-length rule should be more than expected payoff from exercising transfer price, $\Pi^{arl} > \Pi_C^{TP} - \beta\Phi_C$, otherwise, company will choose to cheat. Inequalities below demonstrate which decision is optimal based on fines $\beta\Phi_C$; if gains from cheating are greater than $\beta\Phi_C$, company will apply transfer price; otherwise company opts for arm-length.

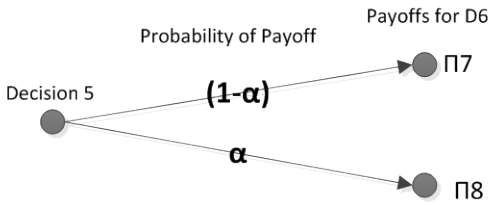
[1] $\Phi_C = t_C(p_{arl} - p_{tp})x(p) + \phi_C\{t_A(p_{arl} - p_{tp})x(p)\} = (1+\phi)t_C(p_{arl} - p_{tp})x(p)$

$\underbrace{\Pi_C^{TP} - \Pi^{arl}}_{\substack{gains\ if\ TP \\ is\ applied}} < \underbrace{\beta\Phi_C}_{\substack{fines \\ due}}$ Decision 3 (arm-length price) is preferable

$\Pi_C^{TP} - \Pi^{arl} > \beta\Phi_C$ Decision 4 (transfer price not equal to arm-length) is preferable

If D5 (decision 5) is selected then after tax profit of the multinational is $\Pi 7 = (1-t_A)\pi_A^{tp} + \pi_B^A + (1-t_C)\pi_C^{arl}$ with probability of 1-α and $\Pi 8 = (1-t_A)\pi_A^{tp} + \pi_B^A + (1-t_C)\pi_C^{arl} - \Phi_A$ [2] with probability of α. And again, penalty rate Φ_A should be high enough to ensure that the multinational comply with the arm-length rules.

Figure 3: Chapter 1. Payoffs for Decision 5



As before, consider expected payoff in decision 5, $E(D5) = (1-\alpha)\Pi_A^{TP} + \alpha(\Pi_A^{TP} - \Phi_A)$; simplifying the equation we receive that the expected payoff is the difference between maximum profit and fines with probability of audit, $E(D5) = \Pi_A^{TP} - \alpha\Phi_A$. Comparison of decisions 3 and 5 brings are to the following conclusions – in order to cheat, profit by obeying arm-length rule should be more than expected payoff from exercising transfer price, $\Pi^{arl} > \Pi_A^{TP} - \alpha\Phi_A$, otherwise, the company will choose to cheat. Inequalities below demonstrate what decision is optimal based on fines $\alpha\Phi_A$; if gains from cheating

[2] $\Phi_A = t_A(p_{arl} - p_{tp})x(p) + \phi_A\{t_A(p_{arl} - p_{tp})x(p)\} = (1+\phi_A)t_A(p_{arl} - p_{tp})x(p)$

are greater than $\alpha\Phi_A$, company will apply transfer price, otherwise company opts for arm-length.

$\underbrace{\Pi_A^{TP} - \Pi^{arl}}_{\substack{gains\ if\ TP \\ is\ applied}} < \underbrace{\alpha\Phi_A}_{\substack{fines \\ due}}$ Decision 3 (arm-length price) is preferable

$\Pi_A^{TP} - \Pi^{arl} > \alpha\Phi_A$ Decision 5 (transfer price not equal to arm-length) is preferable

If D6 (decision 6) is selected then the company may have four possible outputs. The multinational has chance to deviate from arm-length price in both countries (A, C) without being caught and penalized; or it has chance to be caught only by tax authorities in one of the countries (A or C) or it may be audited and penalized in both countries. The list of possible payoffs is the following:

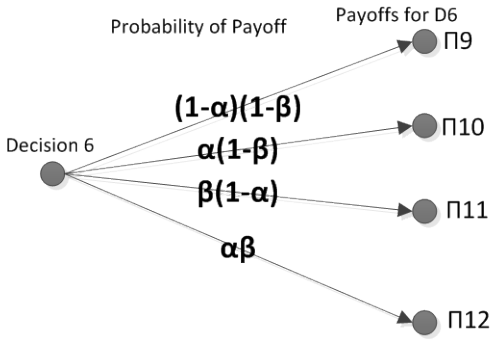
$\Pi 9 = \Pi_{A,C}^{TP} = (1-t_A)\pi_A^{tp} + \pi_B^{A,C} + (1-t_C)\pi_C^{tp}$ with probability (1-α)(1-β);

$\Pi 10 = (1-t_A)\pi_A^{tp} - \Phi_A + \pi_B^{AC} + (1-t_C)\pi_C^{tp}$ with probability α(1-β);

$\Pi 11 = (1-t_A)\pi_A^{tp} + \pi_B^{AC} + (1-t_C)\pi_C^{tp} - \Phi_C$ [3] with probability (1-α)β;

$\Pi 12 = (1-t_A)\pi_A^{tp} + \pi_B^{AC} + (1-t_C)\pi_C^{tp} - \Phi_{AC}$ with probability αβ;

Figure 4. Chapter 1. Payoffs for Decision 6



[3] $\Phi_C = t_C(p_{arl} - p_{tp})x(p) + \phi_C\{t_C(p_{arl} - p_{tp})x(p)\} = (1+\phi_C)t_C(p_{arl} - p_{tp})x(p)$

Where **П9>(П10,П11)>П12**. Penalty payments in **П12** are higher than in **П11** or **П10**, such as Φ_{AC}[4]$=\Phi_A+\Phi_C$, because in this case both countries levy fines. Meanwhile, probability to be audited in both countries at the same time is less than then probability to be audited in one of the countries, i.e. αβ<α,β because α,β are independent, i.e. authorities in countries A and C choose to audit the company independent of each other and they do not cooperate with each other.

The expected payoff for the decision 6 is:

$$E(D6) = (1-\alpha)(1-\beta)\Pi + \alpha(1-\beta)(\Pi - \Phi_A) + (1-\alpha)\beta(\Pi - \Phi_C) + \alpha\beta(\Pi - \Phi_A - \Phi_C)$$

Or simply $E(D6) = \Pi_{AC}^{TP} - \alpha\Phi_A - \beta\Phi_C$

The company chooses not to cheat if the expected payoff in D6 is less than the value obtained by obeying arm-length price in D4; since the possible profit in D6 (Π^{TP}) is bigger than profit in D4 (Π^{arl}), the only factors, which reduce the profit Π^{TP}, are penalties and probabilities of tax audits:

$\underbrace{\Pi_{AC}^{TP} - \Pi^{arl}}_{gains\ \ from\ TP} < \underbrace{\alpha\Phi_A + \beta\Phi_C}_{\exp ected\ \ fines\ due}$, decision 6 is not advisable

$\Pi_{AC}^{TP} - \Pi^{arl} > \alpha\Phi_A + \beta\Phi_C$, decision 6 is advisable

Fines in countries A and C should be high enough to prevent the company from cheating in both countries through tax havens (country B), otherwise the company will always choose tax avoidance schemes. The decision 6 is preferable for company than D4 and D5 if expected profit in D6 is higher, such as,

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[4] $\Phi_{AC} = t_A(p_{arl} - p_{tp}^A)x(p) + \phi_A\{t_A(p_{arl} - p_{tp}^A)x(p)\} + t_C(p_{tp}^C - p_{arl})x(p) + \phi_C\{t_1(p_{tp}^C - p_{arl})x(p)\} =$
$= (1+\phi_A)t_A(p_{arl} - p_{tp}^A)x(p) + (1+\phi_C)t_C(p_{tp}^C - p_{arl})x(p)$

$$\Pi_{AC}^{TP} - \alpha\Phi_A - \beta\Phi_C > \Pi_C^{TP} - \beta\Phi_C$$
$$\Pi_{AC}^{TP} - \alpha\Phi_A - \beta\Phi_C > \Pi_A^{TP} - \alpha\Phi_A$$

Summarizing the above conditions, in order for the decision 6 to be the best decision with maximum payoff, the following conditions should be held:

$$\underbrace{\Pi_{AC}^{TP} - \Pi^{arl}}_{\substack{gains\ from\ TP \\ in\ countries\ A\&C}} > \alpha\Phi_A + \beta\Phi_C$$

$$\underbrace{\Pi_{AC}^{TP} - \Pi_C^{TP}}_{\substack{gains\ from\ TP \\ in\ country\ A}} > \alpha\Phi_A$$

$$\underbrace{\Pi_{AC}^{TP} - \Pi_A^{TP}}_{\substack{gains\ from\ TP \\ in\ country\ C}} > \beta\Phi_C$$

gains from using transfer pricing in both countries simultaneously should exceed the sum of expected fines in both countries; and gains from transfer pricing in each country (A and C) should trump the expected fine ($\alpha\Phi_A$, $\beta\Phi_C$) in each country. If these conditions are satisfied then the multinational will choose to deviate from arm-length principle in all high tax destinations.

Above, we have assumed that two high tax countries don't cooperate with each other on tax audit. What if the high tax countries cooperate? Under coordination efforts I understand the situation when one country has decided to audit the multinational, and if tax mismatch is discovered, the information becomes available to another country, which, in its turns, also conducts tax audit. Therefore, if multinational is caught in one country then it is caught in second country as well. In such coordinated efforts the probability of tax audit becomes α+β, and the probability of escaping audit in both

countries is 1-α-β[5]. The expected payoff of the company in decision 6 is expressed as $E(D6) = (1-\alpha-\beta)\Pi + (\alpha+\beta)(\Pi - \Phi_A - \Phi_C)$, simplifying the equation gives us $E(D6) = \Pi - (\alpha+\beta)(\Phi_A + \Phi_C)$. If gains from transfer price greater than expected fines, then the company chooses to depart from arm-length, otherwise it chooses not to cheat.

$\underbrace{\Pi_{AC}^{TP} - \Pi^{arl}}_{gains\ from\ TP} < \underbrace{(\alpha+\beta)(\Phi_A + \Phi_C)}_{expected\ fines\ due}$, deviation from arm-length is not beneficial

$\underbrace{\Pi_{AC}^{TP} - \Pi^{arl}}_{gains\ from\ TP} > \underbrace{(\alpha+\beta)(\Phi_A + \Phi_C)}_{expected\ fines\ due}$, deviation from arm-length is beneficial

Fines due between cooperation and non-cooperative cases are the following:

$\underbrace{\alpha\Phi_A + \beta\Phi_C}_{\substack{fines\ due \\ non-coop\ case}} < \alpha\Phi_A + \beta\Phi_C + \underbrace{(\alpha\Phi_C + \beta\Phi_B)}_{\substack{additional\ expected\ fines \\ due\ to\ cooperation}}$ [6]

As it is shown, in case of cooperation, expected fines are higher, which should discourage the multinational to cheat and should encourage countries to coordinate their efforts.

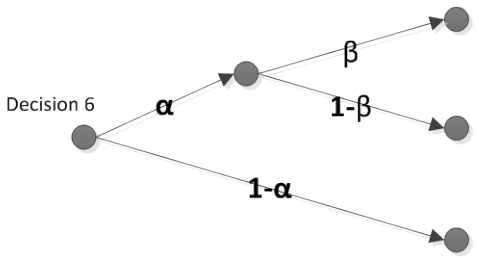
Next case, worth considering, is an episode when the probability of audit in country C is conditional on country A. Such situation is more common, because each country has its own tax audit agenda and some countries due to limited resources may decide to conduct audit only if tax mismatch is discovered by another country, or may ignore the signal from another country. As it is mentioned, the tax audit in country C is conditional on audit in country A – if country A conducts audit, then there is a probability that

[5] We consider mutually exclusive probability events.

[6] In case of non-mutually exclusive events the inequality becomes
$\alpha\Phi_A + \beta\Phi_C < \alpha\Phi_A + \beta\Phi_C + \alpha\Phi_C + \beta\Phi_B - \alpha\beta(\Phi_A + \Phi_C)$

country C will also perform the audit. In this case β is value of conditional probability, such as P(C|A)=β. The picture below depicts the situation in node D6.

Figure 5: Chapter 1. Payoffs for Decision 6 with conditional probability



The expected payoff in decision 6 is expressed by the following equation:

$E(D6) = (1-\alpha)\Pi_{AC}^{TP} + \alpha(1-\beta)(\Pi_{AC}^{TP} - \Phi_A) + \alpha\beta(\Pi_{AC}^{TP} - \Phi_A - \Phi_C)$, which can be simplified to the equation of $E(D6) = \Pi_{AC}^{TP} - \alpha\Phi_A - \alpha\beta\Phi_C$.

Comparison with non-cooperative case, when both high tax countries perform audit independently of each other, provides us with the following results:

$$\underbrace{\alpha\Phi_A + \beta\Phi_C}_{\substack{fines\ due \\ non-coop\ case}} > \underbrace{\alpha\Phi_A + \alpha\beta\Phi_C}_{\substack{fines\ due \\ conditional\ case}}$$

The expected fines in the current case are the lowest among considered in the paper, because country C takes the decision whether to conduct audit or not only after country A finds mismatches in tax payments. Here, multinational has highest incentive to avoid arm-length prices.

1.3. Maximization problem

To understand the maximization mechanism in each node in above decision tree structure I start my analysis from consideration of the typical transfer model described in Koenigsberg (1999) with tradeoff between the optimal transfer pricing and

probability of being penalized for tax aggressiveness. The firm has two operation locations: parent company in the home country and the subsidiary in a foreign country. Parent company sends intermediate good to foreign subsidiary, which in its turn produces final good and sells on local market. The subsidiary pays transfer price to the parent company for intermediate good. The transfer pricing regulations are imposed by the authorities in home country. Pre-tax revenues for home and foreign operations have the following form:

$$\pi_{m1} = p_t x(p) - C_1(\theta_1, x(p))$$
$$\pi_{m2} = px(p) - C_2(\theta_2, x(p), A) - p_t x(p)$$

Where*, x(p)* – intermediate good, where p – is a price of good. The price "p" is internal price of the company, it is not necessary associated with arm's length (p_a), in fact, it can deviate both from arm's length price (p_a) and transfer price (p_t), *C* – cost function which includes rents, wages, and other costs .The probability of being audited by the home government is determined by the parameter α, such as,

$$\alpha(p_a, p_t) \quad and \quad \alpha \in (0,1)$$
$$if \;\; p_t < p_a : \;\; \alpha'(\cdot) \le 0, \;\; \alpha''(\cdot) \le 0$$

If tax rate in foreign country is lower than in home, such as $t_{B,C}<t_A$, then country's transfer price will always be less or equal to arm-length price ($p_t \le p_a$). If $p_t<p_a$ then there is a chance that the home country tax authorities will require a firm to pay discrepancies plus penalty at the rate γ, (γ>0). The higher is difference between the p_t and p_a the higher is probability of audit initiated by the tax authorities. The potential cost for the multinational can be expressed by the following expression:

$$t_A(p_a - p_t)x(p) + \beta\{t_A(p_a - p_t)x(p)\} = (1+\beta)t_A(p_a - p_t)x(p) \quad \textbf{(1)}$$

After-tax profit of the multinational consists of two parts: after-tax profit of the home operation and after-tax profit of foreign operation. The expected after-tax profit with the probability of being audited and penalized will be

$$E(\Pi_m) = (1-\alpha)\Pi_m + \alpha[\Pi_m - (1+\beta)t_A(p_a - p_t)x(p)],$$

Where $\Pi_m = (1-t_A)\pi_A + (1-t_{B,C})\pi_{B,C}$ is after-tax profit of the multinational.

