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Location Investment Decisions**

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Research Papers

Formula Apportionment or Separate Accounting? Tax-Induced Distortions of Multinationals' Locational Investment Decisions

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Abstract

We examine which tax allocation system leads to more severe distortions with respect to locational investment decisions. We consider separate accounting (SA) and formula apportionment (FA). The effects of both systems have been hotly debated in Europe in the past years. The reason is that the EU Member States are striving to implement a common European tax system that would lead to a switch from SA to FA. While existing studies focus primarily on the impact of taxes on locational decisions under either SA or FA, the main innovation of this paper is that it compares both systems with regard to the level of distortions they induce. We compare the optimal pre-tax investment decision with the optimal after-tax investment decision and infer from the difference in the allocation of investment funds which tax allocation system causes more severe distortions. We assume that the multinational group (MNG) has comprehensive book income shifting opportunities under SA. We find that the investment incentives under SA are opposed to those under FA for a profitable investment project. Whereas under SA as much as possible should be invested in a high-tax country, under FA as much as possible should be invested in a low-tax country. The distortions of locational investment decisions tend to be more severe under SA than under FA if a greater share of investment funds is to be invested in a low-tax country from a pre-tax perspective and the investment is profitable. Vice versa, locational decisions may be more distorted under FA if the optimal pre-tax investment decision requires investing a major share of funds in the high-tax country. In contrast to the often stated insensitivity of FA towards income shifting, we find the introduction of a tax allocation system based on FA in Europe could lead to a severe shift of economic substance to low-tax countries. The results of this paper are of particular interest for European policy makers and MNGs as our findings may induce European MNGs to reassess their recent locational investment decisions in the face of a potential future change in the applied tax allocation system.

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1. Introduction

The aim of this paper is to examine which tax allocation system for multinational groups (MNGs) causes more severe distortions of locational investment decisions. We consider two systems, namely separate accounting (SA) and formula apportionment (FA). As both are based on a fundamentally different mechanism for determining the tax base per entity, they offer different incentives with respect to the favorable country of investment. We use the optimal investment decision from a pre-tax perspective as a benchmark to assess the level of distortion caused by taxation. Thus, taking a business perspective, we compare the optimal pre-tax investment decision with the optimal after-tax investment decision and infer from the difference in the allocation of investment funds which tax allocation system causes more severe distortions. Assuming comprehensive income shifting possibilities under SA, we find that the investment incentives under SA are opposed to those under FA for a profitable investment project. Whereas under SA as much as possible should be invested in a high-tax country, under FA as much as possible should be invested in a low-tax country. Furthermore, locational investment decisions tend to be distorted more severely under SA if the largest share of investment funds is invested in the low-tax country from a pre-tax perspective. Vice versa, locational decisions may be more distorted under FA if the optimal pre-tax investment decision requires investing a major share of funds in the high-tax country. In contrast to the often stated insensitivity of FA towards income shifting, we find the introduction of a tax allocation system based on FA in Europe could lead to a severe shift of economic substance to low-tax countries.

The effects of both tax allocation systems have been hotly debated in Europe in the past years,¹ the reason being that the EU Member States are striving to implement a common European tax system. If this should come to pass, the traditional system of SA used currently across the EU will be replaced by FA. The idea behind the Common Consolidated Corporate Tax Base (CCCTB) system is to harmonize EU Member States' tax bases in order to reduce the economic hurdles resulting from 28 different national tax systems. In 2011, the European Commission proposed a Council Directive on a CCCTB.² If the CCCTB is introduced, European MNGs would need to apply only one tax code to determine their tax base. The profits and losses of all single entities could be consolidated on the group level. The consolidated group tax base would subsequently be allocated to each entity according to an apportionment formula based on assets, labor, and sales.

In a globalizing world, companies increasingly establish a multinational company structure to remain competitive and build more permanent establishments and subsidiaries abroad.³ By doing so, they hope to, e.g., tap into new markets, relocate production closer to the required natural resources, or to access lower-wage labor. Furthermore, MNGs attempt to create a tax-favorable group structure so they

¹ For an overview of the historical development of the idea to harmonize the tax systems in Europe see Dahle (2011), pp. 107-109.

² See European Commission (2011).

³ See Devereux & Maffini (2006), p. 1.

can benefit from tax rate differentials between countries. There is plenty of empirical evidence⁴ to indicate that MNGs shift income from high-tax to low-tax countries. They do so largely via two channels. Either MNGs shift accounting profits, meanings they merely move book values. Alternatively, they shift real economic substance, e.g., workforce and assets, to generate profits or losses in tax-favorable environments. Thus, real activity shifting certainly affects the structure of an MNG. In this study we focus on locational decisions relating to real investments as a specific form of real activity shifting. Whereas previous studies mainly identify the direction of activity shifting under either tax allocation system separately, we go one step further and determine the level of activity shifting under either tax allocation system and subsequently compare their respective distortive power.

The fiscal environment is currently undergoing vast changes. In the context of its Base Erosion and Profit Shifting (BEPS) project, the OECD stated that “[t]axation is at the core of countries' sovereignty, but in recent years, multinational companies have avoided taxation in their home countries by pushing activities abroad to low or no tax jurisdictions.”⁵ This statement stresses that fiscal authorities are increasingly concerned about how to ensure that MNGs pay their fair share of taxes in the respective countries. Accordingly, the aim of the BEPS project is to change fiscal framework conditions on an international level in such a way that income shifting is prevented. There are two major tax allocation systems according to which the taxable share of each group entity is determined: SA and FA. SA is currently used in Europe and in most countries around the world. Under SA, each group entity that is incorporated in one country is treated distinctly and has to calculate its tax liability separately according to national tax laws. Under FA, the uniformly determined profits and losses of the entities are consolidated on the group level and are subsequently allocated to the group entities according to a specific apportionment formula. This formula is designed to capture the economic share contributed by each entity to the MNG's profits. FA is already well-known as it is in use, e.g., on the state level in the USA and Canada for cross-state or -province tax base allocation. Empirical and analytical studies show that activity shifting is conducted under both systems.⁶ However, to our knowledge there is no study that compares the distortive impact of either system on locational investment decisions. As both tax allocation systems apply different mechanisms to determine the taxable share per country, they each offer varying leeway for avoiding taxes with respect to activity and accounting profit shifting.

From a macroeconomic perspective, a basic prerequisite for a good tax system is efficiency. Economic entities ought to be taxed in such a way that the scarce resources of an economy are allocated in a welfare-enhancing manner. Generally, free competition between economic entities is considered the market type that leads to such welfare-enhancing allocation. Thus, the tax system ought to be designed in such a way that it does not affect free market conditions. Consequently, economic entities'

⁴ See section 2, literature review.

⁵ See OECD (2013), p. 9.

⁶ See Martini et al. (2013), Altshuler & Grubert (2010).

decisions should not be affected and investment decisions should not be distorted by corporate taxation.⁷ In this study we investigate to what extent SA and FA are capable of ensuring such neutrality with respect to locational investment decisions.

We develop an analytical model to resolve our research question, namely which tax allocation system causes more severe distortions to locational investment decisions. The MNG has to decide which share of total investment funds to invest in each entity. We take a two-step approach, first determining the optimal after-tax allocation of investment funds under both tax allocation systems. The optimal after-tax allocation of investment funds is characterized by the highest after-tax cash flows under each system. Second, to determine the level of distortion caused by each system, we calculate the difference between the optimal allocations of investment funds from a pre-tax and an after-tax perspective. By comparing these differences we can derive conclusions about the distortive power of each system – the greater the difference, the greater the distortive power. The optimal economic pre-tax investment decision is determined by the relative demand per country, as the MNG will aim to produce wherever its sales are incurred. The optimal after-tax investment decision is modeled explicitly in our analysis. In our model the MNG faces a trade-off between choosing a tax-optimal allocation of investment funds and an optimal allocation from a purely economic pre-tax perspective.

We chose a two-country, two-entity setting for an MNG and assume a tax rate differential between both countries. Under SA, we assume that book income can be shifted comprehensively due to favorable transfer pricing arrangements. The shifting possibilities allow for the geographic segregation of sales and expenses, which directly affects the locational investment decision. We are convinced that it is also possible to shift book income under FA⁸ but do not believe that this has a direct impact on the locational investment decision. As under FA the allocation of profits is based on the location of real economic factors, it ought to be an MNG's first priority to locate the economic factors in a tax-optimal way.

The results of this paper are of particular interest for European policy makers. On an aggregated level, our results make it possible to anticipate the macroeconomic effects induced by the potential introduction of the CCCTB system. Furthermore, our results can benefit European MNGs that face locational investment decisions. As we take a business perspective, our results may induce European MNGs to reassess their recent locational investment decisions in the face of a potential future change in the applied tax allocation system. Although our analysis is mainly motivated by the European debate around introducing the CCCTB, the results are also interesting for policymakers and MNGs in other parts of the world. On the state level in the US FA and SA coexist. As a matter of principle, the states apply formula apportionment. However, "if the allocation and apportionment provisions [...] do

⁷ See Kruschwitz et al. (2003), p. 328.

⁸ See Kiesewetter et al. (2014).

not fairly represent the extent of the taxpayer's business activity in this state"⁹ US based companies may also apply separate accounting. Prior US studies on FA¹⁰ have examined its distortive effects yet we are the first to compare the level of distortion induced by FA relative to that induced by SA. Thus, our results may offer new input for potential reform debates about the coexistence of both systems in the US.

The next section consists of a brief review of the related literature. Section 3 presents the assumptions and the model set-up. In Section 4 we examine which tax allocation system offers stronger incentives to make an optimal locational investment decision, on the assumption that no costs are incurred by production and sales being in different countries. In Section 5 we introduce costs for production and sales being in different countries and determine the conditions under which either tax allocation system more severely distorts the investment decision. We conclude with a discussion of the managerial and tax policy implications.

2. Literature Review

Two main streams of research are relevant to our research question. First, prior research examines the impact of taxation on the location of profits and of investment decisions. Many empirical studies investigate how tax rate differences between countries affect the location of profits of MNGs. All of these studies are conducted in an SA setting. We, too, examine the relationship between the location of profits and tax rate differentials. However, doing so reflects our research question only on an aggregated level since we go one step further and examine the underlying locational investment decisions that determine the location of profits.

Harris et al. (1993) examine the level of tax payments of US parent companies depending on the location of their subsidiaries. They find evidence that groups with subsidiaries in low-tax countries pay relatively fewer taxes in the US compared to those that have subsidiaries in high-tax countries. They conclude that US MNGs are likely to shift income. In line with that finding, Bartelsman and Beetsma (2003) find evidence for income shifting in 16 OECD countries as well. They estimate that at the margin 65% of additional revenues from a unilateral tax increase is lost due to a decrease in the reported tax base. By contrast, the more recent income shifting literature identifies fundamentally smaller shifting effects in response to changes in tax differentials. In a meta-analysis Heckemeyer and Overesch (2013) review empirical studies on profit shifting and find that overall, reported profits decrease by about 0.8% for each one percentage point increase in the tax differential between countries. Dischinger et al. (2014) focus on the role of the location of the headquarters of MNG that shift income. Using a large European panel data set, they find that MNGs shift income to a significantly larger extent if the tax rate in the country of headquarter domicile is lower than that in the

⁹ Uniform Division of Income for Tax Purposes Act (1966), pp. 12-13.