If the firm is not audited or if it is audited and p_a-p_t=*0* it pays taxes as reported in the books, if it is audited and p_a-p_t is not equal to zero than it pays adjusted taxes and penalties. Optimization problem for the multinational is defined as to maximize the global profit taking in to account transfer pricing regulations and the probability of being caught. Arm-length transfer price p_a, and parameters α and β are given.

$$\underset{p,\ p_t}{Max}\ \underbrace{(1-t_A)[p_t x(p) - C_A(\theta_A, x(p))]}_{Aftertax\ profit\ in\ A} + \underbrace{(1-t_{B,C})[px(p) - C_{B,C}(\theta_{B,C}, x(p), A) - p_t x(p)]}_{Atertax\ profit\ in\ B\ or\ C} -$$
$$- \underbrace{\alpha(p_t)(1+\phi_A)t_A(p_a - p_t)x(p)}_{penalty\ expenses}$$

The first term represents after-tax profit in home country, second term – after-tax profit in foreign country and third part of the expression are penalty payments if being caught on deviation of the transfer price from the arm-length price.

First order conditions with respect to p and p_t are:

$$\underbrace{(1-t_A)[x(p)+px'(p)-C'_{B,C}(\cdot)x'(p)]-(1-t_{B,C})x'(p)[C'_A(\cdot)]+}_{MR-MC}$$

$$\underbrace{(t_{B,C}-t_A)[p_t x'(p)]}_{Income\ shifting\ effect}-\underbrace{\alpha(\cdot)t_A(1+\phi_A)[p_a-p_t]x'(p)}_{Penalty\ effect}=0 \qquad (i)$$

$$p_t = p_a + \underbrace{\frac{1}{\alpha'(\cdot)}}_{"-"}\left[\underbrace{\frac{(t_A-t_{B,C})}{t_A}}_{"+"}-\underbrace{\alpha(\cdot)(1+\phi_A)}_{"+"}\right] \qquad (ii)$$

First part of the expression (i) represents the difference between marginal revenue and marginal cost, the second part of the expression measures income shifting effect and the third part shows the size of the possible penalty based on deviation of the transfer price from the arm-length price. The expression (ii) denotes optimal transfer pricing condition. From the optimal transfer pricing condition, the model suggests the following propositions:

Proposition 1: the multinational firm's transfer price is equal to the arm-length price if and only if $\frac{(t_A-t_{B,C})}{t_A}=\alpha(\cdot)(1+\phi)$

The firm's transfer price will be less then arm-length if the right-hand expression is less than left hand expression. If tax difference between two destinations is high than a multinational will most probably underprice its intermediate product to shift income to a foreign country subject to the probability of being punished by tax authorities. Shifting profit to locations with zero tax obligations implies that the right side of the expression in () should be equal to 1 – this means that tax audit should be highly likely to prevent the company from shifting the profit to tax havens.

Proposition 2: if $t_A > t_{B,C}$, then firm's transfer price is increasing in penalty rate β and in strictness of audit.

$$\frac{\partial p_t}{\partial \beta} = \frac{(t_{B,C} - t_A)}{\alpha'(\cdot) t_A (1+\phi)} > 0 \ ; \qquad \frac{\partial p_t}{\partial \alpha} = -\frac{1}{\alpha'(\cdot)} > 0$$

The bigger the difference between t_A and t_B the higher is incentive of multinational to reduce its transfer price, therefore the only constraint it faces is the probability of being audited and the penalty rate. Being audited keeps multinational from downgrading its transfer prices, which pushes the firm's transfer price up in beta and audit.

Above I have considered the when taxes in home country are higher than in foreign country: moving profit from destination A to destination B or C. Let's consider the next step, when the profit is transferred from destination B to destination C. As we know, $t_B < t_C$, taxes in final locations are higher than in location B. In this case, multinational decides to set transfer price higher than the arms-length price, $p_t > p_a$, and authorities in country C with higher tax rates (t_C) are involved in occasional audit and punishment if p_t deviates from p_a. When maximization problem is set, the solutions repeat the equations in propositions 1 and 2.

To understand the mechanics of the profit maximization in П12, when the company chooses transfer prices in locations A and C and uses its offshore accounts in location B

for this purpose, we have to define a maximization problem. The following assumptions are made to simplify the case:

(i) $\phi_A=\phi_C=\phi$; (penalties rates are the same in both countries A and C)

(ii) t_B is very small or equal to zero;

(iii) $t_A=t_C=t$; tax rates are the same in both countries A and C, therefore

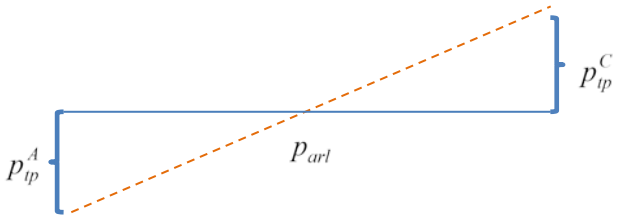
(iv) $\Phi_{AC} = \Phi = t(1+\phi)x(p)(p_{tp}^C - p_{tp}^A)$

where Φ is tax amount due (unpaid taxes and fines) in both countries A and C for the same tax period. The equation of Φ above doesn't contain arm-length price what bring us to the following proposition:

Proposition: if tax rate in both countries is the same ($t_A=t_C=t$) then the difference in intrafirm prices (p_{tp}^C, p_{tp}^A) between subsidiaries A and C indicates the deviation from arm-length principle. The closer is the expression ($p_{tp}^C - p_{tp}^A$) to zero the closer is intrafirm prices to arm-length price. Thus, if intrafirm price between subsidiaries A and B is equal to intrafirm price between subsidiaries B and C then arm-length rule is obeyed.

Figure below illustrates how it works. Transfer price between countries A and B tends to be less then arm-length price, while transfer price between B and C is higher that arm-length. Red dashed line shows deviation from arm-length price, which is represented as blue horizontal line.

Figure 6: Chapter 1. Transfer prices between destinations A and C



Consider maximization problem:

$$\underset{p_m,\, p_A}{Max}\ (1-t)[p_A x(p_m) - C_A(\theta_A, x(p_m))] + (1-t_B)[px(p) - p_A x(p)] + \\ + (1-t)[px(p) - C_C(\theta_C, x(p), A) - p_A x(p)] - \alpha\beta(1+\phi)t(p_C - p_A)x(p)$$

FOC in terms of p_A:

$$(1-t) - (1-t_B) - (1-t) + \alpha\beta t(1+\phi) - (\alpha\beta)'(\cdot)(1+\phi)t(p_C - p_A) = 0$$
$$\Rightarrow -1 + t_B + t(1+\phi)[\alpha\beta - (\alpha\beta)'(p_C - p_A)] = 0$$

$$\Rightarrow p_C - p_A = \frac{-(1-t_B)}{t(1+\phi)(\alpha\beta)'} + \frac{\alpha\beta}{(\alpha\beta)'}$$

And therefore

$$p_C \approx p_A \ iff \quad \frac{1-t_B}{t} \approx \alpha\beta(1+\phi)$$

If transfer prices in country A and C are equal then they comply with arm-length principles. In location A the multinational always tries to set up the transfer price below the arm's length to reduce the profit while in location C it tends to increase transfer prices in comparison to arm's length. Cooperation between authorities in A and C … that they may compare intrafirm prices of the internal good, and if the discrepancies are high, there is the chance that the company has used transfer price to reduce its taxes in

one or both countries. In its turn, the company complies with arms' length only if chances to be audited in both countries and penalty rates are high enough.

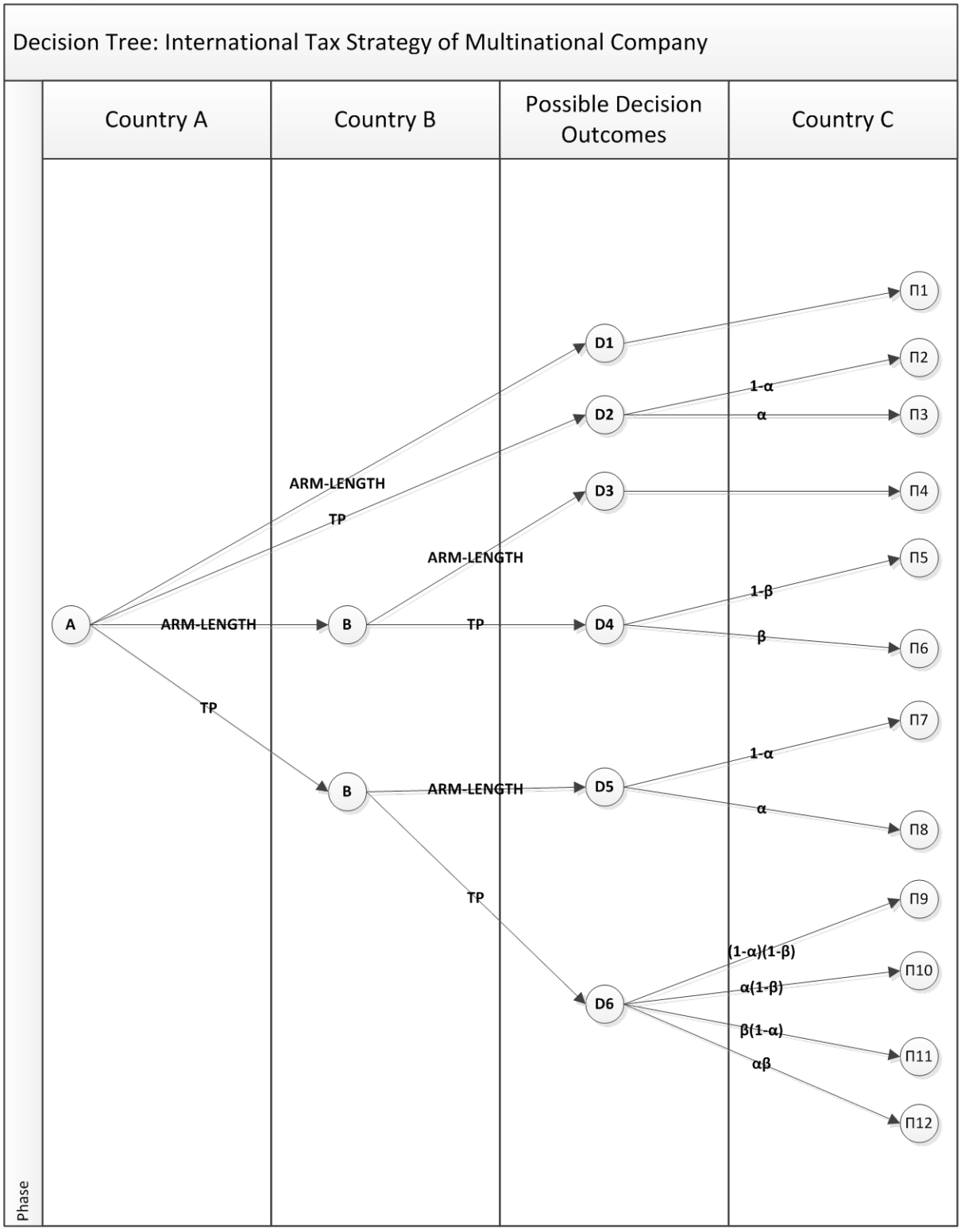
1.4. Conclusion

The paper studies multinational's tax optimization problem in the global environment with the opportunities to move mobile assets in different tax locations and in the presence of possible enforcement of tax authorities in countries with high tax rates. The decision making process is represented as a decision tree, which is used as a tool to evaluate possible payoffs of multinational in regulated environment. Another novelty of the presented approach is inclusion of intermediate destinations (offshores) into existing two ends scheme – home and foreign subsidiary. The model introduces tax authorities in parent and final destinations who enforce the firm to apply arm's length rules by means of audit and penalties. The model envisages three locations: country A, where the intermediate asset is produced; country C, where the asset is consumed; and country B, where the may be moved for tax optimization purposes. The multinational has the following options: (i) open offshore account and conduct business through tax haven or conduct business directly between two destinations, A and C; (ii) deviate from arm's length principle in one or in all tax destinations or comply with the rules. The results suggest that if company chooses to cheat, then operation through the offshore account is preferable, because in this case the company may use transfer price twice – from A to B and from B to C. At the same time transfer pricing regulations in high tax

countries may compel the firm to move the optimal transfer price close to arm-length, if efforts of high tax countries are coordinated.

Tax maximization part of the model presents the following findings. The maximization problem with three destinations doesn't contain the parameter of arm's length price, only transfer prices in locations A and C are involved into equations. In this regard, the difference in intrafirm prices (p_{tp}^{C}, p_{tp}^{A}) between subsidiaries A and C indicates the deviation from arm-length principle. The closer is the expression ($p_{tp}^{C} - p_{tp}^{A}$) to zero the closer is intrafirm prices to arm-length price. Thus, if intrafirm price between subsidiaries A and B is equal to intrafirm price between subsidiaries B and C then arm-length rule is obeyed. In location A the multinational always tries to set up the transfer price below the arm's length to reduce the profit while in location C it tends to increase transfer prices in comparison to arm's length. Cooperation between authorities in A and C implies that they may compare intrafirm prices of the internal good, and if the discrepancies are high, there is the chance that the company has used transfer price to reduce its taxes in one or both countries. In its turn, the company complies with arms' length only if chances to be audited in both countries and penalty rates are high enough.

1.6. Appendix A



1.7. Appendix B

Decision	*Possible outcome*	*Probability of tax audit*
D1	$\Pi 1 = (1-t_A)\pi_A^{arl} + (1-t_C)\pi_C$	
D2	$\Pi 2 = (1-t_A)\pi_A^{tp} + (1-t_C)\pi_C$	*1- α*
	$\Pi 3 = (1-t_A)\pi_A^{tp} + (1-t_C)\pi_C - \Phi_A$	*α*
D3	$\Pi 4 = (1-t_A)\pi_A^{arl} + \pi_B^{true} + (1-t_C)\pi_C^{arl}$	
D4	$\Pi 5 = (1-t_A)\pi_A^{arl} + \pi_B^{C} + (1-t_C)\pi_C^{TP}$	*1-β*
	$\Pi 6 = (1-t_A)\pi_A^{arl} + \pi_B^{C} + (1-t_C)\pi_C^{TP} - \Phi_C$	*β*
D5	$\Pi 7 = (1-t_A)\pi_A^{tp} + \pi_B^{A} + (1-t_C)\pi_C^{arl}$	*1- α*
	$\Pi 8 = (1-t_A)\pi_A^{tp} + \pi_B^{A} + (1-t_C)\pi_C^{arl} - \Phi_A$	*α*
D6	$\Pi 9 = (1-t_A)\pi_A^{tp} + \pi_B^{A,C} + (1-t_C)\pi_C^{tp}$	*(1-α)(1-β)*
	$\Pi 10 = (1-t_A)\pi_A^{tp} + \pi_B^{A,C} - \Phi_A + (1-t_C)\pi_C^{tp}$	*α(1-β)*
	$\Pi 11 = (1-t_A)\pi_A^{tp} + \pi_B^{A,C} + (1-t_C)\pi_C^{tp} - \Phi_C$	*β(1-α)*
	$\Pi 12 = (1-t_A)\pi_A^{tp} + \pi_B^{A,C} + (1-t_C)\pi_C^{tp} - \Phi_{AC}$	*αβ*

Chapter 2: Measuring Tax Avoidance Coefficients by Simultaneous Equation Model

2.1. Introduction: Income Shifting Definition

Usually, under tax-motivated income shifting we understand an event, when the income is reported in a tax jurisdiction different from the location it has been created through sale or any other income generating activity (Hines & Rice, 1994; Dharmapala & Riedel, 2013; Dyreng & Markle, 2013). Income is defined as revenue minus expenses, which are incurred and reported at the same geographical location. There are several approaches by which companies accomplish tax motivated income shifting. The first most common approach is to set prices for goods and services between controlled entities located in different tax jurisdictions in the way, when reported profit in high tax jurisdiction is lower than it should be and the profit in low tax jurisdiction is higher than it should be. Although companies should follow arm's length principle, the incentives and possible benefits may drive companies to move beyond a neutral application of arm's length principle (Dyreng & Markle, 2013). Second approach is to use debt to shift profit between affiliates. Companies can arrange intra-company debt such way that low taxed affiliates lend to high taxed affiliates, and then borrower makes tax-deductible interest payments to lender. Third approach uses intangible assets to shift income. A company may use cost/profit- sharing agreement between affiliates in different tax jurisdictions to recognize profit disproportionally but in favor to the company's objectives. Cost or profit sharing agreements specify how the cost of developing of intangible assets should

be split and/or how future profit will be shared between the parties. Another way how intangibles may be applied to reduce overall tax burden is through intellectual rights and royalties payments: companies may place intellectual rights for using intangibles in low tax jurisdictions and sell the intangibles though royalties to affiliates in high tax locations thus deducting income in high tax jurisdictions and increasing reported profit in low jurisdictions.

2.2. Hypothesis Development and Literature Review

There is a substantial literature on tax motivated income shifting and transfer pricing. The earlier papers such as Harris et al. 1991, Hines and Rice 1994 have found that US tax liabilities of multinationals decreases depending on availability of subsidiaries in low tax countries. The research finding are further contributed by Gruber 2003, who has studied the transfer pricing of intangibles for tax avoidance purposes of US based multinational corporations based on tax return data. The paper focuses on transactions between the parent company in USA and the affiliated, so called CFC, where by definition 51% of shares belong to US shareholders. Desai, and others (2005) answer the question about what type of firms establish tax haven operations, and what purposes do these operations serve and have concluded that tax haven in big countries help to reallocated taxable income of American multinationals while small offshore countries facilitate deferrals of US taxation of foreign income. Dyreng & Lyndsey (2009) study the effect of foreign operations on US MNCs' effective tax rates by using new methodology. Taylor et al, (2007) developed new transfer pricing aggressiveness indicator to investigate

behavior of US MNCs activities related to income shifting; authors develop unique transfer pricing aggressiveness index; further transfer pricing aggressiveness of American multinationals is tested on bunch of variables such as size, tax heaven utilization and share of intangible assets in operation.

In terms of approach used by scholars to study profit shifting the following can be highlighted. The early empirical literature on tax avoidance of US multinational firms compares profitability between low and high taxed subsidiaries using tax returns and finds the profitability in low tax countries to be higher than in high tax countries (Grubert and Mutti, 1991, Hines and Rice, 1994). Latter studies such as Collins, Kemsley and Lang, (1998) or Klassen and Laplante (2012) use foreign pretax income and foreign sales as measurements of profit shifting using publicly available information. Dharmapala and Riedel (2013) propose a new approach to measure income shifting effects – they track how change in company profit is reflected in difference subsidiaries. Given that some profit shifting scheme is already in place it is assumed that any additional dollar earned by the multinational is directed to the low tax locations; thus, authors have found that any increase of consolidated income most probably subside in low tax affiliates, and loses are reported in high tax locations.

Most common approach, to study tax motivated income shifting, implies single regression with one factor as dependent variable and a number of control variables, which are usually associated with profit shifting. A dependent variable in one paper may

appear as control or independent variable in another paper. All these researches are based on classical regression models and central issue for this approach is multicollinearity, where codependences may be of primary concern for accurately establishing the contribution made by each of the variables. Further complications may arise, because some independent variables in single equation model are dependent on one or more other independent variables in the same equation. These co-dependencies would be of paramount concern for understanding the role of each variable in the study.

The current proposal offers the approach, which can capture more realistic and complex system of behavior of a multinational company. The variables that form the basis for the given research fall into the categories of exogenous and endogenous, because they are highly correlated and interdependent. Structural Equation Model (SEM) allows studying the relationship among these variables more accurately. The robustness of this approach eliminates the issue of multi-co-linearity by incorporating it into the structural model. Furthermore, it allows correlations between any pair of variables in the system. Thus, SEM addresses this particular weakness of multiple regressions. SEM also addresses whether variables are observable or latent. Observable variables are directly measurable while latent variables are not directly measurable and require the construction of a measurement model. If SEM uses latent variables, another layer of analysis is needed to ensure that a sound theoretical basis exists for overall SEM analysis. In this study no variables are latent i.e. they directly observable. The lack of latent variables means that measurement models are not needed, and hence, the

traditional issues of validation of the measurement models upon which many structural models rest is not an issue. Thus for many reasons, SEM is the logical alternative to regression in dealing with the complexity and interdependency of the variables in understanding the behavior of multinationals regarding tax motivated income shifting.

The rest part of the section discusses endogenous and exogenous variables included into the SEM analysis.

Income tax payable (Domestic and Foreign)

The paper uses income tax payable, including federal and foreign, from income statements as a first two variables for the analysis of tax avoidance. The variables represent current amount of income taxes due to federal and foreign governments including net of investment tax credits. I use income tax payable instead of foreign and domestic effective tax rates (ETRs) for the following reasons. As we know, the effective tax rate (ETR), which firms are required to disclose in the notes to their financial statements, is the ratio of total tax expense to pretax income. The first reason is ETR includes total accrued taxes that include both current and deferred taxes. Deferred taxes are results of temporary book-tax differences and will be paid (or refunded) in the future, and current taxes are due now (Dyreng et al 2008). Second reason, ETR uses pretax income, and I assume that the foreign and domestic pretax income may not be correctly reported, such as, foreign income may be artificially increased to avoid domestic tax obligations while reported domestic income might be below the true level.

I use income tax payable from income statement for the last 15 years – this time frame should be enough to smooth annual volatility of the variable and incorporate it into the system of equations with other carefully selected indicators, which are traditionally associated with tax aggressiveness, and to evaluate the relationship among them. I use structural equation model approach due to high level of multi-collinearity among variables. Below is the description of other of variables to be evaluated through SEM and the justification of why they should be considered in the model.

Hypothesis: in the presence of tax avoidance the relationship between foreign and domestic income tax payable is negative.

Contribution to the empirical literature: the direct linkage between foreign tax payable and domestic tax payable not been studied in previous researches.

Long Term Debt

The choice between equity and debt is not free. That choice depends on solvency risk, the conditions in the capital market and reduction in tax liability. Equity may be easy to issue, however companies will still go in partly for debt because equity is more expensive to service. Interest on debt is generally treated as cost. This provides firms with an incentive to finance their operations with debt rather than equity, especially in high tax countries (Graham, 1996, 2000; MacKie-Mason, 1990).

Hypothesis: *the size of debt may be associated with tax avoidance; multinationals are likely to increase their debt obligations in high tax countries, therefore long term debt is expected to be negatively related to domestic taxes but not to foreign taxes.*

Difference from previous papers: application of long term debt variable in the system with domestic and foreign taxes to study their interrelationship.

Book tax gap

I use the book tax gap indicator measured by Mazon and Plesko (2002). The book-tax gap is the difference between book income reported by a company to its shareholders using GAAP principles and reflected in SEC files and the tax income reported to the IRS. Because tax returns are confidential I build proxy for tax income for each company/observation using Mazon and Plesko (2002) approach. A current federal tax expense (TE) is the observable data and I use it to estimate an approximate tax income:

$\mathrm{FedTE} = \mathrm{t_s} \times Y_T$ and therefore, $\widehat{Y_T} = \frac{FedTE}{t_s}$

FedTE – current federal tax expense, t_s- statutory tax rate using progressive tax rate structure, $\widehat{Y_T}$-estimated tax income.

Thus, the book to tax difference is expressed as:

$$BTD = Y_B - \widehat{Y_T}$$

Hypothesis: *the higher book to tax ratio may be achieved by excessive use of transfer pricing, intangible assets, and borrowed capital (debt to equity ratio), therefore, it is expected that in the given model, the BTD grows with debt-to-equity ratio, intangibles*

and falls with domestic taxes; at the same time foreign taxes may have positive effect on BTD.

Difference from previous papers: BTD is relatively new proxy of tax avoidance and the relationship of BTD with other profit shifting variables, especially in the context of domestic and foreign taxes, is not very well studied in profit shifting literature.

Income tax paid instead of Cash Effective ETR

Recent academic literature on corporate tax avoidance utilizes the long-run cash effective tax rate introduced by Dyreng et al. (2005). The cash ETR is the ratio of cash paid for taxes in the given period to the pretax financial accounting income less special items. It is the better measurement than traditional ETR because it is not affected by changes of company's tax contingencies. Low cash ETR shows that reduced cash payments reflects any aggressive tax position, or accelerated expenses, deferred income for tax purposes, etc. Cash paid for taxes reduces ETR by tax benefit associated with employee stock options and therefore provides a better measure of the firm's true tax burden than the traditional ETR. Considering cash paid for taxes over one year introduces other problems, such as payments to tax authorities for previous periods, arrears, setting tax audit for past years etc. Therefore, previous studies have used average 3-5 years cash ETR to reduce the effect of the above-mentioned shortcoming.

Application of average 3-5 year cash ETR still assumes that cash tax paid should be less than pretax income, otherwise effective tax rate can be very high and cannot be used in

the regression models. It is also assumed that cash ETR should have positive sign. However, data may contain observations were ETR has negative sign or far above the statutory tax rate, and in order to use it in the regression analysis these observations should be dropped. Therefore, to escape the necessity to omit the conflicting observations, the current study uses another variable – income tax paid which is similar to cash ETR but doesn't need to be constraint to boundaries of zero and statutory tax rate. The variable, 'income tax paid' is standardized to eliminate dollar sign and it allows dealing with observations without putting the boundaries.

Hypothesis: '*income tax paid' may be reduced in the environment of excessive use of borrowed capital, research and development credits, and intangible assets*.

Difference from other papers: income tax paid is used instead of cash ETR as a proxy of tax aggressiveness, due to arguments mentioned above.

Exogenous variables:

CEO Compensation

It is believed that CEO compensation may explain tax aggressive strategy of the company, in other words, companies with more aggressive tax policies pay higher compensation to their executives. Stock-based compensation is traditionally believed to be associated with incentive compensation. Mehran, (1995) and Erickson et al., (2003) measure the value of stock option granted to executives as a fraction of total compensation. The calculations of their variable are the following. The sum of all stock options for all executives for the given company for one year is denoted as $\sum_{j=1}^{n} STO_{j,i,t}$,

where j is each executive of a company i at time t; value of stock options is calculated by the Black-Scholes method. The variable is available at Execucomp. Salaries and bonuses for firm's executives in the given year (Execucomp variables Salary and Bonus) are calculated at the same manner. $ExC_{i,t}$ is the ratio of the sum of the values of stock options to total compensation (defined as the sum of the value of stock options, salary, and bonus) such as:

$$\mathrm{ExC_{i.t}} = \frac{\sum_{j=1}^{n} \mathrm{STO_{j,i,t}}}{\sum_{j=1}^{n} \mathrm{Salary_{j,i,t}} + \sum_{j=1}^{n} \mathrm{Bonus_{j,i,t}} + \sum_{j=1}^{n} \mathrm{STO_{j,i,t}}}$$

However, the $\sum_{j=1}^{n} \mathrm{STO_{j,i,t}}$ is available only to the year up to 2005 and since my data covers the period of 2000-2016 I use only total compensation including options grants, i.e. my variable is

$\sum_{j=1}^{n} \mathrm{Salary_{j,i,t}} + \sum_{j=1}^{n} \mathrm{Bonus_{j,i,t}} + \sum_{j=1}^{n} \mathrm{STO_{j,i,t}}$ {Total Compensation Including Option Grants is sum of total compensation for the individual year, comprised of the following: Salary, Bonus, Other Annual, Total Value of Restricted Stock Granted, Total Value of Stock Options Granted (using Black-Scholes), Long-Term Incentive Payouts, and All Other Total} , which is standardized using inverse hyperbolic sinus function.