¹⁰ See Gordon & Wilson (1986), Goolsbee & Maydew (2000).

domiciles of the subsidiaries. For a comprehensive literature review on the impact of taxes on the location of profits, see Dharmapala (2014) and Devereux and Maffini (2006). In line with our findings and assumptions, all studies find evidence for (accounting) income shifting on the part of MNGs.

Some literature also focuses specifically on the impact of taxes on locational investment decisions. Buettner (2002) empirically examines the relationship between statutory tax rates and foreign direct investment (FDI). He analyzes bilateral FDI flows and finds evidence that tax incentives affect the location of FDI. An increasing difference between the statutory tax rates of the entities' countries of domicile is related to an increase in FDI outflows. Gorter and Parikh (2003) and Bénassy-Quéré et al. (2005) find similar results. At first glance, their results, which implicitly assume SA, seem to contradict ours, since we find that under SA, MNGs preferably invest in high-tax countries. However, whereas we assume that the MNG already has well-established business activities in both types of country and only decides on subsequent investments, the cited studies examine investment decisions prior to establishing a new subsidiary. Thus, the previous studies focus on the earlier stages of the investment decision.¹¹ Our analysis is based on the assumption that the MNG has already taken such a decision and subsequently established a subsidiary in a low-tax country. Thus, in our setting the MNG can shift income to a company that is already established in the low-tax country, which we model explicitly.

Overesch (2009) assumes a setting that is closer to ours. He empirically investigates whether MNGs' real investment in high-tax countries is affected by income-shifting opportunities. Based on a panel of German inbound investments he finds evidence that investments in high-tax countries increase if the MNG is able to shift income to low-tax jurisdictions. Furthermore, Grubert (2003) finds empirical evidence that companies with good income shifting opportunities preferably invest in countries with either very high or very low statutory tax rates. The results of both studies are consistent with our findings under SA.

Two studies focus on investment incentives in a formula apportionment setting. Gordon and Wilson (1986) analytically investigate how FA affects companies' investment incentives. They conclude that a three-factor apportionment formula *de facto* creates three different taxes. Furthermore, largely in line with our results, they find that a formula consisting of assets, labor and sales creates incentives to produce in low-tax countries and sell in high-tax countries. Goolsbee and Maydew (2000) find in a study based on US data that, on average, a reduction in the formula factor weight of payroll from one third to one quarter increases manufacturing employment by around 1.1%. Our findings lend further support to these results. The first stream of research gives us an idea of what kind of investment

¹¹ According to the classification of Devereux & Maffini (2006), p. 4, the cited studies focus on discrete investment choices (second level of the decision tree in Fig. 1) whereas we focus on continuous choices (third and fourth level of the decision tree in Fig. 1).

incentives are created by which tax allocation system. However, we cannot infer which system creates relatively stronger investment incentives and which has relatively stronger distortive power.

The second main stream of research relevant to our study focuses on the comparison of separate accounting and formula apportionment with respect to various aspects. Many studies chose a public finance perspective. Nielsen et al. (2010) compare both tax systems with respect to basic properties such as their impact on capital formation, input choices and transfer pricing. They focus especially on the welfare effects of a switch from SA to FA. Nielsen et al. (2003) investigate the effects of a switch from SA to FA on income shifting via transfer pricing in a setting with imperfect competition. However, none of these studies focuses on the distortive power of one system relative to the other. In empirical research Oestreicher and Koch (2011) and Fuest et al. (2007) estimate the revenue consequences of the introduction of the CCCTB in the European Union in comparison to the currently applied system of SA. From these studies we can only vaguely infer the impact that a change in the tax system could have on locational investment decisions. Only few studies take a business perspective. In an analytical study Ortman and Sureth-Sloane (2016) investigate the conditions under which SA or FA is preferable from the perspective of an MNG, with a particular focus on loss-offsets. These findings give us an idea of the tax base allocation system under which companies should invest in which country if they anticipate temporarily losses. However, the focus of this study is too narrow and hence not able to give us deeper insights into our research question. The study of Martini et al. (2012) is most relevant to our study with respect to the economic setting and the research question. In an analytical setting they investigate the impact of various tax allocation regimes on production and investment decisions. However, they have a managerial accounting focus and distinguish between centralized and decentralized decision structures within the MNG. Their study does not aim at comparing the level of distortion induced by each tax allocation system. Furthermore, unlike our study, they account only for profit scenarios and ignore losses.

To conclude, comprehensive research has been conducted on the impact of taxation on locational investment decisions under each individual tax allocation system. However, no studies explicitly measure the level of distortion induced by each tax allocation system; neither do they appear to have compared the respective levels of distortion. Although there is some literature comparing the specific properties of SA and FA, the studies disregard the distortive power they have on locational investment decisions. Our study aims to fill this gap.

3. Model

3.1. Assumptions

An MNG is assumed to consist of two group entities (entity A and B) that are located in country A and country B. The companies are fully affiliated. It is not necessary to specify which company is the

parent and which is the subsidiary. As our model applies to a wide range of businesses, we provide a fairly abstract outline of the activities and characteristics of the MNG. Both group companies already have well-established business activities. They operate in the same industry, produce the same products or offer the same services, respectively. Each entity is responsible for selling the services/products to local customers. For reasons of simplicity, in the following we refer only to products, although this study applies to the provision of services as well. The executives of the MNG (for simplicity subsequently referred to only as “the MNG”) plan to invest the amount I to expand the business. The MNG has to decide which share of investment funds I to invest in entity A and B,¹² respectively, to maximize its after-tax profits.

They invest the share a_{τ}^c (c indicates transportation costs, τ indicates an after-tax perspective, explained subsequently in more detail) in assets or workforce in country A and $(1 - a_{\tau}^c)$ in country B. The MNG is managed centrally. The investment in the MNG’s business leads to the highest expected returns, so no other investment alternatives need to be considered. The executives can invest any share of investment funds in entity A or B, so the investment decision is continuous with respect to the allocation of the funds. It is conceivable that, for instance, the MNG considers investing a large amount in machinery or in hiring many workers in country A and/or B. Thus, as the investment in each individual investment object is rather low compared to the total investment amount, we assume a continuous allocation of investment funds as an appropriate approximation of accumulated investments throughout the group. By assumption, the share of investment a_{τ}^c and $(1 - a_{\tau}^c)$ in each entity finally leads to corresponding shares of sellable products per entity.

The production conditions are assumed to be identical in country A and country B. In other words, the probability of a successful outcome of the production processes is equal in both countries. Consequently, e.g., the workforce is equally trained and educated in both countries, the level of production know-how is identical and access to resources is identical. Consequently, we abstract from differences in productivity. A successful outcome means that the quality of the products is sufficient to sell them successfully at a profitable price. Furthermore, the costs incurred by the production process and the expected future profits from the investment are assumed to be identical before taxes in both countries. Thus, from a purely output-oriented pre-tax perspective the executives of the MNG are indifferent between investing in the entity in country A or country B. We could easily relax this assumption. However, to be able to isolate the tax effects we take advantage of the power of this stylized setting.

However, the executives are not only interested in the output of the investment, i.e., the quality of products, but also in the opportunities to sell these products to the customers in the respective countries. In this regard the countries deviate from each other. The demand for products need not

¹² Continuous investment decision is also modelled by Dietrich & Kieseewetter (2011), p. 103.

necessarily be the same in both countries. The MNG sells its products to customers in country A/B only via the local entity (entity A/B). Thus, we assume that selling products cross-border to end customers is impossible. Note, however, that selling products cross-border between both group entities is possible.¹³

Both countries levy corporate taxes on the entities' profits. The corporate tax rate in country A τ_A is assumed to be lower than that one in country B τ_B . The tax rates are assumed to be identical under FA and SA.¹⁴ We assume an immediate full tax loss-offset as the entities are expected to generate enough profits from other, well-established business activities to compensate for a loss from the underlying investment project. Thus, the overall business of both entities is assumed to be profitable even if the outcome of the investment project itself may be negative. If the funds are invested in assets (e.g. machinery) they are fully depreciable in the period under review.¹⁵ For reasons of simplicity, in our model the investment amount I is normalized to unity.¹⁶

As each entity sells its products only to local customers (customers in country A or B, respectively) and as the MNG produces and sells only enough products to exactly meet the aggregated demand of both countries, the relative demand in both countries is equal to the relative volume of sales of the group entities. The location of sales cannot be manipulated given the fixed location of end customers.¹⁷ Consequently, the relative sales per country are set in our model. The relationship between sales in country A and sales in country B is assumed to remain constant irrespective of the success of the investment project. Note that it is not possible to make any inferences from the relationship of sales between the entities regarding the relationship between productions in the respective entities. The entities could sell products to end customers that they have produced themselves or products they have bought from the other group entity, since inter-group-entity trade is possible. Due to tax planning considerations, the volumes of products produced and products sold may differ per entity.

With a probability p the development of the investment is successful and the share sold by each entity to end customers is multiplied by the factor $(1 + u)$, $u > 0$. The factor $(1 + u)$ captures the price for the products. The price level is related to the quality of the products. Thus, a high selling price represents a successful production process and high product quality. Note that the investment amount I is normalized to unity, so the price is adjusted in relation to the normalization of I .¹⁸ As the production conditions are identical in both countries the probability p for a successful development of the investment must be identical as well. With the probability $(1 - p)$ the development of the investment

¹³ The concept is well-known in international marketing literature, see for example Binckebanck (2012), p. 387.

¹⁴ Also assumed by Oestreicher & Koch (2011).

¹⁵ Assuming the full depreciation of investment funds in the first period is also a good approximation for multi-period analyses in the current low interest rate period and in case of full loss-offset possibilities.

¹⁶ See Nielsen et al. (2010), p. 123.

¹⁷ See Dyreng & Markle (2013), p. 9.

¹⁸ See Nielsen et al. (2010), p. 123.

is not successful and leads to a loss. In such a case the share sold by each entity is multiplied by $(1 - u)$. Thus, the quality of the products is low and their selling prices are too. For reasons of simplicity the successfulness of the investment project is only reflected in the price of the products, not in the quantity of sold units. However, e.g., in case of an unsuccessful investment, the lower selling price could also be reinterpreted as a reduction in sold products at a constant price level.¹⁹ Due to the exogenously given probabilities for a good development of the project (p), we can determine the expected after-tax profits/losses of the MNG.

Specific costs will occur if the location of production, i.e., where the MNG invested in assets/labor, differs from the location of sales. Thus, from an economic pre-tax perspective, the MNG would optimally allocate the investment funds between entity A and entity B according to the relative demand (which is equal to the relative sales) in each country. In such case no costs would occur since all products are produced there where they are sold. The variable a_e describes the share of total sales/demand incurred in country A (subscript e stands for the “economic”, pre-tax perspective). The “specific costs” can be thought of as transportation costs, costs incurred by language barriers between the countries, or currency differences. In the following we summarize these costs under the term “transportation costs”.²⁰ Whereas we model the optimal after-tax allocation of investment funds explicitly, the optimal allocation of investment funds from an economic, pre-tax perspective is indirectly determined by the occurrence of sales (a_e^*). The sales are, in turn, exogenously given by local demand. In our model, the MNG faces a trade-off between allocating the investment funds in order to reduce tax payments and in order to lower transportation costs. The MNG aims to find the allocation of investment funds (a_τ^c) that leads to highest after-tax cash flows, i.e., the optimal investment decision.