Intangibles, R&D, Long Term Assets:

Other exogenous variables are represented by intangible assets, research and development expenses (R&D), and long term assets. Intangible assets and R&D may play important role in tax avoidance through transfer pricing. Grubert (2003) has studied corporate tax returns of multinationals from 1996 and their subsidiaries; his findings

include that pretax income of subsidiaries of R&D-intensive multinationals are more responsive to local tax rates then pretax income of other subsidiaries. Most recent studies reveal that intangible assets are disproportionally concentrated in low-tax countries, particularly intellectual property, because companies tend to register patents in low tax jurisdictions (Dischinger & Riedel, 2011; Karkinsky & Riedel, 2012). 'Property, plants and equipment' from Compustat is used as a control variable for long term assets. The justification for including long term assets into the analysis is the following: (i) the variable has high impact on tax effective rate and book-to-tax difference through such factors as favorable depreciation rates, re-investments in new plants and equipment, etc. (Dyreng & Kevin, 2013); (ii) firms with high concentration of capital in terms of plants and equipment have more opportunities for tax planning coming from capital related decisions such as decisions over lease or purchase, time of purchase and location of plants (Mills et al. 1998, Dyreng & Kevin, 2013).

2.3. SEM Structure and Methodology

The structure of the model with the above mentioned variables at time t with five endogenous and five exogenous variables can be written as (Green, 2007):

$$\alpha_{11}y_1 + \alpha_{12}y_2 \dots + \alpha_{15}y_5 + \beta_{11}x_1 \dots + \beta_{14}x_5 = \varepsilon_1$$

$$\alpha_{21}y_1 + \alpha_{22}y_2 \dots + \alpha_{25}y_5 + \beta_{21}x_1 \dots + \beta_{24}x_5 = \varepsilon_2$$

$$\dots$$

$$\alpha_{51}y_1 + \alpha_{52}y_2 \dots + \alpha_{55}y_5 + \beta_{51}x_1 \dots + \beta_{54}x_5 = \varepsilon_7$$

In matrix notation the system of structural equations at time t may be written as

$$\vec{y}\mathrm{A} + \vec{x}\mathrm{Б} = \vec{\varepsilon}$$

$$y = \begin{bmatrix} y_1 \\ \vdots \\ y_5 \end{bmatrix}, \mathrm{A} = \begin{bmatrix} \alpha_{11} & \dots & \alpha_{15} \\ \vdots & \ddots & \vdots \\ \alpha_{51} & \dots & \alpha_{55} \end{bmatrix}, x = \begin{bmatrix} x_1 \\ \vdots \\ d_n \end{bmatrix}, B = \begin{bmatrix} \beta_{11} & \dots & \gamma_{1n} \\ \vdots & \ddots & \vdots \\ \beta_{41} & \dots & \gamma_{4n} \end{bmatrix}$$

y_1 – fed tax payable (income statement)

y_2 – foreign tax payable (income statement)

y_3 – income tax paid (cash)

y_4 – book to tax gap

y_5 – long term debt

x_1 – intangible assets to total assets

x_2 – long term fixed assets

x_3 – research and development expenses

x_4 – CEO compensation

x5 – pretax income

x1, x2, x3, x4 and x5 are exogenous variables and are not influenced by other variables in a model. For example, consider intangibles assets, there is only one way relationship: intangibles can affect the level of taxation – i.e. MNEs can manipulate with location of intangibles to achieve greater tax savings, however, the level of intangibles produced by

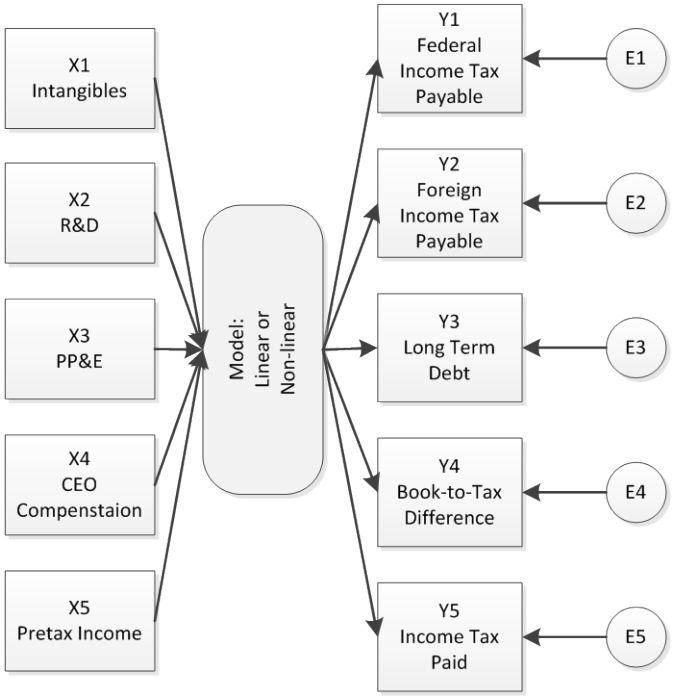
MNEs are not depend on tax rates but on other factors, such as type of company, level of output, its management goals etc.

y1, y2, y3, y4 and y5 are endogenous variables that are influenced by other variables in the model.

All the above mentioned variables are manifest variables because they are directly observed and measured. The level of tax avoidance and profit shifting is not directly measured and therefore is considered to be **latent** variable. Tax avoidance and profit shifting, as it is an internal, non-observable state, is indirectly assessed by firm's accounts, and thus it is a latent variable. Current latent variable increases the complexity of the structural equation model because now it is necessary to take into account all the items that are used to quantify our tax avoidance and profit shifting "factor". In this instance, each above manifest variable would be significantly or insignificantly involved in the level of profit shifting.

The picture below illustrates the relationship among all variables in the structural equations.

Figure 7: Chapter 2. Proposed structural model



I estimate the parameters of the model using two-stage least squares (2SLS), which is common method for estimating parameters in simultaneous equation systems. The procedure for 2SLS is the following (Fox 2002):

1. In the first stage, the predictors X are regressed on the instrumental variables Z, obtaining fitted values

$$\widehat{\mathrm{X}} = \mathrm{X}(\mathrm{Z}'\mathrm{Z})^{-1}\mathrm{X}$$

2. In the second stage, the response y is regressed on the fitted values from the first stage, $\widehat{\mathrm{X}}$, producing the 2SLS estimator of δ:

$$\hat{\delta} = (\widehat{\mathrm{X}}'\widehat{\mathrm{X}})^{-1}\widehat{\mathrm{X}}'\mathrm{y}$$

This is justified because as linear combinations of the instrumental variables, the columns of $\widehat{\mathrm{X}}$ are (in the probability limit) uncorrelated with the structural disturbances.

An alternative, but equivalent, approach to the second stage is to apply the fitted values from the first stage, $\widehat{\mathrm{X}}$, as instrumental variables to the structural equation (2):

$$\hat{\delta} = (\widehat{\mathrm{X}}'\widehat{\mathrm{X}})^{-1}\widehat{\mathrm{X}}'\mathrm{y}$$

The two stages of 2SLS can be combined algebraically, producing the following expression for the estimates:

$$\hat{\delta} = [\mathrm{X}'\mathrm{Z}(\mathrm{Z}'\mathrm{Z})^{-1}\mathrm{Z}'\mathrm{X}]^{-1}\mathrm{X}'\mathrm{Z}(\mathrm{Z}'\mathrm{Z})^{-1}\mathrm{Z}'\mathrm{y}$$

The estimated asymptotic covariance matrix of the coefficients is

$$\widehat{\Omega}(\hat{\delta}) = \mathrm{s}^2[\mathrm{X}'\mathrm{Z}(\mathrm{Z}'\mathrm{Z})^{-1}\mathrm{Z}'\mathrm{X}]^{-1}$$

where s^2 is the estimated error variance for the structural equation, that is, the sum of squared residuals divided by residual degrees of freedom:

$$\mathrm{s}^2 = \frac{(\mathrm{y} - \mathrm{X}\hat{\delta})'(\mathrm{y} - \mathrm{X}\hat{\delta})}{\mathrm{n} - \mathrm{p}}$$

Description of Data

Data is retrieved from Compustat North America Fundamentals covering the period of 2000-2014. The managerial compensations and incentives' data is obtained from Execucomp for the same period and merged into Compustat North America Fundamentals resulting in 11,423 initial observations. Variables are presented in the following forms:

(i) federal tax payable is the current tax obligation of US firms and reported in income statement; (ii) foreign tax payable represents foreign obligations of US firms; (iii) income tax paid is the cash amount paid by firms to tax authorities worldwide; (iv) book to tax difference is calculated based on the formula described above in the text; and (v) long term debt represents loans and financial obligations lasting over 12-month period.

The below table provides summary statistics of the endogenous variables in nominal form (mln USD):

Table 1: Chapter 2. Summary Statistics of endogenous variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Tax federal (mln USD)	11,423	93.36251	385.8175	-3,253	10,169
Foreign tax payable, mln USD	11,423	68.86447	466.9052	-119.7	16,548
Income tax paid, mln USD	11,423	161.4907	708.549	-1,883	19,130
Book-to-tax difference	11,423	295.8265	1,918.011	-44,813.14	42,225.43
Long term debt	11,423	1,686.953	10,856.97	0	377,138

Tax related variables take as positive as negative signs – negative sign may indicate that in some cases tax authorities owe money to firms. Data has been further standardized by inverse hyperbolic sin function.

Exogenous variables are presented by the following indicators: (i) intangibles assets, (ii) property plants and equipment, research and development expenses and CEO compensations. CEO compensation data is taken from Execucomp database and merged

into Compustat North America Fundamentals. Merging the databases has resulted in 11,423 observations further used in the regression analysis.

The model with five equations is described as:

$$y_1 = \alpha_{11}y_2 + \alpha_{12}y_3 + \beta_{11}x_1 + \beta_{12}x_2 + \beta_{13}x_3 + \beta_{14}x_4 + \beta_{15}x_5 \quad (1)$$

$$y_2 = \alpha_{21}y_1 + \alpha_{22}y_3 + \beta_{21}x_1 + \beta_{22}x_2 + \beta_{23}x_3 + \beta_{24}x_4 + \beta_{25}x_5 \quad (2)$$

$$y_3 = \alpha_{31}y_1 + \beta_{31}x_1 + \beta_{32}x_2 + \beta_{33}x_3 + \beta_{34}x_4 + \beta_{35}x_5 \quad (3)$$

$$y_4 = \alpha_{41}y_1 + \alpha_{42}y_2 + \alpha_{43}y_3 + \beta_{41}x_1 + \beta_{42}x_2 + \beta_{43}x_3 + \beta_4 4x_4 + \beta_{45}x_5 \quad (4)$$

$$y_5 = \alpha_{51}y_1 + \alpha_{52}y_2 + \alpha_{53}y_3 + \alpha_{54}y_4 + \beta_{51}x_1 + \beta_{52}x_2 + \beta_{53}x_3 + \beta_{54}x_4 + \beta_{55}x_5 \quad (5)$$

	Endogenous variables		**Exogenous variables**
Y1	Federal Income Tax Payable	X1	Intangibles
Y2	Foreign Tax Payable	X2	Property Plant and Equipment (PP&E)
Y3	Long Term Debt	X3	Research and Development Expenses
Y4	Book-to-Tax Difference	X4	CEO Compensation
Y5	Income Tax Paid	X5	Pre-tax Income

First equation shows that the level of domestic taxation depends on level of taxes to be paid abroad and the level of total long term borrowings. Second equation constructed on assumption that the level of foreign taxation depends on taxes to be paid at home and total long term borrowings. Third equation, long term borrowings, shows that MNE decides on the level of borrowings to reduce domestic taxes. Frist three equation shows that MNE picks domestic and foreign tax rates as well as level of borrowing simultaneously. Other endogenous variables are not entered to the first three equations: income tax paid and book-to-tax difference are consequences of domestic

and foreign effective tax rates as well as borrowings. In this regard, forth equation shows that 'book-to-tax difference' depends on effective tax rates of MNE inside and outside of the country and other deductions including borrowings. The last equation shows that 'income tax paid' is a result of difference between the effective tax rates, level of borrowing and cash effective tax rate plus control variables. All equations have the same set of control variables.

2.4. Interpretation of Results

Current section presents finding from three simulations equation models. First two models have identical structure with same package of variables but with different set of observations: whilst first model includes all possible observations, the second model considers the observations with non-negative values in pretax income and assets. Third model differ from the previous models with pretax variable – it is split into domestic pretax income and foreign pretax income; therefore, only companies, who reports both types of pretax income, are embraced by the analysis.

The results of the first simultaneous equations model are presented in the Table 2. The SEM model illustrates that domestic income tax payable has negative relationship with foreign tax payable confirming that foreign taxes are deductible from domestic income tax. Domestic income tax payable is also negatively related with long term debt and research and development expenses – both these items reduce the taxable pretax income. Assets, both intangibles and PP&E, increase domestic income tax, which can be justified by the argument that larger assets usually associated with larger earning, and

therefore, greater amount of taxes to be paid. The same argument can be applied to CEO compensation – taxes grow with compensation of executives, because higher compensation is associated with higher pretax income.

Second equation with foreign tax payable as endogenous variable provides the following results. “Foreign tax payable” is negatively associated with domestic income tax payable, however, the coefficient is close to zero. US multinationals taxed in foreign jurisdictions only on incomes earned on those jurisdictions but not on worldwide income, therefore the results show that coefficient is nearly zero. Another interesting interaction is between foreign tax and long term debt coefficient – it is also close to zero, i.e. the result assumes that US multinationals use borrowing instrument to address domestic tax issues not foreign. R&D coefficient of foreign tax equation is strongly positive while in domestic tax equation it is negative. Whilst US multinationals bear their R&D expenses in US, they move intellectual property to low tax countries and therefore R&D boosts foreign pretax income and as a result positively associated with foreign income tax. Regressing the same SEM model without R&D in the second equation demonstrates higher pretax income coefficient than in the current model.

Third equation involves long term debt as endogenous variable. Pretax income, R&D and federal tax due are negatively correlated with long term debt. It is notable that R&D is also negatively correlated with long term debt – i.e. companies with higher debts limiting their R&D expenses. Long term debt positively correlated with intangibles and

long term assets indicating that companies with larger assets can afford to borrow more.

Fourth equation with Book-to-tax difference (BTD) as response variable demonstrates that BTD is negatively correlated with federal income tax payable. BTD itself represents the interaction between effective and statutory tax rates. Value of the BTD decreases as effective tax rate approaches statutory tax rate and increases if effective tax rate moves away from statutory tax rate. Therefore, the higher is the federal tax payable the lower is the value of BDT, what is actually depicted by the fourth equation.

Current model also supports concerns that intangible assets are may be moved out of US to foreign jurisdictions with lower tax rates. Comparing first equation with second equation we see that coefficient β_{11} is two time bigger than β_{21}, which demonstrates 'foreign income taxes due' grow faster with variable x_1 (intangibles) than domestic income taxes. At the same time pretax income coefficient β_{15} is bigger than β_{25} – in other words, domestic income taxes due grow faster with pretax income than foreign taxes. It indicates that effective tax rates in US for multinationals may be higher than abroad. It also can be associated with the fact that US multinationals pays federal taxes from their worldwide income and not only from the income earned in US. R&D coefficient is negative in the first equation and strictly positive in the second equation providing us with the evidence that R&D activities are taking place in US. If the R&D expenses are associated with development of intangibles, and intangibles are taxed

more outside the country than inside the country then, we have indirect evidence of shifting intangibles outside the US. Any particular impact of CEO compensation on tax aggressiveness has not been found; managerial incentives grow with company profits what results in higher tax indicators.

Table 2: Chapter2. Results of SEM-1

Variables	**I**	**II**	**III**	**IV**	**V**
Dependent/ Independent	Federal income tax due	Foreign income tax due	Long term debt	Book-to-tax difference	Income tax paid
Intercept	-2.575944	-3.774415*	-2.635212	-1.020136**	-.6028644***
Federal income tax due		-.0105655	-.0167182***	-.0340188	.3702356***
Foreign income tax due	-.0176007			.6161164***	.2995457***
Long term debt	-.0547555	.0030479		.0334308	-.0093608
Book tax difference					.0174845**
Income tax paid					
Intangibles	.1316057	.2772384***	.3870902***	.072741***	.0571762***
PP&E	.3165483	.4042757*	.8325963***	.0894542**	.2478879***
R&D	-.2030609	5.437089***	-4.732888***	-1.668861	-.750475**
CEO compensation	.2994574	.2044969	.0856732**	.0476148	.0695965***
Pretax income	6.356442**	1.368728	-2.476186***	12.64539***	1.272239***

The next system of equation has the same variables as before but sample size contains only observations where profit and assets, including “intangibles”, “property plant and

equipment" have positive values. The results are provided in the Table 3. Number of observations is reduced to 8,477.

The results of the simultaneous equations model 2 repeat findings in model 1 with better statistical indicators because now data is clean from outliers. The SEM model 2 confirms that domestic income tax payable negatively correlated with foreign tax payable, because every dollar paid to foreign tax jurisdiction deducts overall pretax income and therefore reduces domestic income tax obligations. Long term debt and R&D deduct domestic taxes while assets, both intangibles and PP&E increase domestic taxes. Second equation, with 'foreign tax payable' as response variable, reaffirms the findings from model one. Foreign taxes are negatively associated with domestic taxes, long term debt doesn't decrease foreign taxes, R&D coefficient of foreign tax equation is strongly positive while in domestic tax equation it is negative. Intangibles and other assets are more taxed in foreign jurisdictions than at home. And in general, in comparison to domestic taxes, foreign taxes change less with overall pretax income. Long term debt as dependent variable decreases with pretax income, R&D and domestic taxes and increases with all types of assets indicating that either companies with larger assets afford more borrowings or loans are taken to acquire assets. BTD shrinks with domestic taxes but enhances with foreign taxes; debts, intangibles, R&D and pretax income increases BTD. Comparing response to pretax income in last equation and in first equation we can observe that 'income tax paid' is more than two times lesser than 'domestic tax due' and higher than foreign tax obligations. The model also confirms that

intangibles are taxed more abroad than in the US while R&D expenses are accounted in US books. Therefore, if the R&D expenses are associated with development of intangibles, and intangibles are taxed more outside the country than inside the country then, we have indirect evidence profit shifting thorough intangibles.

Table 3: Chapter 2. Results of SEM-2

	I	II	III	IV	V
Variables	Federal income tax due	Foreign income tax due	Long term debt	Book-to-tax difference	Income tax paid
Intercept	2.292691***	-2.80827***	-3.072694***	4.14228***	1.340901***
Federal income tax due		-.0555454***	-.0185667***	-.4735775***	.2664835***
Foreign income tax due	-.0673053***			.5062052***	.2908712***
Long term debt	-.046297***	.0196383**		.0850721***	.0062334
Book tax difference					-.064446***
Intangibles	.289347***	.3569004***	5056004***	.2332456***	.1638561***
PP&E	.3376881***	.4311332***	.7259558***	.3821195***	.2828607***
R&D	-3.31341***	8.754438***	-10.93274***	1.146862	-1.963333***
CEO compensation	.1683995***	.1814128***	.0989892**	-.0051508	.0289749
Pretax income	1.349112***	.3284443***	-.4198353***	1.471952***	.5528909***

Third system of equations contains domestic pretax income and foreign pretax income as exogenous variables instead of total pretax income as in first and in second equation. Current system of equations allows looking at specific interaction among domestic taxes, domestic income, foreign taxes and foreign income. We also see how other

interactions changes when the pretax income is split between foreign and domestic, and whether other factors are changing together with this modification of the model.

Table 4: Chapter 2. Results of SEM-3

	I	II	III	IV	V
Variables	Federal income tax due	Foreign income tax due	Long term debt	Book-to-tax difference	Income tax paid
Intercept	-1.577473***	-2.60631***	-2.610322***	-.9157951*	-.3093868
Federal income tax due		.0155276***	.0034521	-.0788432***	.2950529***
Foreign income tax due	.0265429*			.6061643***	.3866341***
Long term debt	-.0735737*	.0065421		.0484844**	-.0030492
Book tax difference					.01941*
Intangibles	.1501819***	.1559127***	.4008521***	.062418**	.0972093***
PP&E	.1411395***	.3981198***	.824442***	.1020241**	.1878559***
R&D	.5193795	1.865172***	-6.189607***	.2945426	-.4211438
CEO compensation	.1763881***	.1389607***	.0825822*	-.0105983	.0259728
Pretax income/total assets			-3.207535***	17.55093***	1.598287***
Pretax domestic income	.3437337***	-.0157366***			
Pretax foreign income	.0503607	.2376984***			

First equation contains pretax domestic and pretax foreign income as exogenous factors. Federal income tax due is measured by other factors taking into account these modifications of the model. As it is illustrated in the table 4, domestic tax drops with

debt and the value of drop is higher than in previous tables – domestic tax due is more sensitive to long term debt in this model where pretax income is split between domestic and foreign. The relationship between domestic tax due and pretax domestic income reveals that tax due grows 0.34 per unit change in pretax income, which can be considered as effective tax rate. Fed tax increases together with foreign income as well but only on 0.05.

Foreign income tax due doesn't change with long term debt – current model shows that foreign income tax is not sensitive to borrowings, therefore the decisions made by multinationals about borrowings to reduce taxes are made explicitly to reduce domestic tax burden, not foreign. Foreign tax obligation positively correlates with intangibles and research and development activities but magnitude is higher than in previous models. The slope of PPEs is more than two times higher in foreign tax equation than in domestic tax equation which indicates that firms prefer keeping their physical production and operation activities in foreign jurisdictions, therefore incomes associated with the production are taxed in those jurisdictions. Foreign pretax income is taxed by the rate of 0.23, while domestic income is taxed by 0.34, which indicates that multinationals have lower tax obligations abroad and higher taxes at home.

Long-term debt increases with all kind of assets indicating that the borrowings are used to acquire assets and negatively correlates with research and development showing that multinationals in general do not finance their R&Ds activities with borrowings. The

interaction of long-term debt with pretax income in all three models is negative – debt drops when income grows.

BTD decreases with domestic taxes and increases with foreign taxes indicating that some sources of book to tax difference may lay in foreign operations. Influence of PPE on book to tax difference is higher than intangibles, thus MNEs are able to keep high BTD by better managing their productions and physical assets rather than shifting intangibles. R&D expenses contribute to BDT, while compensation of CEO doesn't grow together with book-to-tax difference – though both results are insignificant and are not explained well by the current model.

2.5. Conclusions

Current paper offers simultaneous equations approach in studying profit shifting, which allows observing all indicators of profit shifting simultaneously in the model instead of separately. The study provides an integrated analysis of the interrelations among main indicators of profit shifting, such as book-to tax difference, foreign and domestic tax obligations, long term debt, intangibles, research and development expenses, etc. Additional advantage of this technique lays in possibility to evaluate the relationships among factors in the presence of multi-co-linearity.

The analysis conducted by the simultaneous equation model reveals the following findings regarding nominal domestic and foreign tax obligations: domestic taxes grow

faster with pretax income than foreign taxes, what suggests that US multinationals face higher tax obligations at home in comparison to overseas. The analysis also detects a negative relationship between domestic and foreign taxes. This observation suggests that multinationals are able to keep overall overseas tax obligations lower than domestic and report their income abroad. The study supports previous evidences about book-to-tax difference as a good sign of tax aggressiveness – 'taxes paid' reduce the book-to-tax indicator while 'taxes accrued but not yet paid' increases the indicator. Debt financing reduces domestic tax obligations, at the same time, foreign taxes do not change with debt. The study also confirms that intangibles are shifted abroad to reduce domestic taxes. The model demonstrates tax motivated mobile assets shifting with the following interconnections: domestic taxes decrease with intangibles assets and R&D expenses while foreign taxes grow with intangible assets and with R&D.

Chapter 3: Luxemburg Tax Agreements: Did the companies involved in tax agreements with the Luxemburg Government do any better than others?

3.1. Introduction: Luxemburg Tax Agreements and Description of the Financial Scandal

Luxembourg tax agreements is a financial scandal first time leaked to newspapers in November 2014 by the group of journalist from the International Consortium of Investigative Journalists. It is based on confidential information about Tax Rules of Luxembourg facilitated by leading consulting companies to the benefits of their clients. The investigation of the journalists revealed to the public names of three hundred multinational companies, which used Luxembourg tax avoidance scheme. (Wayne, Leslie; Carr, Kelly, 2014).

LTAs tax scheme is believed to be highly beneficial to multinational companies. In the early 1990s Luxembourg adopted the EU Directive that allowed companies to pay taxes in EU member country, where their headquarters located, even if their operations and subsidiaries located in another EU member country (*Karnitschnig, Matthew; van Daalen, Robin, 2014*). The tax schemes include transfer pricing mechanisms to reallocate profits to Luxembourg, such as intra-firm loans, i.e. a subsidiary based in a high-tax country provide a loan at a low interest rate, subject to credit rating of the company group, to a subsidiary in Luxembourg. In its turn, a subsidiary in Luxembourg loans money at

significantly higher interest rates to another subsidiary outside Luxembourg. Investment profit is almost exempted from taxes in Luxembourg, what makes it an effective mechanism to erode tax bases in countries with high tax rates and to shift profits to countries where they are less taxed (*Ting, Antony, 2014).*

The purpose of the current paper is to compare the world profit of the US multinationals involved in LTAs with those companies, which are not involved. EU authorities claim that companies involved in LTA were able to reduce their tax obligations in EU members using the Luxembourg domicile. Current paper doesn't have any purpose to support or reject the EU claim about unpaid taxes and cannot be considered as any kind of evidence for court hearings. My intention is to learn whether the companies engaged in scandal did any better in tax saving than those, which haven't been mentioned in the list. If they did any better then what are specific characteristics defining such tax behavior.

Due to some limitations current paper focuses only on US multinationals. Another limitation concerns the size of companies to be investigated. I choose US companies from S&P 500 narrowing the sample to large US companies to make two groups more or less comparable. From S&P 500 list I mark those US companies, which involved in LTAs and compare them with US companies, which are not mentioned in the scandal.

The paper structured as follows: chapter 2 provides some background on tax haven and transfer pricing, chapter 3 describes the data, and discusses each variable, chapter 4 reports results of the regression analysis and chapter 5 provides readers with conclusions.

3.2. Background and Definitions

The concerns on harmful tax practices involving preferential regimes have been first raised two decades ago by OECD Report (1998) on *Harmful Tax Competition: An Emerging Global Issue*. The report highlighted different types of preferential regimes that could be used to reduce tax obligations in certain domiciles and concerned about lack of transparency with that regard. Since that OECD tracks the countries with potential harmful practice issuing regular progress reports and updating the list of countries. In 2013 OECD included harmful tax practices into the BEPS Action Plan, under the section Action 5: *Countering Harmful Tax Practices More Effectively, Taking into Account Transparency and Substance*.

The OECD Report (1998) considered harmful tax practices in three dimensions: (i) preferential regimes in OECD; (ii) preferential regimes outside OECD; (iii) tax havens. Further the report defines specifications by which a tax regime can be potentially harmful. First criteria is a tax rate – zero or low nominal taxation can serve as an initial alert to evaluate a tax jurisdiction as a tax haven. For preferential regimes this factor is low effective tax rate instead of statutory tax rate. The tax rate itself is not enough to treat a jurisdiction as a tax haven or harmful preferential regime. If a particular country

applies the same tax rate to all industries than low tax rate is not preferential even if it is lower than rates used in other countries. Therefore, other factors are necessary to evaluate the regime. Second criterion is “lack of efficient exchange of information” with tax authorities from other tax jurisdictions. Due to certain circumstances countries with favorable tax regimes, due to some administrative or legal policies, may be unable or willingly resistant to share the information about financial accounts of investors, by which creating opportunities for tax dodging. “Lack of transparency” is another crucial specification to evaluate tax regime. The regime is considered to be nontransparent if special treatment of low taxation is provided to certain operations, particularly mobile activities (such as financial services and intangibles) or industries but not made public or available to tax authorities of other countries; such situation provides opportunities to multinational companies to reduce their tax obligations in high tax destinations. Forth sign of harmful tax policy is, so called, “ring-fencing from domestic economy” – a situation when residents are prevented from benefiting the tax regime or when nonresidents don’t have access to the domestic economy. In this case, tax jurisdiction is able to secure its tax revenue base by limiting tax incentives to certain areas or certain investors.

In addition, eight additional factors are used to identify countries with potentially harmful tax practice. They are (OECD, 2015): i) an artificial definition of the tax base; ii) failure to adhere to international transfer pricing principles; iii) foreign source income exempt from residence country taxation; iv) negotiable tax rate or tax base; v) Existence

of secrecy provisions; vi) Access to a wide network of tax treaties; vii) The regime is promoted as a tax minimization vehicle; viii) The regime encourages operations or arrangements that are purely tax-driven and involve no substantial activities.