If the share of products sold (α_e) is not identical to the share of products produced (a_τ^c) by the entity in country A, entity A either has to buy part of the products from entity B ($\alpha_e > a_\tau^c$) or has to supply entity B with products ($\alpha_e < a_\tau^c$). As both companies produce in sum exactly as many products as demanded in sum in both countries, the surplus of products produced by entity A can be sold to entity B, which sells them to the customers in country B, and vice versa. By subtracting a_τ^c from α_e we obtain the share of produced products that exceeds the share of products that can be sold directly by entity A. Table 1 graphically illustrates these relations.

¹⁹ Similarly modelled by Devereux & Griffith (1998), p. 340.

²⁰ Devereux & Griffith (1998), p. 336 also focus on transportation costs as the crucial factor in deciding where to produce.

	Country A	Country B
share of products produced	a_{τ}^c	$(1 - a_{\tau}^c)$
share of demand = share of products sold	α_e	$(1 - \alpha_e)$
$a_{\tau}^c > \alpha_e$	More products produced than sold → difference $(a_{\tau}^c - \alpha_e)$ transferred to entity B	More products sold than produced → difference $(a_{\tau}^c - \alpha_e)$ supplied by entity A
$a_{\tau}^c < \alpha_e$	More products sold than produced → difference $(\alpha_e - a_{\tau}^c)$ transferred to entity B	More products produced than sold → difference $(\alpha_e - a_{\tau}^c)$ supplied by entity A

Table 1: Relations between sold and produced products per country

Transportation costs need to be further specified. We assume that the deviation from the optimal economic, pre-tax allocation of funds causes quadratic costs. Hence, the more the MNG deviates from the optimal economic allocation of funds in the investment decision, the higher the expected costs resulting from the deviation:²¹

$$E[C] = c \cdot (a_{\tau}^c - \alpha_e)^2. \quad (1)$$

The bigger the difference between the optimal allocation of funds from a pure tax perspective and an economic, pre-tax perspective, the more products need to be transferred cross-border from country A to country B or vice versa. We assume that more inter-group-entity trade requires a more professional product exchange system between the entities. The required higher level of sophistication causes higher (quadratic) costs.

3.2 After-tax cash flows

In this subsection we build a model to calculate the after-tax cash flows. In the following sections (Sections 4 and 5) we determine the optimal after-tax allocation of investment funds in order to determine the level of distortion caused by each tax system. The optimal after-tax allocation of investment funds is characterized by the highest resulting after-tax cash flows. Thus, to clarify, here we introduce a model to calculate the after-tax cash flows only with the aim of deriving the optimal after-tax allocation of investment funds a_{τ}^{c*} . We are not interested in the level of maximal after-tax cash flows under each tax system *per se*; rather, we need to calculate them to identify the optimal allocation of investment funds a_{τ}^{c*} .

The expected sales for the MNG are calculated as follows:

²¹ Quadratic transportation costs are a common assumption in spatial industrial economics; see Andree (2014), p. 195. See also Jara Diaz (1982).

$$E[S] = p * (\alpha_e \cdot (1 + u) + (1 - \alpha_e) \cdot (1 + u)) + (1 - p) * (\alpha_e \cdot (1 - u) + (1 - \alpha_e) \cdot (1 - u)). \quad (2)$$

The expected after-tax cash flows $E[CF^{Group}]$ of the MNG are obtained by deducting the expected tax payments $E[TP]$, the expected transportation costs $E[C]$, and the investment costs (normalized to unity) from the expected sales $E[S]$.

$$E[CF^{Group}] = E[S] - E[TP] - E[C] - 1. \quad (3)$$

The expected transportation costs $E[C]$ and the expected tax payments $E[TP]$ are a function of the decision variable a_τ^c ; see eqs. (1, 5 and 6). The expected tax payments $E[TP]$ depend on the applied tax allocation system; we show in the following two subsections how they are determined under FA and under SA, respectively. To determine the expected tax payments from the investment project we calculate the tax payments in the good and bad case for both entities and weight them with the probability of success. See Table 1 for a tabular overview under SA.

3.2.1 Separate Accounting

If products are traded cross-border between the group entities, transfer prices need to be applied under SA. Furthermore, transportation costs are incurred for the cross-border trade between the entities. We assume that these costs are borne equally by both entities. Thus, the costs reduce the tax base of both entities equally. The International Commercial Terms (Incoterms)²² contain rules that are intended to clearly communicate the costs incurred by the transportation of goods. Incoterms are widely used in international trade. In most of the cases considered in Incoterms, the transportation costs are somehow shared between the buyer and the seller. Thus, as an approximation, we assume that the transportation costs are equally shared between both group entities. The transportation costs could be used to incur costs in the more tax-favorable country. However, for reasons of clarity we account for manipulations of the tax bases only by transfer prices n .

If company A produces more products than it sells, it transfers these excess products to entity B at the transfer price n . By assumption the tax authorities accept the applied transfer price. Consequently, the following expression reflects the total expected transfer pricing payments (TPP) from entity B to entity A:

$$E[TPP] = n \cdot (a_\tau^c - \alpha_e). \quad (4)$$

Depending on the relation between α_e and a_τ^c , the transfer payments increase or decrease the tax bases of entity A or entity B. If, for example, entity A sells more products than it produces, it receives products from entity B and has to make transfer payments to entity B. Table 2 shows the tax bases for

²² ICC Germany (2015).

both entities in the good and the bad case after transfer pricing considerations. Note that the expected transfer pricing payments $n \cdot (a_t^c - \alpha_e)$ are added to the tax base of entity A and subtracted from the tax base of entity B. Thus, it depends *de facto* on the sign of the term $(a_t^c - \alpha_e)$ if the tax base of entity A or B is increased or decreased by the transfer payments.

	entity A	entity B
good p	$(\alpha_e \cdot (1 + u) - a_t^c - 0.5 c \cdot (a_t^c - \alpha_e)^2 + n \cdot (a_t^c - \alpha_e))$	$((1 - \alpha_e) \cdot (1 + u) - (1 - a_t^c) - 0.5 c (a_t^c - \alpha_e)^2 - n \cdot (a_t^c - \alpha_e))$
bad $(1 - p)$	$(\alpha_e \cdot (1 - u) - a_t^c - 0.5 c \cdot (a_t^c - \alpha_e)^2 + n \cdot (a_t^c - \alpha_e))$	$((1 - \alpha_e) \cdot (1 - u) - (1 - a_t^c) - 0.5 c \cdot (a_t^c - \alpha_e)^2 - n \cdot (a_t^c - \alpha_e))$

Table 2: Tax bases in each case under SA after transfer pricing

The expected tax bases per country are then determined by weighting the tax bases per case with the probability of success p and $(1 - p)$. Eq. (5a) and eq. (5b) reflect the expected tax bases for entity A and entity B.

$$E[TB_{SA}^A] = p \cdot (\alpha_e \cdot (1 + u) - a_t^c - 0.5 c \cdot (a_t^c - \alpha_e)^2 + n \cdot (a_t^c - \alpha_e)) + (1 - p) \cdot (\alpha_e \cdot (1 - u) - a_t^c - 0.5 c \cdot (a_t^c - \alpha_e)^2 + n \cdot (a_t^c - \alpha_e)), \quad (5a)$$

$$E[TB_{SA}^B] = p \cdot ((1 - \alpha_e) \cdot (1 + u) - (1 - a_t^c) - 0.5 c \cdot (a_t^c - \alpha_e)^2 - n \cdot (a_t^c - \alpha_e)) + (1 - p) \cdot ((1 - \alpha_e) \cdot (1 - u) - (1 - a_t^c) - 0.5 c \cdot (a_t^c - \alpha_e)^2 - n \cdot (a_t^c - \alpha_e)). \quad (5b)$$

We obtain the expected tax payments for the whole group by multiplying the expected tax base per country with the respective tax rate. Eq. (6) shows how the overall tax payments are calculated:

$$E[TP_{SA}^{Group}] = E[TB_{SA}^A] \cdot \tau_A + E[TB_{SA}^B] \cdot \tau_B. \quad (6)$$

3.2.2 Formula Apportionment

For apportioning the consolidated tax base of an MNG the design of the formula is decisive. The so-called Massachusetts Formula consists of the equally weighted factors assets, labor and sales:

$$\frac{1}{3} \cdot \left(\frac{\text{sales of entity } i}{\text{sales of the group}} + \frac{\text{assets of entity } i}{\text{assets of the group}} + \frac{\text{labor expenses of entity } i}{\text{labor expenses of the group}} \right).$$

The Massachusetts Formula is – with a small deviation – the proposed formula for apportioning the tax base of European MNGs under the CCCTB system. Only in the calculation of the factor “labor” does the proposed formula under the CCCTB system deviate slightly from the Massachusetts Formula. Whereas the labor factor consists only of the expenses for the workforce under the Massachusetts Formula, it consists in equal parts of those expenses and number of workers under the proposed

CCCTB formula. However, this small simplification of the Massachusetts Formula is negligible for the purpose of our analysis. The Massachusetts Formula was originally used by almost all states in the US to apportion the consolidated tax base of national groups to the entities. However, whereas under the proposed CCCTB system the factors are weighted equally, in the US there is room for deviation from these weights. States tend to give more weight to the sales factor and distribute the remaining weights equally across the asset and the labor factor. As we focus on the CCCTB setting in this study we assume fixed and equally weighted factor weights as under the Massachusetts Formula.

Furthermore, we assume that under FA the share of assets is equal to the share of labor for each entity. The basic idea of this assumption is that assets, e.g., machinery, require a proportional number of workers to operate them. Thus, they are seen as complements.²³ Note that the MNG already has some well-established business activities that also have to be taken into account when determining the allocation of the group tax base. The existing shares of assets, labor, and sales per entity induced by other business activities are assumed to correspond to the shares of these factors that result from the investment. Thus, the allocation of the group tax base between the entities does not change due to the investment. Consequently, the variables a_{τ}^c and α_e contain all necessary information to determine which share of the group tax base is allocated to which entity.

In contrast to SA, under FA the costs and sales from the investment are consolidated on the group level. Thus, the MNG cannot benefit from segregating expenses and sales and incurring them separately in tax-favorable environments. We take the provisions governing FA under the CCCTB system as a model for this study. According to Section 96 of the CCCTB proposal,²⁴ sales are assigned to the destination country of the sold products. Thus, under FA, it is generally possible to segregate the location of sales and the location of assets and labor (i.e., the location of production). Under FA, segregation is decisive for the tax-optimal arrangement of the apportionment factors between country A and country B. Note that such a segregation would not be possible if the sales were assigned to the country where the products were produced. Due to the consolidation of profits and/or losses on the group level, no transfer pricing issues arise. As a side note, it would not make a difference to the sales factor if we relax the assumption of prohibiting direct sales in other countries. If we assume that entity A sells its products directly to the end customers in country B instead of selling them indirectly to them via entity B, the share of the group tax base allocated to each entity does not have to be adjusted.