Potentially harmful regime may not necessary be harmful unless it doesn't created damaging economic effects. In order to evaluate whether the tax regime is actually harmful the following features should be in place (OECD, 2015):

- economic assets (mobile capital, intangibles, other economic values) are shifted from one country to another due to preferential regime, rather than through new economic activity;
- volume of revenues and income doesn't correspond to the level of economic activities;
- preferential regime is the primary reason to use the tax jurisdiction;

Following the Report of 1998, the OECD created the list of countries with potential harmful tax regimes. The OECD list has been continuously changing over time; the countries, which cooperate with OECD and make progress in changing their legislation toward more fair and transparent tax regimes, are dropped from the list. The original US version of the list copied the OECD but excluded U.S. Virgin Islands from the list of tax havens (S.396, 110th Congress, Gravelle, 2015). According to S.396, all US multinationals with domicile in tax havens were treated as domestic companies for corporate income

tax purposes. Similarly, IRS and GAO compiled their own lists of countries with potential harmful tax regimes. Gravelle (2015) provides all countries mentioned in various lists:

Table 5: Chapter 3. List of Tax Havens

Andorra	Gibralter	Montserrat
Anguilla	Grenada	Nauru
Antigua and Barbuda	Hong Kong	Netherlands Antilles
Aruba	Ireland	Niue
Bahamas	Isle of Man	Panama
Bahrain	Jordan	Samoa
Barbados	Lebanon	San Marino
Belize	Liberia	Seychelles
Bermuda	Liechtenstein	Singapore
British Virgin Islands	Luxembourg	St. Kitts and Nevis
Cayman Islands	Macau	St. Lucia
Channel Islands (Guernsey and Jersey)	Maldives	St. Vincent and Grenadines
Cook Islands	Malta	Switzerland
Costa Rica	Marshall Islands	Tonga
Cyprus	Mauritius	Turks and Caicos

Dominica	Monaco	US Virgin Islands
		Vanuatu

Luxembourg's Preferential Tax Regime

For the last decade overall corporate tax rate in Luxembourg has slipped down from 29.6 percent in 2008 to the current rate of 27.08 percent (PWC, 2008-2018). The overall corporate taxation consists of three elements: (i) statutory tax rate, which is progressive with highest rate of 18% of income above 30,000 EURO; (ii) solidarity surtax, which is imposed on corporate income tax; (iii) and municipal business tax; for examples for the city of Luxembourg the tax is 6.75 percent. Therefore, the combined effective corporate income tax is around 27.08 percent for Luxembourg City.

Common tax regime in Luxembourg doesn't look like a tax haven, however, there are some features in the tax system, which makes it attractive to multinational companies, and allow avoiding taxation from certain operations. Particularly, Luxembourg doesn't levy taxes on any mobile assets or income derived from usage of mobile assets, such as interests, loyalties, intellectual properties etc. Such features define Luxembourg as a country with preferential tax regime, what makes it potentially harmful.

In general, most common scheme of preferential tax regime employed by multinationals, which leaked to public, is intra-firm loan transactions. A company

creates group of subsidiaries in Luxembourg, mostly in the form of holding, which on its turn lends money to a subsidiary in a high tax country. Since borrowings are deductible, interests return to the holding group in Luxembourg; however the group of holding companies pays almost zero taxes in Luxembourg from interests because that the holding group is positions itself as a middle link, in lending chain – "conduit rather than a lender". In such way, multinationals around the globe, according to leaked documents, have avoided tax obligations in the amount of hundred million dollars.

The purpose of the current research is to study large US multinational companies from S&P500 list in connection to their relationship with Luxembourg leaked papers and attempt to answer the following question: whether the companies from the leaked papers did any better in tax savings then other US companies from S&P500. The indicators of tax savings used in the current paper are effective tax rate (overall, domestic, foreign), cash effective tax rate and book-to-tax difference. The study applies three types of "difference-in-difference" regression measurements – traditional, quantile and semiparametric.

3.3. Description of the Sample

Current paper investigates whether the LTAs helped to reduce worldwide tax obligations of the US multinationals from the S&P 500 list. I used the S&P 500 list of 2015 in my study. Companies incorporated in jurisdictions other than US are excluded from the sample; the purpose of the current paper to investigate whether the US corporations

took advantage of LTAs. The countries excluded from the study are Ireland, UK, Germany, Switzerland, etc. However, some companies which incorporated in tax haven islands, but who position themselves as US companies are included in the sample as US companies. Total US companies after sampling comprised 369. The requirement of non-missing data of the period of 2000-2014 further shrinks the sample. Data is retrieved from Compustat North America, data regarding number of subsidiaries, foreign subsidiaries and the countries where subsidiaries are located is taken from OSIRIS foreign subsidiary dataset. Companies from all industries are covered by the study, including insurance and banking.

3.1 Effective tax rate

Annual ETR is calculated as “pretax income” divided by “income tax total”. I start my description of the mean ETR for the whole period of 1999-2014. Number of companies and observations are 372 and 4,969 respectively. Mean ETR of the sample for the period of 1999-2014 comprised 27.7 percent with std 1.7 percent. This value includes very extreme points: +29,900 percent and -41,840 percent.

Mean ETR of the sample over the period of 1999-2014 without extreme points is 27.5 (observations 4,959), which is not differ significantly from the previous value. As we can

see in both cases ETR for 372 US biggest companies from S&P500 list for the last 15 years is lower than US statutory tax rate for the same period.

ETR of the sample	Mean	Std. Error	95% confident interval	
With extreme points (4,969 obs)	.2766995	.0169247	.2435195	.3098795
Without extreme points (4,959 obs)	0.2746128	0.0078164	0.2592892	0.2899363

Annual mean ETR for the sample provides with contradictory results. Thus it shows that annual ETR for the whole sample fluctuated with the highest points of 35.1 in 1999 and 35.8 in 2014 and with the lowest ETR of 20.3 in 2005, which was lower than the ETR of 21.1 percent of 2009, the time of financial crisis. Annual mean ETR of the sample without extreme points from the table above provides different perspective. The highest ETR was recorded in 1999, with value of 35.1, and in consecutive years the ETR fluctuated between 24 and 27 percent. The below graph depicts the discussion.

Figure 8: Chapter 3. Annual mean ETR of the sample (S&P 500, US corporations) for the period of 1999-2014

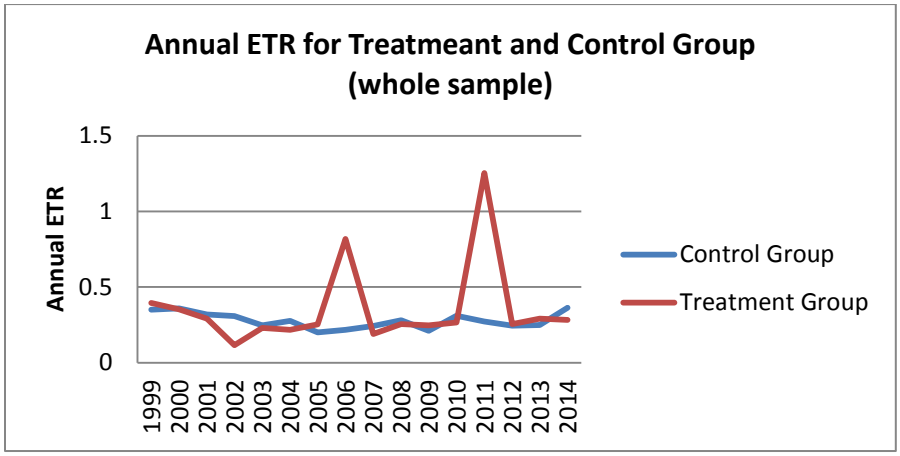
Next, I consider the ETR between two groups – control and treatment. Average ETR for control group over the period of 1999-2014 comprises 27.2 percent while the same indicator for the treatment group is 35.6 percent. Number of observations for control and treatment are 4,717 and 252 accordingly. Dropping extreme value reduces the ETR for the treatment group to 25.4 percent.

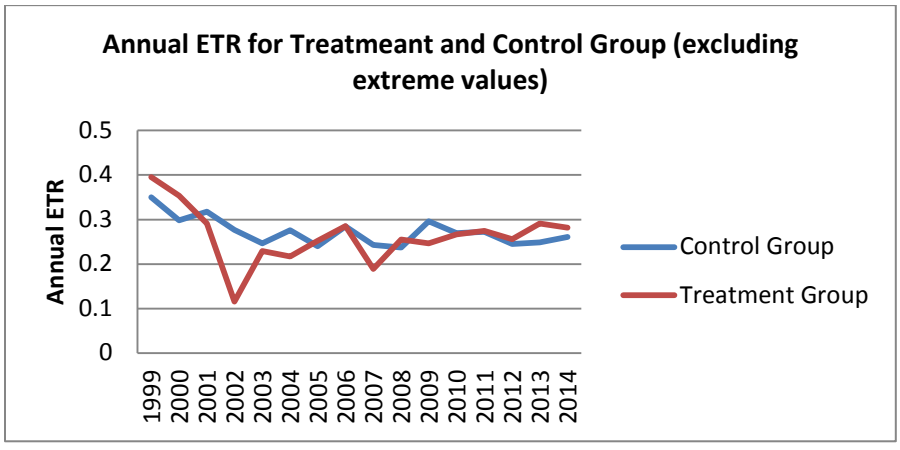
ETR of the sample	Mean	Std. Error	95% confident interval	
Whole sample (4,969 obs)				
Control Group (4,717 obs)	.2724575	.0173432	.2384572	.3064578
Treatment Group (252 obs)	.3561028	.0773529	.2044569	.5077487
Without extreme points (4,958 obs)				
Control Group	.2737897	.0079471	.2582099	.2893695

(4,708 obs)				
Treatment Group (250)	.2538107	.0179664	.2184252	.2891963

Annual mean ETR of the sample within two groups (control and treatment) shows the impact of extreme points. The picture below illustrates the effect of extreme values on data.

Figure 9: Chapter 3. Annual ETR for Treatment and Control Group





3.2 Domestic and Foreign ETR

In previous section ETR was calculated as the ratio of the total payable taxes to total pretax income. Domestic ETR is calculated as total federal taxes payable to total domestic income. Foreign ETR is calculated as foreign income taxes payable to total foreign income. The results are presented in the table below. Surprisingly, average domestic ETR is not any higher than foreign ETR.

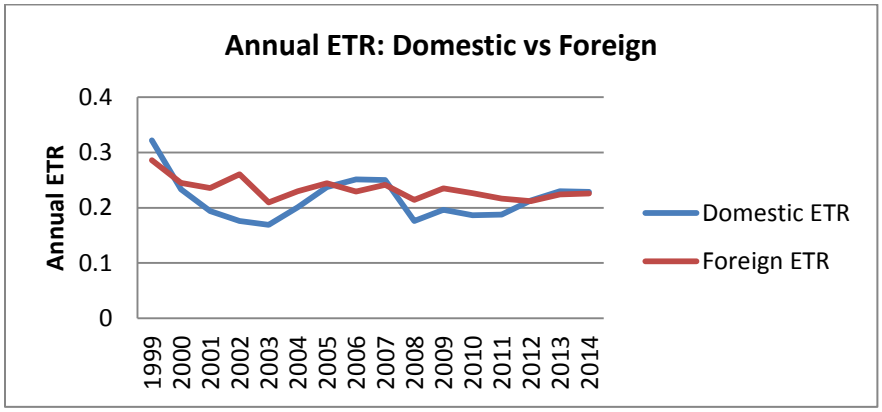
Table 6: Chapter 3. Domestic ETR vs Foreign ETR

	Mean	Median	Mean without extreme values	Median without extreme values
# of observations	2,853	2,853	2,743	2,743
Domestic ETR	0.2217868	0.2437554	0.2098299	0.2424381
# of observations	3,002	3,002	2,886	2,886
Foreign ETR	0.3672186	0.2363442	0.2291434	0.2346902

Annual domestic and foreign ETRs depicted in the picture below. For the most of the period (1999-2014) US multnationals have faced lower domestic ETR than foreign ETR. Despite of the high statutory tax rate, US multinationals were able to keep very low domestic ETR. In ideal scenario, such factors as flexibility of tax legislation, multinationality and resourcefulness of US corporations should allow them to keep

domestic ETR equal to foreign ETR, however due to external shocks domestic ETR deviate from the foreign ETR.

Figure 10: Chapter 3. Annual ETR: Domestic vs Foreign



ETR with respect to control and treatment group shows that though domestic ETR is not any differ between two groups (see table below for details) the foreign ETR differs significantly – foreign ETR of the control group is 39.7 percent while the same indicator for the treatment group is only 19.1 percent. The obvious question is how foreign ETR can be so different when general ETR (which includes foreign and domestic ETRs) between two groups was 27.4 for control group and 25.4 for treatment group. The most possible explanation lays in the volume of foreign operations vs domestic operations. If the domestic operations outweigh foreign operations than domestic ETR will have more weight in total ETR and vice versa. I used the ratio of foreign pretax income to total pretax income as the measurement of foreign operations. The given indicator for the control group is 49.7 percent indicating that multinationals from this group registered in average 49.7 percent on their worldwide income to foreign jurisdictions. The same variable for the treatment group is 76.9 percent showing that treatment group's foreign

operations outweighs its US operations. Coming back to our foreign ETR between two groups, we know now that even foreign ETR for control group is much higher than for the treatment group (39.7 vs 19.2 percent) since the volume of foreign operations of the control group is smaller than of the treatment group therefore overall ETR between two groups differs only on 2 percent (27.4 vs 25.4 percent).

Table 7: Chapter 3. Domestic ETR vs Foreign ETR, control/treatment perspective

Without extreme values	Control		Treatment	
	Mean	Median	Mean	Median
Domestic ETR	.2104365 (2,576 obs)	.2440461	.2004731 (167 obs)	.2158193
Foreign ETR	.3971892 (2,531 obs)	.2389876 (2,531 obs)	.1919329 (167 obs)	.2252874

3.3 Cash ETR

The ability of the firm to reduce its current tax payments or tax avoidance is generally measured by cash effective tax rate, which is expressed as the ratio of taxes paid during the year to pretax financial reporting income. Cash ETR is also a good measure of the effect of LTAs on companies' tax obligations involved in the scheme.

Average cash ETR (CETR) for the whole period of 1999-2014 is 24.2 percent with std of 2.8 percent. Median value is 22.7 percent. Number of companies, which report data for CETR, is 357 and number of observations is equal to 4,797. Current values include extreme points. Dropping the extreme values reduces mean of CETR of the sample for the given period to 19.7 (observations=4,694). As it can be observed, annual CETR is lower than ETR for the same period indicating the ability of the companies to defer current tax obligations.

Table 8: Chapter 3. Cash ETR, descriptive statistics

Cash ETR of the sample	Mean	Std. Error	95% confident interval	
With extreme points (4,797 obs)	.2423802	1.96024	-47.2	74.96899
Without extreme points (4,694 obs)	.1974524	.0078562	.1820506	.2128541

Next step, I consider the cash effective tax rate between two groups (control and treatment) excluding extreme values. Mean CETR for control and treatment groups over the period of 1999-2014 comprise 19.8 and 19.3 accordingly, indicating that treatment group was slightly more successful in reducing current tax obligations.