The formula apportionment systems that exist around the world offer different ways to deal with losses. Whereas in the US the overall loss of the group is allocated to the group members and is carried forward on the entity level, under the European CCCTB system it is not allocated to the group entities and is carried forward on the group level. However, in the scenario considered here we assume that the group incurs profits from other business activities so that the overall tax base of the group is

²³ See Runkel & Schjelderup (2011), p. 916 and Dietrich & Kiesewetter (2007), p. 507.

²⁴ See European Commission (2011).

positive and losses can be offset against profits within the group. Consequently, under this assumption we do not need to distinguish between a formula apportionment system that does or does not allow for allocating losses to the entities.

To apply the apportionment formula we need to know which share of sales, assets, and labor accrue in which country. As described in the section headed “Assumptions”, the variables α_e and $(1 - \alpha_e)$ represent the shares of sales and the variables α_t^c and $(1 - \alpha_t^c)$ represent the shares of assets and labor present in each country. The transportation costs do not impact the relative allocation of assets and labor between the countries. The MNG is assumed to outsource transportation to a logistics company. The share of assets and labor is assumed to be equal in each country. Thus, the share of the overall tax base apportioned to country A is calculated as follows

$$f_A = \frac{1}{3}(\alpha_e + 2 \cdot \alpha_t^c). \quad (7)$$

Consequently, the share allocated to country B is $f_B = (1 - f_A)$, respectively.

Due to cross-border consolidation, the expected tax base on the group level is determined by summing up the results of both group entities:²⁵

$$\begin{aligned} E[TB_{CCCTB}^{Group}] &= E[S] - E[C] - 1 \\ &= (-1 + 2p) \cdot u - c \cdot (\alpha_t^c - \alpha_e). \end{aligned} \quad (8)$$

By multiplying the tax base with the apportionment factors $f_A \cdot \tau_A$ and $f_B \cdot \tau_B$, we obtain the expected tax payments of the group:

$$E[TP_{CCCTB}^{Group}] = E[TB_{CCCTB}^{Group}] \cdot (f_A \cdot \tau_A + f_B \cdot \tau_B). \quad (9)$$

4 No costs for the segregation of sales and assets/labor

In a first step, we assume that no transportation costs (or costs for language or currency differences) are incurred for products that are sold within the group. Such a setting would be reasonable for example in the EU, where two countries have the same currency, have the same official language, and where intangible products like software are sold by one entity to another. However, a setting without transportation costs may be more specific than a setting with transportation costs. As we assume no transportation costs, there is no optimal pre-tax investment decision. From a pre-tax perspective the group is indifferent to investing in country A or country B. Therefore, in this section we cannot draw any conclusions about the level of distortion caused by each tax system. However, as a preliminary step, we can infer which tax allocation system offers stronger incentives to make a tax-optimal

²⁵ Note that unlike under SA, transfer prices do not affect eq. (8).

investment decision. The incentive for an optimal investment decision is measured by the additional tax payments that are caused by a marginal deviation from the optimal after-tax allocation of funds. The higher the additional marginal tax payments, the higher the incentives to invest optimally. In the next section we introduce transportation costs and thus are able to draw conclusions about the level of implied distortions. As the assumption of zero transportation costs slims down the complexity of the model, it allows us to understand the basic mechanism behind each tax allocation system in depth. It thus also serves to prepare for the following more complex model setting with transportation costs. Note that in this section we label our decision variable α_τ (not α_τ^c) as no transportation costs c occur. However, with exception of the transportation costs, the explanations and formulas given in Section 3 for α_τ^c are fully applicable to this section, too.

The after-tax cash flows indicate for which value of α_τ the after-tax allocation of funds is optimal (α_τ^*), i.e., when the after-tax cash flows are maximal. However, in case the transportation costs are assumed to be zero, we refrain from modeling the after-tax profits explicitly. The investment decision does not affect the expected pre-tax cash flows ($E[CF_{No\ Costs}^{Group\ pre-tax}] = E[S] - 1$) but only the tax payments. Thus, as tax payments are the only dimension that is affected by the decision variable α_τ , here we focus only on tax payments. The after-tax cash flows can be easily determined by subtracting the tax payments from the pre-tax cash flows of the MNG. The higher the tax payments, the lower the after-tax cash flows.

4.1 Separate Accounting

To determine the optimal after-tax investment decision under separate accounting, we need to know for which value of α_τ the expected tax payments of the group $E[TP_{SA}^{Group}]$ are lowest. Remember that in this setting without transportation costs, it is sufficient to consider only the tax payments in order to conclude for which value of α_τ the expected after-tax profits are highest. By differentiating the expected tax payments $E[TP_{SA}^{Group}]$ with respect to the share of investment funds invested in A α_τ we can draw conclusions about how a change of invested funds affects the overall expected tax payments of the MNG:

$$\frac{\partial E[TP_{SA}^{Group}]}{\partial \alpha_\tau} = (\tau_A - \tau_B) \cdot (n - 1). \quad (10)$$

Since by assumption the tax rate in country B is higher than that in country A ($\tau_B > \tau_A$), the expression in the first bracket is always negative. The bigger the tax rate differential, the higher the impact of a change in the allocation of investment funds α_τ on the expected tax payments $E[TP_{SA}^{Group}]$. The transfer price n determines whether a change in α_τ affects the expected tax payments positively or negatively (expression in the second bracket). As the MNG strives to minimize its tax burden, it

strategically sets transfer prices in order to benefit from tax rate differentials.²⁶ Anecdotal and empirical evidence gives us an idea of how MNGs *de facto* set their transfer prices in a scenario as assumed in our model.²⁷ A statement by the former chief financial officer of the automotive manufacturer BMW suggests that BMW strategically attempted to uncouple the location of expenses from the location of sales. At a press conference on financial statements, the CFO announced that the company attempted to accrue expenses wherever the tax rates were highest.²⁸ Subsequently, top executives at BASF and Merck referred to the tax organization of BMW as a role model for their own groups.²⁹ Based on those statements, Feld (2000) states that MNGs have opportunities to incur costs in that country with the relative higher tax rate and use income-shifting channels like transfer pricing structures to incur profits in low-tax countries. Empirical evidence found by Egger et al. (2010) supports Feld's finding that MNGs attach particular importance to the costs of an investment when choosing the investment location. They find evidence that in Europe, profit shifting seems to be more pronounced than debt shifting. As MNGs have an incentive to separate investment costs from the resulting sales for tax purposes, and as it seems to be easier for them to shift the resulting sales than the costs, the investment is ideally carried out in a high-tax country and the resulting sales are then shifted to low-tax countries. Consequently, MNGs seem to focus on placing the real activity (i.e., labor and assets) in a favorable high-tax tax environment if they have an opportunity to shift income.

There is also some empirical evidence that indicates that MNGs are able to uncouple the costs of an investment from the resulting sales. Grubert (2003) finds that MNGs invest either in extra-low- or in extra-high-tax countries if they have good opportunities for income-shifting. MNGs invest in extra-low-tax countries to establish a destination for the shifted income and in extra high-tax countries to benefit from high tax refunds on the resulting losses of the investment. Note that in our setting there is already a company in a low-tax country to which income can be shifted (entity A). Thus, in line with the findings of Grubert, the MNG aims to carry out the real investment in the high-tax country and may shift potential income to the low-tax country in our setting. The empirical evidence found by Overesch (2009) supports Grubert's results. Based on German panel data for inbound investments he finds evidence that real investment in high-tax countries is positively affected by a lower taxation of income shifted abroad. The results of an analytical study by Hong and Smart (2010) points in the same direction. They suggest that the possibility to shift income to tax havens makes the MNG less responsive to tax rate differentials when choosing the location where the investment shall be carried out.

²⁶ See Dietrich & Kiesewetter (2011), p. 101.

²⁷ As both entities are assumed to produce identical products and sell them to end customers at the same expected price, at first glance it seems reasonable to use this expected price as the transfer price.²⁷ However, the expected price is only an estimated value for planning purposes and will certainly not occur, as the investment develops either positively or negatively. Thus, the expected market price cannot serve as a reasonable benchmark for the transfer price.

²⁸ Doppelfeld cited by Schaefer, (1993) p. 2.

²⁹ Weichenrieder (1996), p. 38.

There is also analytical evidence that indicates explicitly that MNGs try to incur costs or losses in high-tax countries. Results found by Becker and Fuest (2007) indicate that MNGs try to carry out real investments in high-tax countries if marginal profits are allowed to be negative. In our model the MNG incurs negative or zero marginal profits in the high-tax country since it shifts profits away. Becker and Fuest state that in such case higher taxes may attract more real investment. They argue that strategic investments in non-profitable projects could explain why the stock of foreign capital held in Germany increased tremendously between 1990 and 2000 even though the corporate tax rate was very high during that period. Haufler and Strähler (2013)'s argument for low tax bases in high-tax countries points in the same direction. They argue that firms rank their entities according to profitability. According to their line of argumentation, highly profitable low-cost entities settle in low-tax countries, which are usually fairly small. By contrast, high-cost entities settle in large, high-tax countries.

All in all, we infer from these studies that MNGs can geographically uncouple the expenses and sales of an investment. The most complete segregation between costs and sales is achieved when one entity produces all products and gives them free of charge to the other group entity, which sells them. Note that in our model the location of sales is determined by local demand and can be neither changed nor optimized. By contrast, the location of production can be determined by the MNG via the share of funds invested in the production process (in labor and assets, α_τ) in each country. If the producing entity offers the products free of charge to the selling company, the transfer price n takes on a value of zero ($n = 0$). If the producing entity sells the products to the selling company at its production costs, the transfer price amounts to one ($n = 1$). The transfer price is the only means for income-shifting in our model. We assume that the transfer price captures all possible income-shifting channels.³⁰ Besides shifting income via transfer pricing, the MNG could shift income, e.g., by internal debt³¹ or by royalty payments. We assume comprehensive income-shifting opportunities so that the MNG is in any case able to set transfer prices that are smaller than or equal to one ($0 \leq n \leq 1$).

Eq. (10) illustrates that an increase in α_τ increases the expected tax payments $E[TP_{SA}^{Group}]$ if n is smaller than one ($n < 1$). In that case the entity, which produces more products than it sells to end customers, sells the remaining products to the other group entity at a price that is lower than the production costs. As follows from eq. (10), the partial derivative is strictly monotonously decreasing in α_τ if $n < 1$. As the definition range for α_τ is given by the interval $[0,1]$, i.e. $0 \leq \alpha_\tau \leq 1$, the lowest expected tax payments/the highest tax refunds occur for $\alpha_\tau = 0$. That is to say, all investment funds are invested in country B. This conclusion is intuitive. As we assume an immediate and full loss-offset, the expected tax payments are lowest if as many investment-related expenses as possible are incurred in the high-tax country and – in case of successful development – if at the same time as much profits as possible are shifted to and taxed in the low-tax country. The more the transfer price n

³⁰ See Grubert & Mutti (1991), p. 286.

³¹ See Dietrich & Kieseewetter (2011), p. 101.

approaches zero, the lower the expected tax payments or the higher the expected tax refunds, respectively. Thus, MNGs try to negotiate transfer prices in such a way that these are as low as possible. Furthermore, the closer the transfer price n is to zero, the higher the expected tax payments $E[TP_{SA}^{Group}]$ with an increase in α_τ .

Moreover, eq. (10) shows that in the case of a transfer price that is equal to the production costs ($n = 1$) the partial derivative with respect to α_τ is equal to zero. Consequently, a marginal change in the allocation of investment funds α_τ does not impact the expected tax payments. Thus, the expected tax payments/expected tax refunds are independent of the value of α_τ . The intuitive explanation therefore is that at $n = 1$ the MNG is not able to allocate the investment costs between the two countries and thus it cannot strategically accrue losses in the tax-favorable environments. A value of $n = 1$ does not offer any scope for tax-motivated income-shifting.

4.2 Formula Apportionment

To get an idea of how the allocation of investment funds α_τ affects the expected tax payments/expected tax refunds $E[TP_{FA}^{Group}]$ under FA, we calculate the partial derivative of eq. (8) with respect to α_τ :

$$\frac{\partial E[TP_{FA}^{Group}]}{\partial \alpha_\tau} = \frac{2}{3} \cdot (\tau_B - \tau_A) \cdot (-1 + 2p) \cdot u. \quad (11)$$

The tax rate differential in the first brackets is by definition always positive. The variable u is by definition also always positive. Thus, only the probability of a successful production p determines if the marginal change in the allocation of investment funds α_τ affects the expected tax payments $E[TP_{FA}^{Group}]$ negatively or positively. If the probability of success is exactly one half ($p = 0.5$), then α_τ has no influence on the expected tax payments. That is intuitive as the expected tax base is then zero. If the probability of success p is smaller than 0.5 ($p < 0.5$) we obtain an expected loss from the investment project. It follows from eq. (11) that in such a case, an increase in the share of investment funds α_τ in country A increases the expected tax payments. Thus, as the partial derivative shown in eq. (11) is strictly monotonously decreasing if $p < 0.5$, the MNG would be best advised to invest all funds in country B ($\alpha_\tau = 0$). Under an immediate and full loss-offset, the expected tax payments for the MNG are lowest if all losses are allocated to the high-tax country B. In country B the tax refunds for the losses are highest. If p is greater than 0.5 ($p > 0.5$), the investment generates expected profits. In such a case, an increase in α_τ decreases the expected tax payments since the partial derivative of eq. (11) is strictly monotonously increasing, so the MNG should invest all funds in A ($\alpha_\tau = 1$).³² The expected tax payments for the MNG are lowest if all profits are allocated to and taxed in the low-tax country A.

³² See Dietrich & Kiesewetter (2007), p. 514.

4.3 Comparison of both tax allocation systems with respect to the incentives to invest optimally

A substantial difference between both tax allocation systems is that under FA the tax-favorable allocation of investment funds depends on whether the investment project is expected to be profitable or not. If the MNG expects a profit and invests the funds in line with this expectation but finally incurs a loss, the allocation of investment funds turns out to be worst from a tax perspective. By contrast, the optimal allocation of investment funds under SA does not depend on whether the MNG incurs profits or losses. As a side note, we refer always to the optimal investment decision from an after-tax perspective in this section as there is no optimal pre-tax investment decision (remember $c = 0$). Due to the possibility to segregate costs and sales, under SA, the MNG should always invest all funds in the high-tax country. Thus, in a profit scenario both tax allocation systems create opposing investment incentives, while in a loss scenario the incentives are identical. Our main goal in this section is to find out which tax allocation system creates stronger incentives (i.e., higher tax payments in case of a marginal deviation from the optimal after-tax allocation of funds) to invest optimally.

By comparing the partial derivatives for the expected tax payments with respect to α_τ with each other (eq. (10) and eq. (11)), it becomes evident under which system a potential misallocation of funds results in higher expected tax payments. To be more precise, we can infer from comparing eq. (10) with eq. (11) under which tax allocation system a marginal deviation from the optimal tax-allocation of funds α_τ^* results in a stronger increase in expected tax payments. The stronger the increase in tax payments with a deviation from the tax-optimal allocation of funds, the stronger the incentives to invest tax-optimally. The partial derivative with respect to α_τ under SA is greater than under FA if the following condition holds:

$$n < \frac{1}{3} \cdot (3 - 2 \cdot u + 4 \cdot p \cdot u). \quad (12)$$

Under that condition the MNG has to pay more taxes for a marginal deviation from the optimal allocation of investment funds α_τ^* under SA than under FA. Consequently, the incentives under SA are stronger than those under FA to allocate the investment funds optimally between both countries from an after-tax perspective. Vice versa, the incentives are stronger under FA if the following condition holds: $n > \frac{1}{3} \cdot (3 - 2 \cdot u + 4 \cdot p \cdot u)$. The relative distortive power of either tax allocation system depends on the relation between the transfer price n and the expected sales $p \cdot u$.

To get an idea of which tax allocation system offers stronger incentives to make an optimal investment decision, we determine realistic parameter settings. According to CSI Market³³ the pre-tax margin for US companies currently ranges between about 21% in the healthcare sector and about 5% in the retail sector. We take the median of this range (13%) as the expected average realistic pre-tax margin in our

³³ See CSI Market (2015).

analysis, allowing us to deduce a variety of possible combinations of p and u that lead to an expected pre-tax rate of return of 13%. For example, this is true for $p = 1$ and $u = 0.13$ (setting I) and $p = 0.6$ and $u = 0.65$ (setting II). For all combinations of p and u that lead to a pre-tax margin of 0.13, the incentives for an optimal allocation of investment funds are greater under SA than under FA if $n < 1.08667$. As by assumption $n \leq 1$, this relation always holds. The same interpretation, e.g., holds true for a pre-tax margin of 21% (healthcare sector, $n < 1.14$) or 5% (retail sector, $n < 1.03$). Thus, if the expectations of pre-tax margins are in line with currently observable sector margins of US companies, the incentives for an optimal allocation of investment funds are always stronger under SA than under FA.

Note that so far we have not been able to draw conclusions about the distortive effects of each tax allocation system with respect to locational investment decisions as there has been no optimal pre-tax investment decision ($c = 0$). The MNG has been assumed to be indifferent between investing in entity A or B from a pre-tax perspective. In the following section we change this assumption. By assuming transportation costs the MNG is no longer indifferent in the pre-tax allocation of investment funds. Thus, by introducing an optimal allocation of investment funds in the pre-tax scenario, we are able to draw conclusions about the distortional power of either tax allocation system.

5 Costs for the segregation of sales and assets/labor

So far we have determined the MNG's optimal allocation of investment funds across countries A and B assuming no transportation costs. Thus, until now taxation has been the only crucial determinant for deciding where to invest. Now we expand this setting and assume transportation costs incurred by the geographical segregation of sales and asset/labor (production). Hence, in this section the transportation costs are an additional determinant of the optimal investment decision. From a purely pre-tax perspective, the MNG should invest in entity A and entity B relative to demand in country A and country B (α_e^*) in order to avoid transportation costs.

The occurrence of an optimal allocation of investment funds from a pre-tax perspective (α_e^*) creates a trade-off between the optimal allocation of investment funds from a tax perspective and from a pre-tax perspective. Transportation costs force the MNG to weigh the economic pre-tax benefits against the taxation benefits to arrive at a final investment decision (α_τ^{c*}).³⁴ Thus, the unidimensional optima from either a tax perspective or a pre-tax perspective are merged to form an overall, multidimensional optimum (α_τ^{c*}). The transportation costs reduce not only the overall cash flows of the MNG but also the tax base.³⁵ Thus, it is necessary to explicitly model not only the tax payments – as in Section 4 – but the entire after-tax cash flows. Note that the main goal of this analysis is to find out the optimal

³⁴ Devereux & Griffith (1998) make a similar assumption. However, in their model transportation costs are weighed up against gains from economies of scale.

³⁵ Also assumed by Devereux & Griffith (1998), p. 340.

after-tax allocation of investment funds a_τ^{c*} (i.e., the allocation that leads to highest after-tax cash flows) in order to determine the distortional power of each tax base allocation system.

5.1 Separate Accounting

Under SA the allocation of the transportation costs between both entities is crucial for the tax payments of the MNG. The transportation costs $(c \cdot (a_\tau^c - \alpha_e)^2)$ have opposing effects on the expected after-tax cash flows $E[CF_{SA}^{Group}]$. On the one hand, they decrease the pre-tax profits; on the other hand, they decrease the tax base and thus the tax payments. However, the impact of the decrease in tax payments is in any case smaller than the decrease in pre-tax cash flows. Thus, the tax base effect of the transportation costs is smaller than the pre-tax effect. To find the optimal allocation of investment funds a_τ^{c*} the MNG has to weigh up the benefits from a tax-optimal allocation of funds against the benefits from an economically favorable allocation of funds (i.e., an allocation that results in low transportation costs). As the transportation costs are assumed to be quadratic, they start at a very low level and then increase rapidly. At a specific critical \widetilde{a}_τ^c the benefits of a tax-favorable allocation of investment funds are outweighed by the transportation costs. Given quadratic transportation costs, the expected after-tax cash flows (after transportation costs) decrease with an increasing deviation from the optimal after-tax allocation of funds a_τ^{c*} . Thus, the curve reflecting the expected after-tax cash flows $E[CF^{Group}]$ (see eq. (3)) depending on a_τ^c is bell-shaped.

Differentiating eq. (3) with respect to a_τ^c shows how a change in the decision variable a_τ^c impacts the expected after-tax profits:

$$\frac{\partial E[CF_{SA}^{Group}]}{\partial a_\tau^c} = \underbrace{(\tau_A - \tau_B) \cdot (1 - n)}_{-/0} + \underbrace{(\tau_A + \tau_B) \cdot c \cdot (a_\tau^c - \alpha_e)}_{+/0} + \underbrace{2c \cdot (\alpha_e - a_\tau^c)}_{+/-0} \quad (13)$$

I	II
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The symbols (“-/0”, “+/0” and “+/-0”) under the braces indicate the potential signs the expression can take in accordance with the model assumptions. The allocation of funds is optimal if the partial derivative of eq. (13) is equal to zero for a value of a_τ^{c*} that lies within a range of zero and one ($0 \leq a_\tau^{c*} \leq 1$). Note that the (mathematical) optimum (i.e. where $\frac{\partial E[CF_{FA}^{Group}]}{\partial a_\tau^c} = 0$) need not necessarily lie in this economically reasonable area ($0 \leq a_\tau^c \leq 1$). In such a case, a_τ^{c*} takes the extreme values of zero if the (mathematical) optimum occurs for values of a_τ^c smaller than zero or of one if the (mathematical) optimum occurs for values of a_τ^c bigger than one. We can draw this conclusion as the curve reflecting the expected after-tax results $E[CF^{Group}]$ (see eq. (3)) in dependence of a_τ^c is bell-shaped.

Eq. (13) shows that the relation between a_τ^c and α_e will determine how a change in the allocation of investment funds a_τ^c affects the expected after-tax cash flows $E[CF_{SA}^{Group}]$. The terms in eq. (13) labeled with I and II have opposing effects on the marginal change in expected after-tax cash flows in reaction to a marginal change in a_τ^c . However, the impact of term II on the marginal change of the expected after-tax cash flows is always stronger than that of term I. The following table illustrates under which conditions a change in a_τ^c affects the expected after-tax cash flows and how.