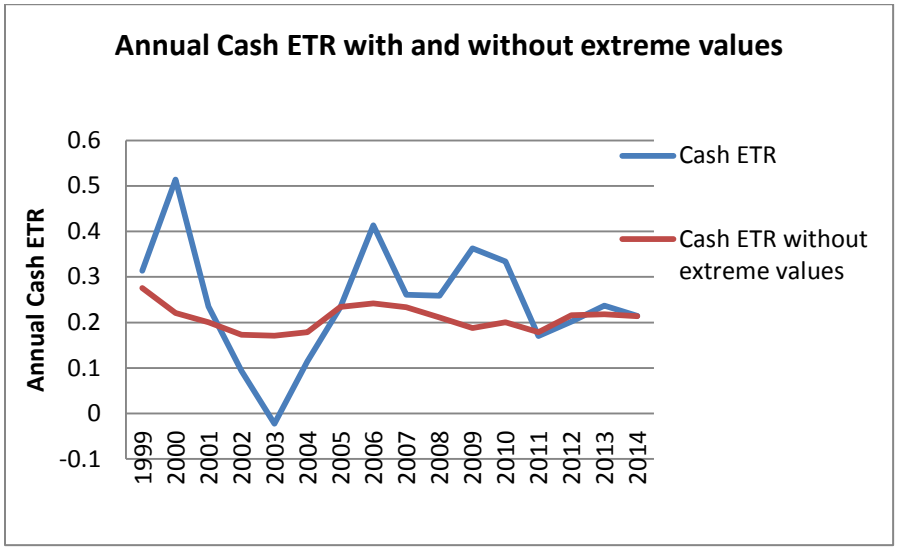
Table 9: Chapter 3. Cash ETR, control/treatment perspective

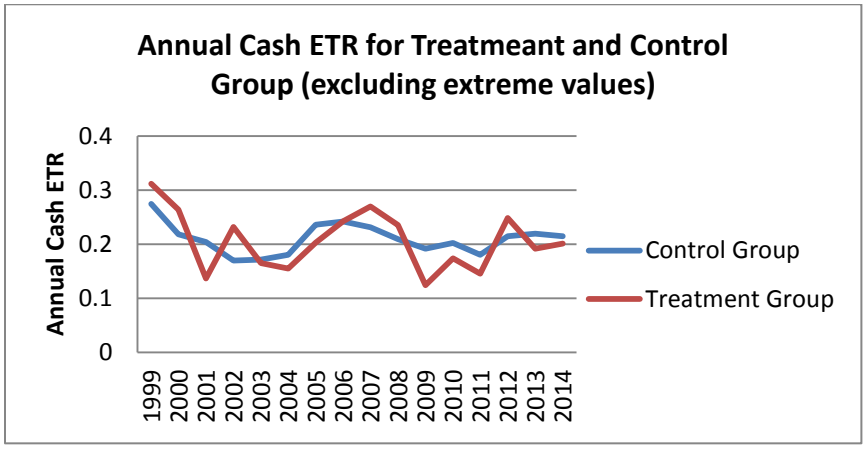
Cash ETR of the sample	Mean	Std. Error	95% confident interval	
Control group (4,453 obs)	.1977095	.008237	.181561	.213858
Treatment group (241 obs)	.1927009	.0158589	.1614604	.2239414

Annual CETR of the sample varies from highest of 51.4 percent to lowest of -2 percent. Dropping the extreme points smooths volatility with the highest point of 27.5 percent in 1999 and the lowest points of 17.3 and 17.1 percent in 2002-2003.

Annual CETR of the control group had the highest value of 27.4 percent in 1999 and the lowest value of 17.0 in 2002. In the same time the annual cash ETR of the companies involved in LTA was 31.1 in 1999, but they kept lower cash ETR during the period with the lowest rate of 12.4 percent in 2009 during financial crisis. The difference of annual cash ETR between control and treatment is depicted on picture below.

Figure 11: Chapter 3. Annual Cash ETR





3.4 Book to tax difference

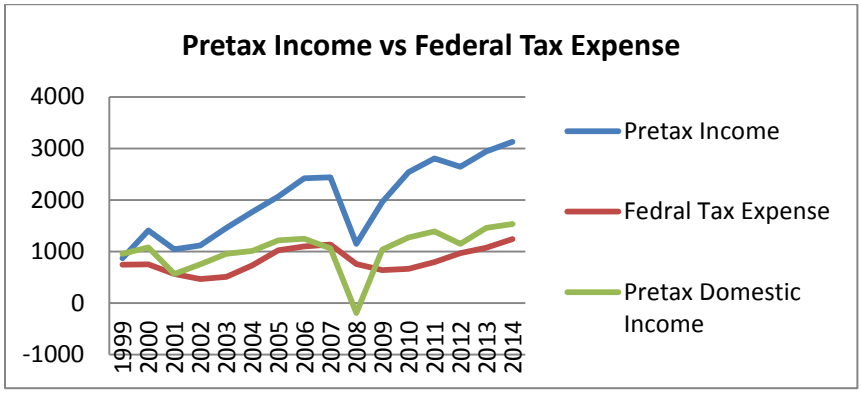
Book tax gap indicator, which I use in my current study has been developed by Mazon and Plesko (2002). Book-tax gap is the difference between book income reported by a company to its shareholders using GAAP principles and reflected in SEC files and the tax income reported to the IRS. Because tax returns are confidential I build proxy for tax income for each company/observation using Mazon and Plesko (2002) approach.

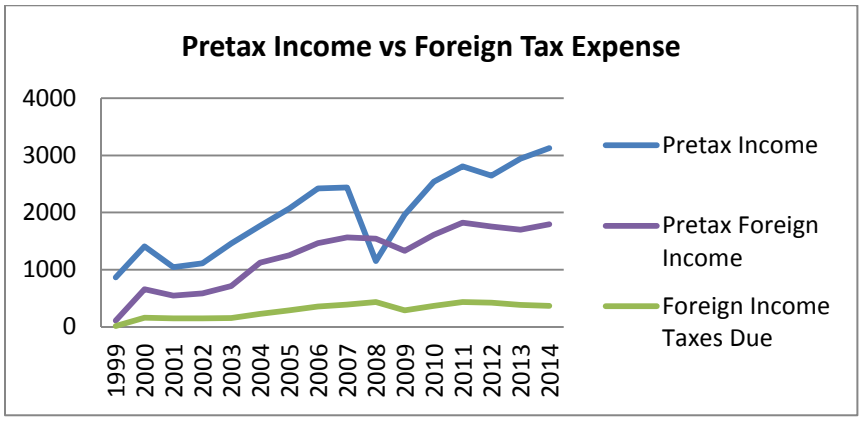
Current federal tax expense (TE) is observable data and I use it to estimate approximate tax income:

Average pretax income of the sample has increased 3.5 times during 1999-2014 from USD 870.2 mln to USD 3,128.5 mln this measurement includes domestic and foreign pretax income. Average domestic pretax income growth wasn't as impressive as (total) pretax income – from USD 959 mln to 1,533.1 mln. The gap between domestic and overall pretax income grew significantly during last 15 years.

Federal tax expenses is the indicator of particular interest for us. As it can be observed from the picture below the federal tax expense didn't grow fast in last few years while the gap between it and the average pretax income grew significantly. At the same time difference between domestic pretax income and federal tax expense almost didn't change. Foreign pretax income soared for the given period from 112.1 mln to 1,797.9 mln. The difference between foreign pretax income and foreign tax expense also increased but not as much as between domestic pretax income and federal tax expense.

Figure 12: Chapter 3. Pretax Income vs Federal Tax Expense





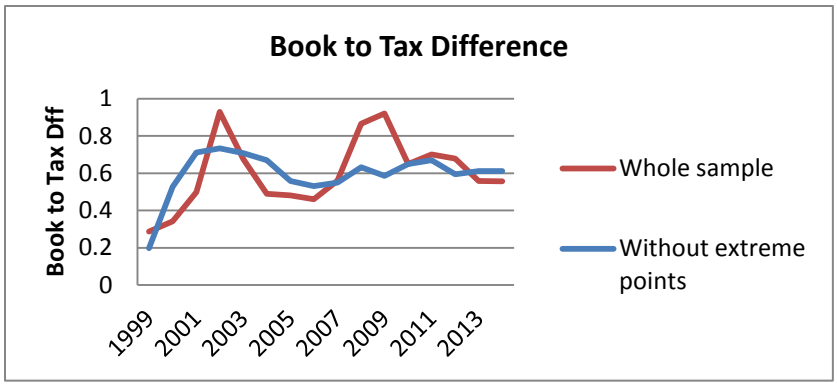
Before going to deeper discussion of book-to-tax difference, I would like to make some comments about the absolute value. Absolute value has a limitation in analysis; it is difficult to compare companies with different characteristics. The absolute value of BTD for any specific firm may depend on specific characteristic of firm, such as size, profitability, industry, etc. , but at the same time its relative value can be the same as other firm. For example, the size of the firm may have influence on the size of BTD in absolute values but relative to its size it can be comparable to other firm. Therefore, there is the necessity to convert absolute values of BTD to relative values using size of

the firm or its profit. I turn the BTD to relative value – ratios, which are expressed as a fraction of the book to tax difference relative to pretax income. So, my BDT variable is

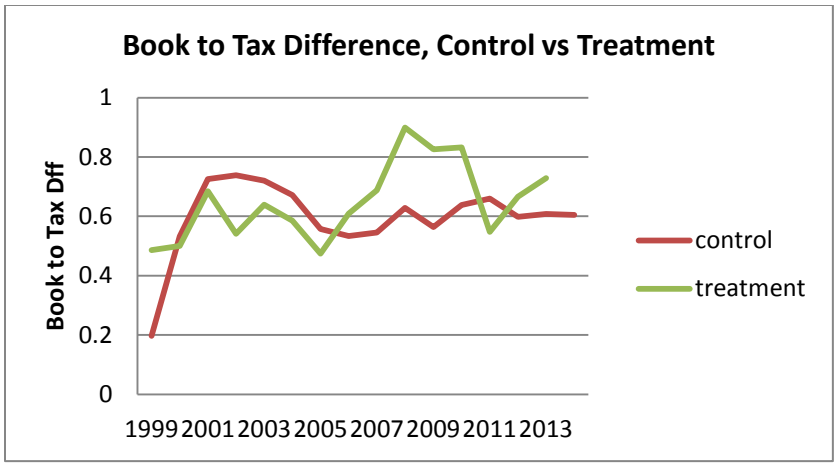
$$btd = \frac{pretax\,income - IRS\,income}{pretax\,income}$$

The descriptive statistics of the variable is the following. Mean of the "btd" is 0.617, median is 0.603 – thus, in average "book to tax difference" for the sample is 61.7 percent of the pretax income[7]. For the control group this figure is 61.4 percent while for treatment group is 65.6 percent, thus, BTD of the treatment group is higher than for of the control group. Annual mean BTD varies from 0.52 to 0.73 with the lowest point in 1999 of 0.19. Values of BTD for control and treatment groups are different in most of the period with higher values of the treatment group. The picture below depicts the discussion.

Figure 13: Chapter 3. Book to Tax Difference of the Sample



[7] Without extreme points of the ETR.



3.5 Multinationality index

Multinationality is measured by number of foreign affiliates to total number of affiliates and number of foreign affiliates to number of countries. The descriptive statistics of the ratio of foreign to total affiliates is the following: mean is 0.32 and median is 0.27 – we can say that on average for any company in the list every third affiliate is a foreign affiliate. 33 companies didn't have or didn't report foreign affiliates. The value of the ratio is higher for treatment group, thus the ration of foreign to total number of affiliates for control group is 0.31 while for treatment group this value is 0.47. Providing only number of foreign affiliates doesn't give the full picture about internationality of the multinationals. Some companies have very high concentration of foreign subsidiaries but only in one or few countries, while others can have less subsidiaries but in a number of countries. Therefore, one more available variable is added – ratio of number of countries to number of foreign affiliates. Thus companies with "N" affiliates in "N" countries, i.e. one affiliate per country, have ratio equal to 1. In the same time if company, for example, has 10 affilates in one country (Canada), then its index equal to

0.1. The descriptive statistics provides us with the following information: mean and median are equal to 0.5, smallest value is 0.02 and highest is 1. In fact 35 companies have the index equal to 1 but none of the companies from the treatment group are among them.

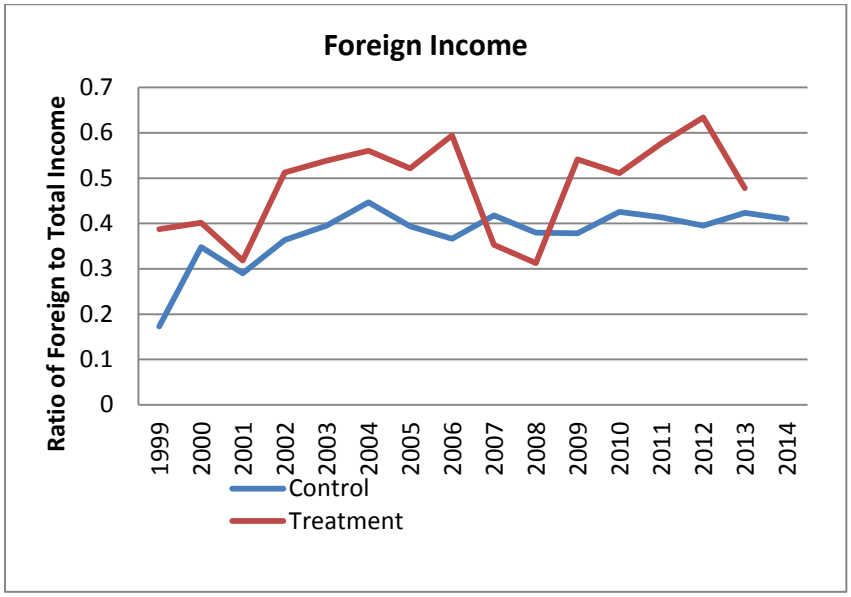
3.6 Foreign income to total income

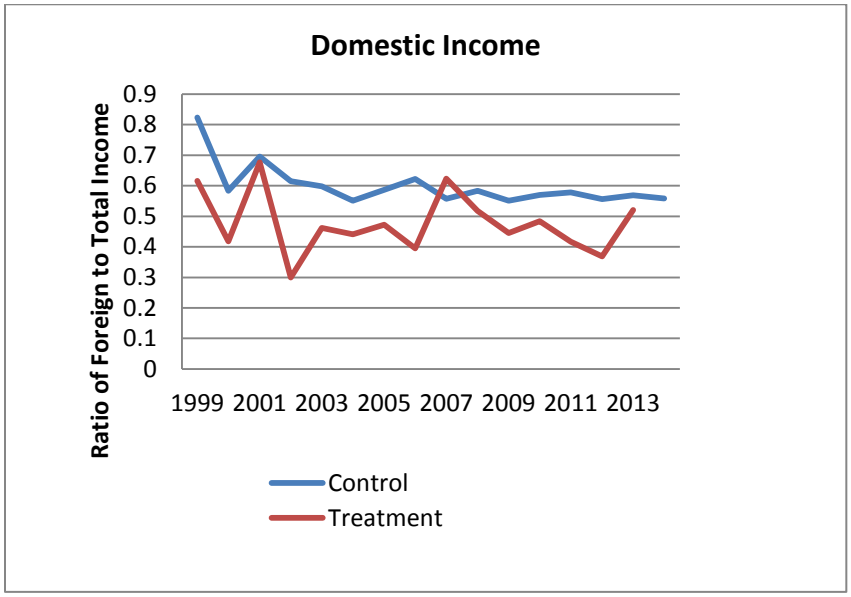
List of independent variables includes the ratio of foreign pretax income to total pretax income, which exhibits the volume of income received or recorded out of US soil. Based on 3,081 observations the mean of the variable is 0.51 and the median is 0.37. Dropping the extreme points and allowing the foreign profit to be as twice as bigger than a total pretax income in absolute values shrinks the number of observations to 2,991 with mean of 0.398 and median of 0.37. The situation, when the absolute number of the ratio is bigger than one, is possible - a company may have pretax foreign income bigger than total pretax income due to domestic losses.

Mean of treated group (0.49)[8] is higher than control group (0.39) indicating that the treatment group generated or registered more income outside the home country than the control group. Year-by-year comparison illustrates that foreign income higher for treatment groups in all years except 2008, the year of financial crisis.

[8] mean x3 if x3>-2 & x3<2, over(treated)

Figure 14: Chapter 3. Foreign Income vs Domestic Income





3.7 Domestic income to total income

Ration of domestic income to total income has mean 47.6 percent and median 62.1 percent. Dropping very extreme points and allowing the domestic income to be as twice as bigger than the total income in absolute values we can observe that the gap between

mean and median reduces with the value of mean being 57.6 percent. Group difference: control mean is 58.3 and median is 63.6 percent, treatment group – mean=47.5 and median=50.6. Year to year comparison shows that companies from control group are more domestic oriented than companies from the treatment group. Financial crisis of 2008 shows us that treatment group lost the foreign income, and therefore domestic income that year was higher compare to control group.

3.8 Intangible assets to total assets

Intangible assets enter the equation as the ratio of intangible assets to total assets. The sample of the given period had mean of 18.5 percent and median of 11.8 percent. Comparison between control and treatment group shows that companies involved in LTAs hold more intangible assets (mean of the group is 20.3 percent and the medial is 14.6 percent) than control group' companies (mean - 18.4 percent and median - 11.5 percent). Year by year comparison is made to see if difference persists over whole period or spikes only in certain times. The picture 8 depicts the year by year comparison of the control group and treatment group shows that although the level of intangibles to total assets are growing over the given period for both groups the growth rate for the treatment is stepper.

3.4. Regression analysis

Regression analysis is based on difference in difference method. I'd like to know if LTA had impact on following indicators: (i) overall effective tax rate, (ii) US effective tax rate,

(iii) foreign effective tax rate, (iv) cash effective tax rate and (v) book to tax difference. The general form of the equations is expressed through the following equation:

$$y = \alpha + \beta Z_{it} + \gamma time_t + \delta treatment_i + \theta(time \times treatment)_{it}$$

where *y* is the variable of interest, which can take the value of our interest such as effective tax rate, cash effective tax rate, domestic tax effective tax rate, foreign tax effective tax rate, book to tax difference.

Z is the vector of control variables, which includes ratio of domestic to total pretax income, foreign to total pretax income, number of foreign subsidiaries to total number of subsidiaries, number of countries to number of foreign subsidiaries, ratio of intangibles to total assets, in some cases ETR and cash ETR and Book-to-tax difference are also included. Time and treatment are binary variables with values 0 and 1. "Time x treatment" is the difference-in-difference effect, which I'd like to estimate.

I start my analysis from traditional pooled cross-section regressions presented in the table 10. The variables of my interest are ETR, cash ETR, foreign ETR, domestic ETR, and book-to-tax difference, i.e. we would like to know whether LTAs had any effect on these variables.

As it is illustrated in the table below the LTAs didn't have any significant impact on companies' accounts – all results are strongly against the assumption that companies involved in the agreements have done any better than companies, which didn't have

agreements with Luxembourg authorities. The analysis support the argument that LTA didn't reduce the overall tax burden of the involved firms or effect was very insignificant. The only variable which can be close to truth is the BTD. The regression shows that involvement in the LTAs could increase BTD of the companies on 8 percent subject to the condition that there are no other unknown factors which could impact on BTD. However, the results are not statistically significant (P>|t|=0.124).

Table 10: Chapter 3. Conventional Difference and Difference Regressions

Dependent variable (y)	**_cons**	**Time effect**	**Treatment effect**	**DID**	**R sqrd**
ETR	0.3485383	-0.028516	-0.0021879	0.0198288	0.1484
Std. Err.	0.0146252	0.0070348	0.0117996	0.01463	
P>|z|	0	0	0.853	0.175	
Cash ETR	0.2617971	0.0196787	0.0146551	-0.007304	0.2414
Std. Err.	0.0294633	0.0102232	0.0233934	0.025452	
P>|z|	0	0.054	0.531	0.774	
Domestic ETR	0.3966222	0.0015994	0.0342677	-0.0256885	0.3094
Std. Err.	0.1207862	0.0178332	0.0270731	0.0438053	
P>|z|	0.001	0.929	0.206	0.558	
Foreign ETR	-3.131944	0.3554588	0.4143632	-0.0639446	0.0418
Std. Err.	2.799322	0.4319453	0.5640824	0.3211404	
P>|z|	0.263	0.411	0.463	0.842	

BTD	0.185675	-0.010712	0.002697	0.0685383	0.3403
Std. Err.	0.0433863	0.0216462	0.0384816	0.0464556	
P>|z|	0	0.621	0.944	0.14	

The next group of equations is quantile regressions. I would like to take into account distributional effects while evaluating treatment effect. I assume that the distribution of the dependent variables may change in many ways that is not observed or only partially observed by the examination of average. In descriptive statistic section it is shown that for some variables the median is significantly deviates from the mean due to outliers; at the same time some data report upper-tail increase while the lower tail decreases. In order to be able to take into account the specifics of the dataset and reduce the noisiness of outliers the estimation of quantile treatment effects on treated (QTET) is used (results bootstrapped, 2000 republications).

The results are presented in the table at the end of this section. QDID indicator for cash ETR is found significant at $p<0.1$. The effect of QDID is negative meaning that treatment group was able to decrease the cash effective tax rate on 3 percent during the involvement into LTA. Other covariates are as follow. Dummy time shows that overall both groups increased their cash ETR in second period on 2 percent, and at the same time treatment group's cash ETR was higher for both periods than control group on 4 percent. Cash ETR decreases with domestic reported income and increases with foreign income, indicating that multinationals are more flexible with taxes in US than in foreign

jurisdictions. Companies with higher mulitnatinality indexes are able to save slightly more on cash paid for tax liabilities, thus reducing cash ETR on 1 percent. Relationship between ETR and cash ETR reveals that for every dollar increase in ETR companies pays 28 cent.

Book to tax difference also has significant QDID indicator. Companies involved in LTA were able to increase their BTD on 8 percent. Other estimators of the BTD regression have the following interpretations. BTD reduced over time on 1.5 percent, being in treatment group reduces BTD on 1.7 percent. Domestic pretax income decreases BTD on 13 percent while foreign income increases BTD on 8.8 percent. Multinationality indexes decreases BTD on 3.1 and 4.6 percent accordingly. Effective tax rate and cash ETR suppress BTD on 6.3 and 18.7. Cash paid for taxes due is the strongest indicator of BTD – the more cash paid the less will be BTD.

Other dependent variables of our interest don't have significant QDID estimators therefore I don't discuss them in detail. Application of QDID reveals that ETR, domestic ETR and foreign ETR of the companies which involved in the LTA didn't change compare to the same characteristics of the companies, which were not involved in tax agreements.

Table 11: Chapter 3. Median Difference and Difference Regressions

	_cons	Time effect	Treatment effect	DID	R sqrd
ETR	0.3533296	-0.0253979	-0.0022553	-0.0052379	0.1469
Std. Err.		0.0039652	0.0041391	0.0058205	
P>|z|	0	0	0.586	0.368	
Cash ETR	0.2663376	0.0209997	0.0415169	**-0.0335187***	0.2355
Std. Err.	0.0114963	0.0061216	0.017095	**0.0184245**	
P>|z|	0	0.001	0.015	**0.069**	
Domestic ETR	0.468368	-0.000028	0.0001255	-0.0012399	0.4681
Std. Err.	0.0077069	0.000967	0.011857	0.0122224	
P>|z|	0	0.977	0.992	0.919	
Foreign ETR	-0.098819	0.0008481	0.0030224	-0.0069433	0.0419
Std. Err.	0.018546	0.0105906	0.0187067	0.0209026	
P>|z|	0	0.936	0.872	0.74	
BTD	0.1603311	-0.0157141	-0.0172254	**0.0808204****	0.2865
Std. Err.	0.0325159	0.0155777	0.0343331	**0.0397729**	
P>|z|	0	0.313	0.616	**0.042**	

The evaluation of the effect of LTAs on tax liabilities of multinationals is not full without comparing parametric results to results obtained by more flexible semiparametric model. In conventional regression models we assume that the parallel trend assumption holds, however, as it can be seen from the graphs to descriptive statistics, the parallel

trend assumption for dependent variables may be violated. Semiparametric methods may be used to analyze the treatment effect when parallel trend assumption is violated. One of the semiparametric methods have been offered recently is a weighting method by Abadie (2005).

The setup for Abadie's approach is the following: consider the expression for estimation of the treatment on treated (ATT):

$$ATT = \mathrm{E}\left(Y_{1t} - Y_{0t} \middle| D = 1\right) \qquad (1)$$

With x_b being a set of pre-treatment characteristics, the conditional probability function to be in the treatment group is

$$\pi(X_b) \equiv P\left(D = 1 \middle| X_b\right) \qquad (2)$$

If conditions in (3) and (4) are hold:

$$\mathrm{E}\left(Y_{0t} - Y_{0b} \middle| D = 1, x_b\right) = \mathrm{E}\left(Y_{0t} - Y_{0b} \middle| D = 0, x_b\right) \qquad (3)$$

$$P(D = 1) > 0 \; and \; \pi(X_b) < 1 \qquad (4)$$

Then the expression (5) provides unbiased estimate of ATT (Stata Journal, p…):

$$\mathrm{E}\left(\frac{\Delta Y_t}{P(D=1)} \times \frac{D - \pi(X_b)}{1 - \pi(X_b)}\right) \qquad (5)$$

Condition (3) is a classical assumption and it states that conditional on X and in the absence of treatment the average outcomes for treated and control groups would have followed parallel paths (Abadie 2005). Condition (4) implies that support of the propensity score for the treated is a subset of the support of the propensity score for the untreated (Abadie 2005, p. 7)

The estimator is a weighted average of the difference trend ΔY_t across treatment groups. It proceeds by reweighing the trend for the untreated observations based on their propensity score $\pi(X_b)$. Observations with higher propensity score are given higher weight. The propensity score $\pi(X_b)$ is approximated semiparametrically using polynomial series of predictors:

$$\hat{\pi}(X_b) = \hat{\gamma}_0 + \hat{\gamma}_1 \times X_1 + \sum_{i=1}^{k} \hat{\gamma}_{2i} \times \prod_{j=1}^{i} X_2^i \qquad (6)$$

$\hat{\pi}(X_b)$ is approximated propensity score, k is the order of polynomial function used to approximate propensity score, $\hat{\gamma}_0, \hat{\gamma}_1, \hat{\gamma}_{21} \ldots \hat{\gamma}_{2k}$ are computed by least square estimator.

Another method to estimate propensity score $\pi(X_b)$ is suggested by Hirano et al (2003) and implies application of series of logit estimator (SLE). With SLE method the expression above will look like (Houngbedji, Stata Journal…):

$$\hat{\pi}(X_b) = \Lambda\left(\hat{\gamma}_0 + \hat{\gamma}_1 \times X_1 + \sum_{i=1}^{k} \hat{\gamma}_{2i} \times \prod_{j=1}^{i} X_2^i \right) \qquad (7)$$

where $\Lambda(X) = \frac{\exp(X)}{1 + \exp(X)}$.

The table below presents results of semiparametric difference-in-difference (SDID) using both methods in calculating the propensity score: with polynomial series of predictors proposed by Abadie (2005) and with logit estimator proposed by Hirano et al. 2003. The estimated outputs show that the companies involved in LTA were able to increase their

BTD on 6.2 percent and to reduce their cash effective tax rate on 2.1 percent. In addition to BTD and CETR, SDID estimator for ETR is significant, indicating that firms involved in LTA reduced their yearly ETR in average on 3 percent.

Table 12: Chapter 3. Results of Semiparametric Estimation

Semiparametric Estimation				
	SLE	**Obs**	**ORDER 4**	**Obs**
BTD1	**0.0615689**	1970	-0.0308425	1637
Std. Err.	**0.026367**		0.0224943	
P>|z|	**0.02**		0.17	
Cash ETR	0.0086536	2113	**-0.020947**	1755
Std. Err.	0.013443		**0.010956**	
P>|z|	0.520		**0.056**	
ETR	0.0127967	2121	**-0.032717**	1763
Std. Err.	0.0088776		**0.0070114**	
P>|z|	0.149		**0.000**	
Domestic ETR	0.0226981	2121	-0.024857	1755
Std. Err.	0.0304054		0.0227283	
P>|z|	0.455		0.274	
Foreign ETR	-0.0035308	2116	-0.084282	1755
Std. Err.	0.0851476		0.0806164	
P>|z|	0.967		0.296	

3.4. Conclusion

Current paper has attempted to evaluate multinational companies involved in Luxemburg Tax Agreements of 2005-2008 to answer the question whether those companies were able to reduce their worldwide tax obligations. EU authorities (State Aid) have concerns that companies involved in LTAs were able to reduce their taxes and these agreements signed by multinationals only for tax avoidance purposes and therefore those taxes to be paid in EU. In the same time multinationals claim that LTA were used by them to pursue other management goals such as expansion the presence in the EU market and for investment decisions. By comparing results from various difference-in-difference regressions – traditional, quantile and semiparametric, I found that these companies may have saved more on taxes then other companies of the S&P list, which might support the arguments of EU authorities.

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