	$0 \leq n < 1$	$n = 1$
$a_\tau^c > \alpha_e$	–	–
$a_\tau^c = \alpha_e$	+	0
$a_\tau^c < \alpha_e$	ambiguous	+

Table 3: Impact of a_τ^c on the expected after-tax cash flows depending on the relation between n , a_τ^c and α_e under SA.

The table entry “ambiguous” indicates that the impact of a_τ^c on the expected after-tax results can be positive or negative, it depends on the specific parameter settings.

5.2 Formula Apportionment

Under FA it is not necessary to determine which share of transportation costs is borne by which entity since the group tax base is determined by consolidating all sales and expenses of both entities. However, the overall decision about the allocation of investment funds is more complex than that under SA. By introducing transportation costs into the model, under FA the optimal after-tax allocation of investment funds is driven by three effects. Transportation costs

- reduce the pre-tax cash flows (which affects the expected after-tax cash flows negatively)
- reduce the tax base (which affects the expected after-tax cash flows positively)
- change the apportionment of the tax base across both entities (f_A) (where the impact depends on the specific constellation).

The following equation clarifies how a change in a_τ^c affects the expected after-tax results:

$$\frac{\partial E[CF_{FA}^{Group}]}{\partial a_\tau^c} = \underbrace{2(-1 + \alpha_\tau \cdot (\tau_A - \tau_B) + \tau_B)}_{-/0} \cdot \underbrace{c \cdot (a_\tau^c - \alpha_e)}_{-/+ / 0} - \underbrace{\frac{2}{3}(\tau_A - \tau_B)}_{+} \cdot \underbrace{(-1 + 2p) \cdot u}_{-/+ / 0}. \quad (14)$$

Again, the symbols (“+”, “-/0” and “+/-/0”) under the braces indicate the potential values of the respective terms under the given set of assumptions. The allocation of funds is optimal if the partial derivative of eq. (14) is equal to zero ($\frac{\partial E[CF_{FA}^{Group}]}{\partial a_\tau^c} = 0$) and the optimal allocation of investment funds lies within a range of zero and one ($0 \leq a_\tau^{c*} \leq 1$). If that is not the case, more complex approaches

have to be applied to find the optimum within the definition area of a_t^c ($0 \leq a_t^c \leq 1$).³⁶ Under FA the relation between a_t^c , α_e and p determines whether a_t^c affects the expected after-tax results positively or negatively. The probability of success p determines if the investment leads to an expected after-tax profit or loss. We show already in subsection 4.3 that under FA, the sign of the expected after-tax cash flows of the MNG (determined by p) is decisive for the optimal investment decision. Table 4 shows under which conditions a marginal change in a_t^c affects the expected after-tax cash flows and how.

	$p < 0.5$	$p = 0.5$	$p > 0.5$
$a_t^c > \alpha_e$	–	–	ambiguous
$a_t^c = \alpha_e$	–	0	+
$a_t^c < \alpha_e$	ambiguous	+	+

Table 4: Impact of a_t^c on the expected after-tax cash flows depending the relation between p , a_t^c and α_e under FA.

If, for example, $a_t^c > \alpha_e$ and $p < 0.5$, an increase in a_t^c reduces the expected after-tax cash flows. The table entry “ambiguous” indicates that the impact of a_t^c on the expected after-tax results is ambiguous and depends on the specific parameter settings.

Under SA the expected after-tax cash flows decrease when a_t^c deviates more strongly from the optimal after-tax allocation of investment funds a_t^{c*} (bell-shaped curve, see subsection 5.1). Under FA that relation does not necessarily hold (under FA the curve is not necessarily bell-shaped). This is due to the rather complex impact of a_t^c on the expected tax payments. Whereas under SA the introduction of transportation costs impacts the tax payments solely through the decreased tax base, under FA more complex interrelations between the tax base and its allocation impact the tax payments. Thus, with respect to the tax payments, an increasing difference between a_t^c and α_e^* may be up to a critical value of \widetilde{a}_t^c beneficial as higher costs reduce the tax payments. However, if that critical value of \widetilde{a}_t^c is exceeded, the favorable tax base effects may be outweighed by an unfavorable allocation of the group tax base to the entities (i.e., extensive losses are allocated to the low-tax country or extensive profits to the high-tax country).

5.3 Comparison of distortional effects of both tax allocation systems

The introduction of transportation costs affects the locational decisions under FA in more dimensions than under SA. In addition to the expected pre-tax profits and the tax base, the allocation of the tax base between the group entities is affected as well. Under one of the following conditions the expected after-tax cash flows (after transportations costs) are higher under SA than under FA:

$$a_t^c < \alpha_e \text{ and } n < \frac{1}{6} (6 + 3c \cdot a_t^c - 4c \cdot a_t^{c2} - 3c \cdot \alpha_e + 2c \cdot \alpha_e \cdot a_t^c + 2\alpha_e^2 - 4u + 8pu) \quad (15a)$$

³⁶ Note that the curve of $[CF_{FA}^{Group}]$ depending on a_t^c is not necessarily bell-shaped (as it is under SA). Thus, finding the maxima within the definition area of a_t^c ($0 \leq a_t^c \leq 1$) is not that straightforward if the following condition does not hold within the definition area: $\frac{\partial E[CF_{FA}^{Group}]}{\partial a_t^c} = 0$.

or

$$a_t^c > \alpha_e \text{ and } n > \frac{1}{6} (6 + 3c \cdot a_t^c - 4c \cdot a_t^{c^2} - 3c \cdot \alpha_e + 2c \cdot \alpha_e \cdot a_t^c + 2\alpha_e^2 - 4u + 8pu). \quad (15b)$$

However, the main goal of this analysis is to find out the optimal after-tax allocation of investment funds a_t^{c*} (i.e. the allocation that leads to highest after-tax cash flows) in order to compare that allocation with the optimal pre-tax allocation. From this comparison we learn which tax allocation system has stronger distortional effects.

To draw economically meaningful conclusions given the rather complex models, we fall back on a numerical analysis. In a first step, we determine reasonable and realistic parameter settings. In subsection 4.4 we already explain reasonable values for the parameters p and u in line with recent pre-tax margins (median of 13%) of companies in various sectors. In the period 1990-2008 average transportation costs for industry and trade ranged between 7% and 27% of total costs.³⁷ To account for realistic tax rate differentials we take the highest and lowest tax rates within EU member states (i.e., Slovenia with 17% and France with 34.43%) for 2015.³⁸ As we believe that the fraction of income that the MNG is able to shift to the low-tax country A under SA is highly dependent on the industry and the characteristics of the MNG, we refrain from attaching a value to n . We apply the same argumentation for not attaching a value to the optimal pre-tax allocation of investment funds α_e^* . In Fig. (1), we show for three levels (“low”, “medium”, “high”) of α_e^* and n under which system the distortion of the optimal investment decisions is more severe. The vertical black line in Fig. (1) indicates the optimal pre-tax allocation of investment funds.

Fig. (1) shows the expected after-tax cash flows depending on the after-tax allocation of investment funds a_t^c . The tax allocation system that leads to a bigger difference between the optimal pre-tax allocation of funds α_e^* and the optimal after-tax allocation of funds a_t^c is identified as the more distortive system. Remember that the optimal after-tax allocation of funds is characterized by the maximal after-tax cash flows. The upper abbreviation (SA or FA) in the framed boxes above each graph indicates under which tax allocation system the distortions of the investment decision are greater. The lower abbreviation indicates which system leads to the higher expected after-tax cash flows in the optimum. The latter information is not directly relevant for our research question yet it is an interesting side note. The parameter constellations in Fig. (1) are chosen in such a way that, under optimal allocation of investment funds, the investment project is profitable under either system. Note that the curves for FA in Fig. (1) do not change with changing income-shifting possibilities (represented by the level of the transfer price n) as transfer pricing only exists under SA.

Fig. (1) shows that the distortions tend to be greater under SA than under FA for better possibilities of income-shifting (decreasing value of n) and for a higher share of funds that is optimally invested in

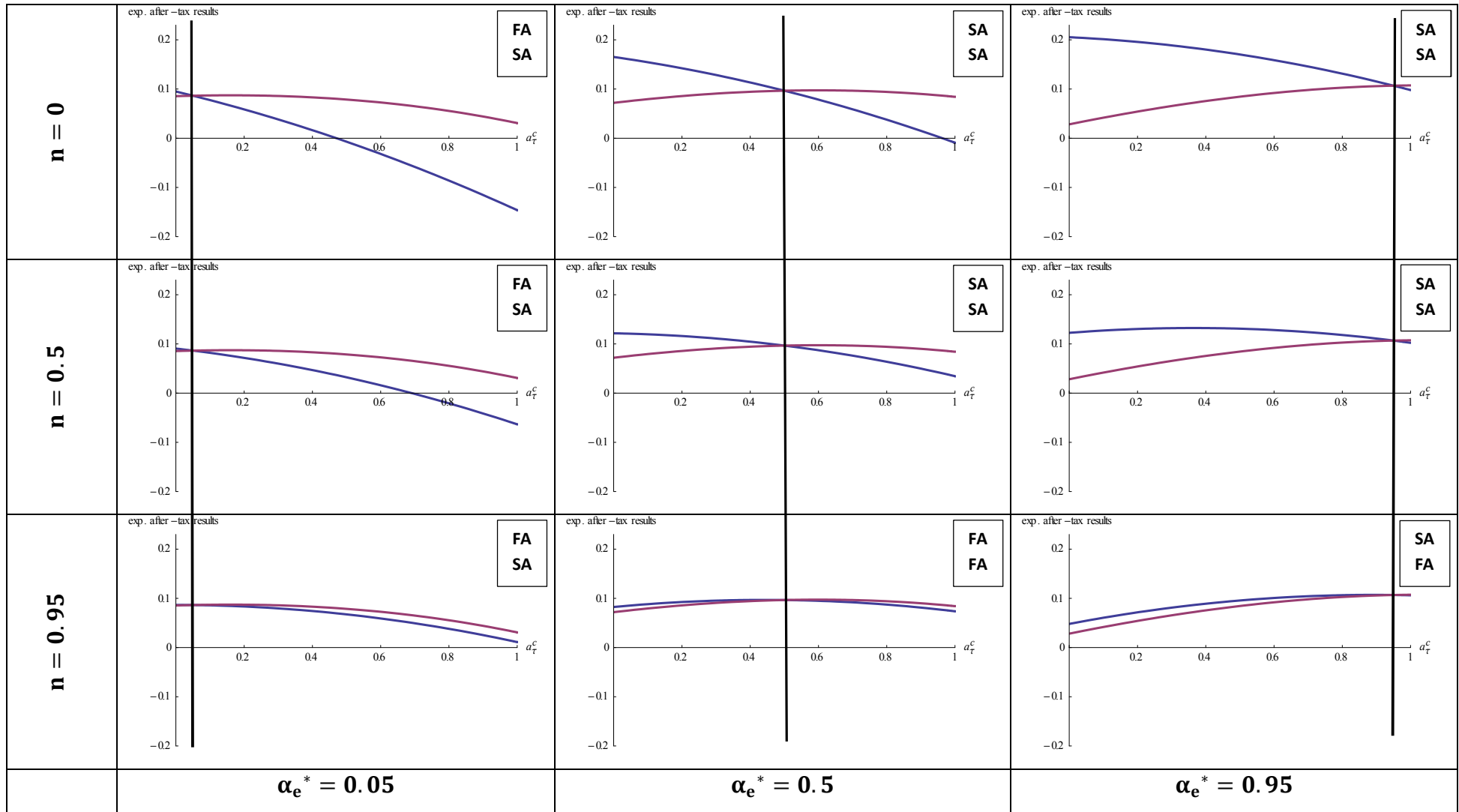
³⁷ Statista (2015).

³⁸ We use the combined corporate income tax rate. OECD (2015).

entity A in the pre-tax case (increasing value of α_e^*) under SA. The income-shifting possibilities determine the level of distortion under SA. The better the income-shifting possibilities (the lower n), i.e., the stricter the local segregation of costs and sales, the more the MNG can benefit from a tax-favorable allocation of funds. Consequently, it is worthwhile for the MNG to deviate more from the optimal pre-tax allocation α_e^* to approach the optimal tax allocation α_τ^* for its final investment decision (α_τ^{c*}). High transportation costs for a greater deviation from α_e^* are refunded by high tax savings in case of good income-shifting possibilities. Remember from the no-cost scenario in Section 4 that the optimal allocation of funds from a tax perspective is always extreme. Under SA the optimal allocation is $\alpha_\tau^* = 0$ while under FA it is $\alpha_\tau^* = 1$ in a profit situation.

The greater the difference between the unidimensional optima α_τ^* and α_e^* under each tax allocation system, the greater the resulting distortions with respect to the final investment decision α_τ^{c*} . This is because due to the quadratic transportation costs the MNG surrenders only few pre-tax profits for a small deviation from α_e^* but greatly reduces its taxes by choosing an after-tax allocation of investment funds α_τ^{c*} that is closer to α_τ^* . The optimal investment decision α_τ^{c*} is reached if the marginal tax savings are equal to the marginal transportation costs. In line with that explanation, Fig. (1) shows that the distortions of the investment decisions are greatest under SA and lowest under FA for high values of α_e^* . In such a case the difference between the unidimensional optima ($\alpha_e^*, \alpha_\tau^*$) are highest under SA and lowest under FA. Vice versa, for low values of α_e^* the difference between the unidimensional optima ($\alpha_e^*, \alpha_\tau^*$) is low under SA and high under FA and thus the distortion tends to be higher under FA.

The results do not change qualitatively with respect to the relative distortion caused by each tax allocation system if we vary the transportation costs c , the profitability (determined by p and u , as long as they ensure still a profitable setting) or the tax rate differential ($\tau_A - \tau_B$) within economically reasonable ranges (see Appendix 1-3). However, in the following we change our setting from a profit to a loss scenario (changing the probability of a successful investment outcome p from 0.6 to 0.1, see Fig. (2)). To consider an investment project which results in an expected after-tax loss needs to be justified in our model set-up as a rational executive of an MNG would not invest in such a project from the outset.



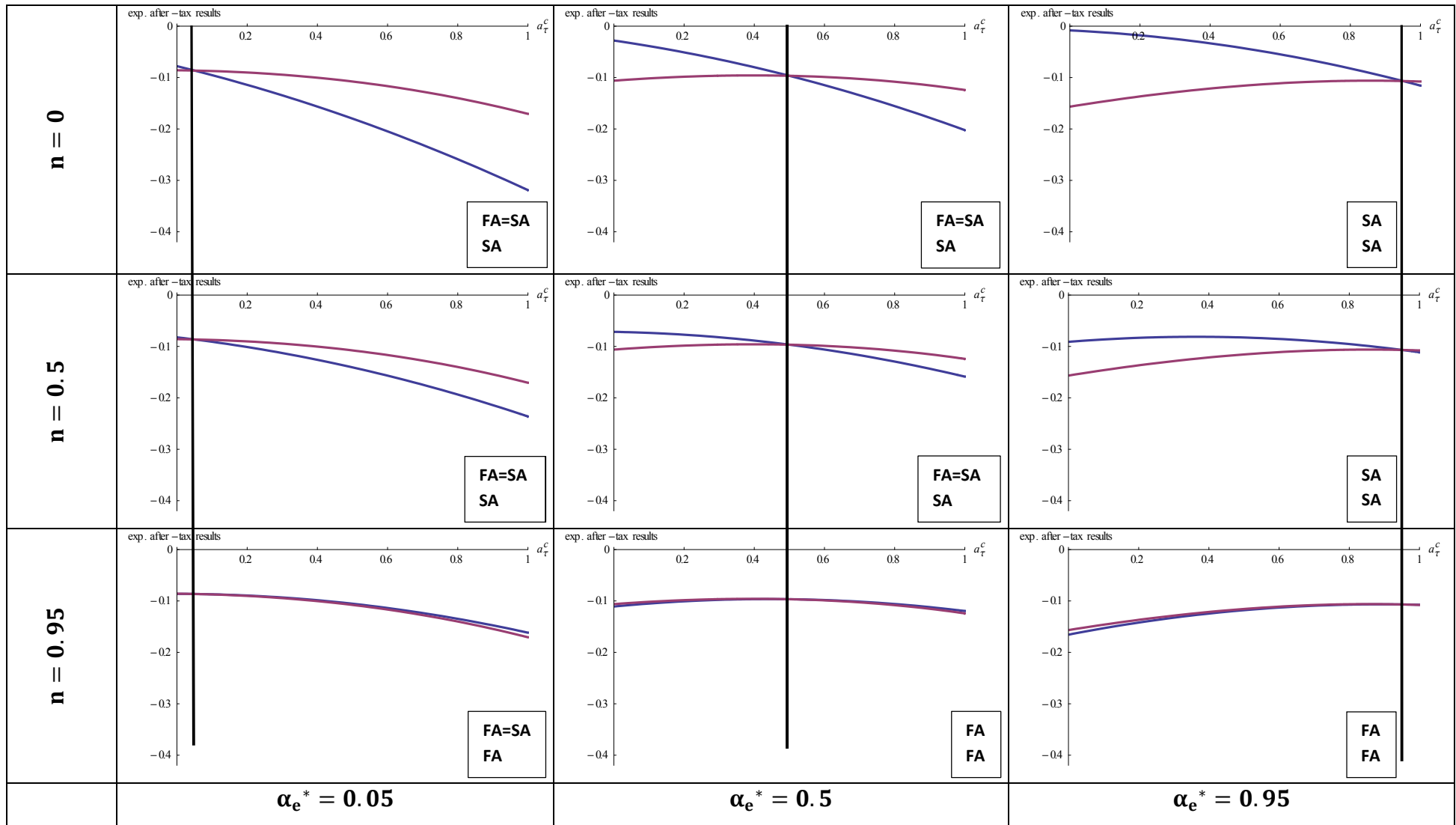
Notes: This figure is generated by assuming the following parameter setting: $c = 0.1, \tau_A = 0.17, \tau_B = 0.3443, p = 0.6, u = 0.65$. The abbreviations FA and SA in the framed boxes indicate which tax allocation system leads to more severe distortions of the investment decision (upper abbreviation) and which system results in the optimum in higher expected after-tax profits (after transportation costs).

— SA
— FA

Figure 1: Expected after-tax profits (after transportations costs) for varying values of transfer prices n and of the optimal pre-tax allocation of investment funds α_e^* .

For example, the MNG may pursue a high-risk business model and invest in a number of highly risky projects. The MNG is aware that most of the projects could fail but hopes that one project brings forth a highly profitable final product. Consequently, the expected value for a single investment project may be negative even though the expected value for the whole portfolio is expected to be profitable. Furthermore, legal obligations or safety regulations could force the MNG to carry out an unprofitable investment. An example of such a safety regulation is the duty to equip certain machines with an emergency off-button. The MNG needs to undertake the investment to equip the machines with the required function but the investment is not expected to increase the demand for/the price of the product. Furthermore, by relaxing our strict assumption of a one-period model, the consideration of a (temporarily) unprofitable investment reflects a common scenario MNGs have to face. If we assume that we consider just the first period of an investment project with a multi-period life span, it is likely that the investment project will be loss-making in the initial stage (e.g., start-up projects). However, these losses are expected to be overcompensated by future profits. Our setting captures such investment projects in the first unprofitable periods. However, the MNG may attach greater weight to the expected initial losses in its investment decision as it is uncertain whether the project will ever be profitable in the future. Furthermore, favorable tax utilization conditions in the initial stage of a project could ensure the survival of the project in critical cases.

Fig. (2) shows that in the loss scenario, in five out of nine cases the final investment decisions (a_{τ}^{c*}) are distorted equally severe under both tax systems (in cases where the upper row in the framed boxes reads “FA=SA”). The reason for this is that in a loss scenario, under both tax allocation systems the expected tax refunds are highest if all funds are invested in the high-tax country B ($\alpha_{\tau}^* = 0$). Thus, in a loss scenario both systems imply the same investment incentives from a tax base allocation perspective. Compared to the profit scenario, the shape of the curves under SA remain identical. Due to the assumed immediate and full loss-offset, the change in net cash flows of the MNG (from profit to loss) does not affect the optimal final investment decision (a_{τ}^{c*}) under SA. By contrast, under FA the optimal final investment decision (a_{τ}^{c*}) depends on the expected outcome from the investment project and thus the shape of the curves changes slightly compared to the profit scenario.



Notes: This figure is generated by assuming the following parameter settings: $c = 0.1, \tau_A = 0.17, \tau_B = 0.3443, p = 0.4, u = 0.65$. The abbreviations FA and SA in the framed boxes indicate which tax allocation system leads to more severe distortions of the investment decision (upper abbreviation) and which system results in the optimum in higher expected after-tax profits (after transportation costs).

— SA
— FA

Figure 2: Expected after-tax losses (after transportations costs) for varying values of transfer prices n and of the optimal pre-tax allocation of investment α_c .

6 Conclusions and implications

We examine which tax allocation system leads to more severe distortions with respect to locational investment decisions. While existing studies focus primarily on the impact of taxes on locational decisions under either separate accounting (SA) or formula apportionment (FA), the main innovation of this paper is that it compares both systems with regard to the level of distortions they induce. We model after-tax investment decisions of a centrally managed MNG under both tax allocation systems and take the optimal pre-tax investment decision as a given. The optimal pre-tax investment decision serves as a benchmark for the level of distortion caused by each system. Under SA, the MNG is assumed to have comprehensive income-shifting opportunities. We focus on an investment decision of an MNG that has already established business activities in the entities in which it invests.

We make the following contributions to the literature. First, in line with the results of Martini et al. (2013) yet in contrast to some commonly held views, we find that the application of transfer pricing under SA has real economic effects. As transfer prices offer the possibility to shift income within group entities, they allow – at least to some extent – the segregation of production and sales. This segregation impacts locational investment decisions. Second, the tax allocation systems differ in their ability to allow MNGs to make optimal investment decisions under cash flow uncertainty. Under SA, the tax-optimal investment decision is independent of whether the investment project is successful or not. By contrast, under FA the tax-optimal allocation of investment funds is completely reversed when the expected outcome of the investment project does not occur. Consequently, if the MNG allocates the funds between the entities on the basis of expected positive future cash flows but ultimately experiences a loss from the project, the allocation of the tax base is highly tax-unfavorable. Thus, in comparison to SA, FA is more likely to be crisis-intensifying.

Third, as an important extension of the literature, we show that both tax allocation systems imply opposing investment incentives with respect to locational investment decisions in a profit scenario. From a purely tax allocation perspective, the MNG expects lowest tax payments if it invests all funds in assets and labor in the high-tax country and shifts resulting sales via transfer prices to a low-tax country. By contrast, under FA the expected tax payments are lowest if as much funds as possible are invested in assets and labor in the low-tax country. Owing to the consolidation of profits and losses of all group entities, FA offers less scope for tax planning compared to SA with good income-shifting possibilities. The more profitable the MNG, the greater the incentives under FA to allocate the investment funds in a tax-optimal manner. Under SA, the MNG is more incentivized to allocate funds tax-optimally with the possibility to set tax-optimal (i.e., low) transfer prices. By applying realistic parameter settings, we find that the incentives for a tax-optimal allocation of funds are higher under SA than FA. This has a number of important policy implications, especially given the potential introduction of the CCCTB in Europe. Since the incentives to invest in a tax-optimal manner tend to

be lower under FA, the tax-optimal allocation of funds is less important under that system. That is desirable from a tax policy perspective as it tends to distort pre-tax investment decisions to a lesser extent. However, only by considering specific optimal pre-tax investment decisions can we draw conclusions about the level of distortion caused by either system.

Finally, by introducing costs for the geographical segregation of production and sales, we can draw conclusions about the level of distortions induced by each tax allocation system. The distortions under SA tend to be more severe than under FA if a greater share of investment funds is to be invested in a low-tax country from a pre-tax perspective and the investment is profitable. In such a setting, the MNG would deviate rather strongly from the optimal pre-tax investment decision in order to benefit from a more tax-favorable environment. Such pre-tax investment decisions are typical for German MNGs (particularly those in the manufacturing industry) that invest e.g. in low-tax Eastern European countries to gain access to a low-wage workforce.³⁹ The after-tax investment decision tends to be distorted more severely under SA than under FA if comprehensive income-shifting opportunities under SA are assumed. Vice versa, pre-tax decisions that result in the investment of a big share of funds in the high-tax country tend to be distorted less under SA than under FA. R&D investments in the pharmaceutical industry may be a model for such pre-tax investment decisions. MNGs need highly skilled and well-educated workers and seek a very high level of legal certainty to maintain a hold over, e.g., their patents. Such conditions are typical for the European high-tax countries such as Germany, France, or Belgium.

From our results we can derive some important policy implications. The introduction of the CCCTB in Europe may have a tremendous impact on locational investment decisions and the shifting of economic substance to low-tax countries.⁴⁰ It depends on the sector in question how well an MNG is able to adjust the company structure to reverse investment incentives under FA. While a company in the manufacturing industry may be able to easily adjust to incentives offered by FA, companies in the pharmaceutical industry may find this more difficult.

Our findings must be interpreted against the background of our set of assumptions. Our results are driven by the assumption that MNGs have ample opportunity to shift income to low-tax countries under SA. Even if we validate this assumption by empirical, anecdotal, and analytical evidence, it may not be appropriate for all MNGs. Several important issues have not yet been sufficiently addressed. It is a rather strong assumption to assume quadratic transportation costs. It would be desirable to test our results under different cost functions, too. Furthermore, it would be interesting to examine distortional effects under both tax allocation systems if the assumption of a direct loss-offset is dropped.

³⁹ See Devereux (2008), p. 636.

⁴⁰ See Devereux (2008), p. 636.

Appendix 1): Increase in profitability (p, u)

For reasons of comparability the parameter settings are equal to that of the graphs in the second row of Fig. (1) ($n = 0.5$) with the exception of profitability (here $p = 0.9, u = 1$). The parameter settings result in a pre-tax profit margin (before transportation costs) of 90%, which is absolutely exceptional. Note the changed values of the y-axis compared to Fig. (1).

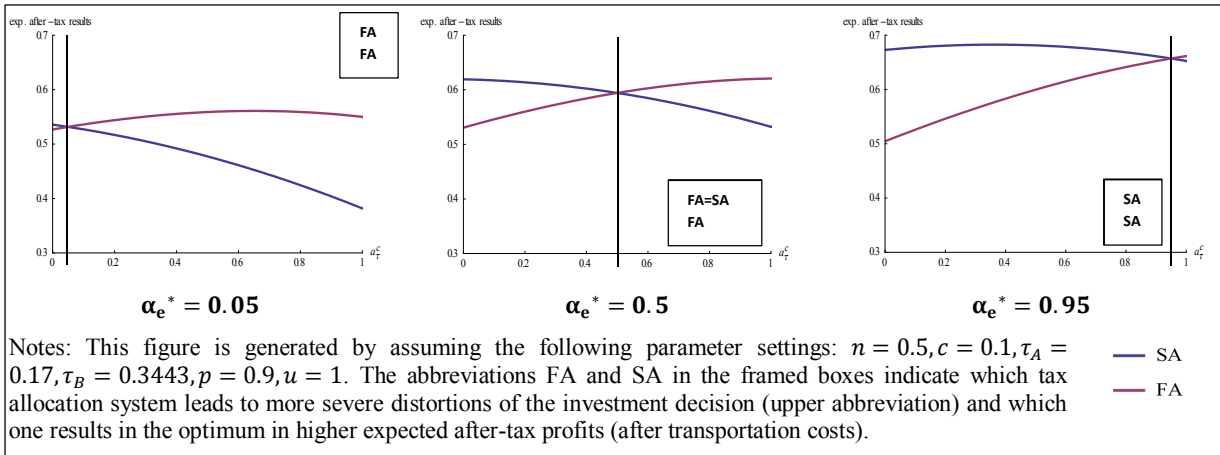


Figure 3: Expected after-tax profits (after transportations costs) for varying values of the optimal pre-tax allocation of investment funds α_e^* .

The increased profitability benefits the relative advantageousness of FA compared to SA with respect to the after-tax results. However, not even in this extreme case (pre-tax profit margin of 90%) is the rank order of the tax allocation systems changed with respect to their distortive power.

Appendix 2: Increased transportation costs c

For reasons of comparability the parameter settings are equal to that of the graphs of Fig. (3) with exception of the transportation costs (here $c = 0.7$). We need a highly profitable situation (like in Fig. (3)) to assume high transportation costs and remain in a profitable setting in the optimum. Note the changed values of the y-axis compared to Fig. (3).

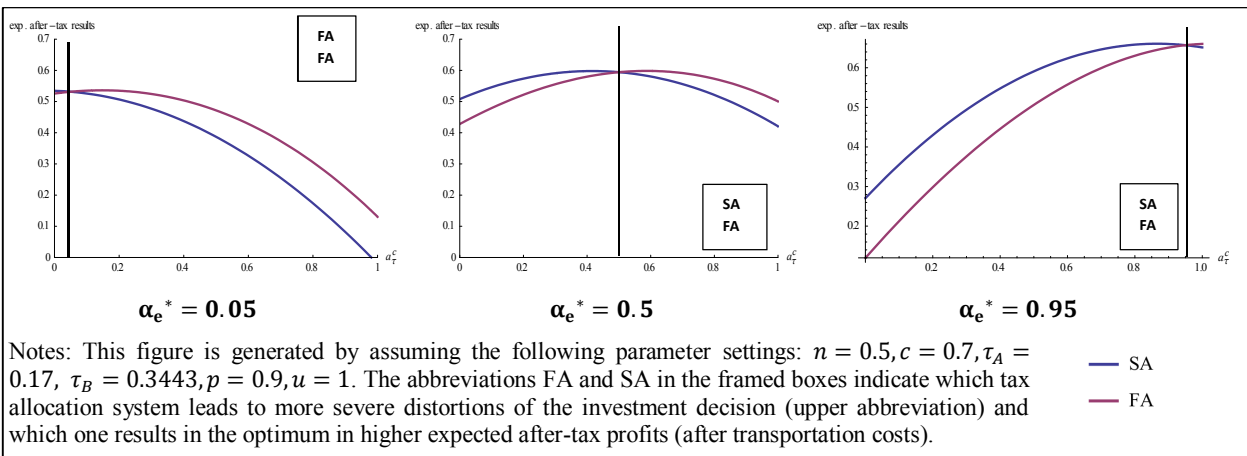


Figure 4: Expected after-tax profits (after transportations costs) for varying values of the optimal pre-tax allocation of investment funds α_e^* .

Due to the increased transportation costs, the expected after-tax profits decrease more strongly with a greater distance between α_e^* and a_τ^c . Thus, the curves under both tax allocation systems are more pronounced. The rank order of both systems does not change with respect to their distortive impact.

Appendix 3: Decreased tax rate differential ($\tau_A - \tau_B$)

For reasons of comparability the parameter settings are equal to that of the graphs in the second row of Fig. (1) ($n = 0.5$) with exception of the tax rates (here $\tau_A = 0.2, \tau_B = 0.3$). Since we have chosen the most extreme tax rates (France and Slovenia), in this setting we want to account for more moderate tax rate differentials. Note the changed values of the y-axis compared to Fig. (1).

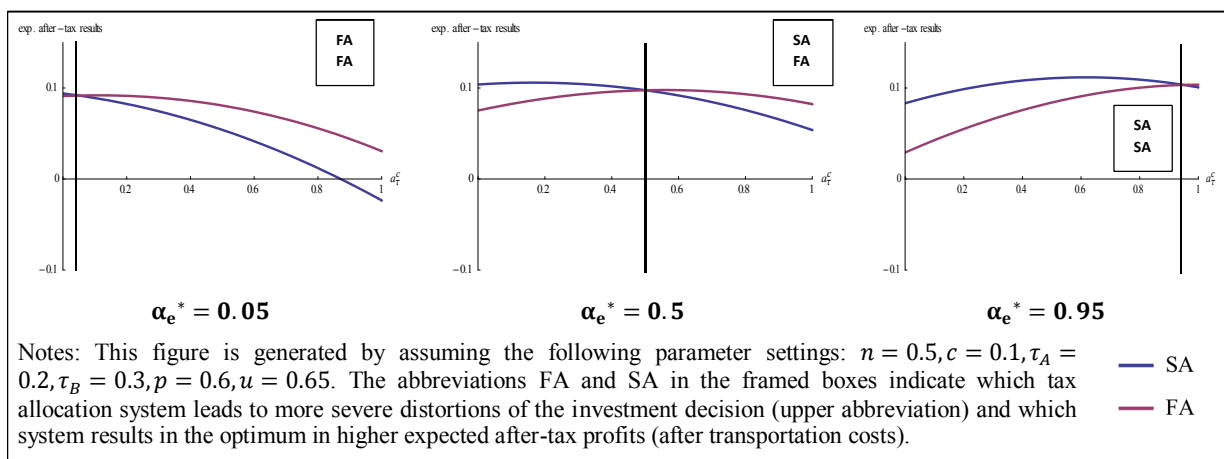


Figure 5: Expected after-tax profits (after transportations costs) for varying values of the optimal pre-tax allocation of investment funds α_e^* .

Fig. (5) shows that the difference between the expected after-tax results decreases between both tax allocation systems. There is no change with respect to the rank order of distortional impact under each system.

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