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Novel Configuration of Formulary Apportionment Using the Correlated Random Effect Approach

Markéta Mlčúchová

Faculty of Business and Economics, Mendel University in Brno, Czech Republic,
e-mail: xmlcucho@mendelu.cz

Abstract

This paper examines various configurations of the formula under the formulary apportionment methodology from the perspective of the explanatory power of the variability in profitability of multinational companies with the aim to identify the best-performing formula based on analytical evidence of panel microeconomic data. The considered configurations of the formula are based on the novel composition of the allocation formula indicated under the BEFIT proposal, preceding the CCCTB proposal, and traditionally used formulas, at the sub-national level, in Canada and the United States. The empirical analysis uses microeconomic panel data obtained from the Orbis database for 77,087 subsidiaries affiliated with 2,283 parent companies observed from 2011 to 2020. Utilising the correlated random effect approach, accounting for time-specific effects, including the time-constant explanatory variables such as economic activity, classified by NACE codes and the EU Member States' jurisdiction, this paper devises a novel formula configuration. Besides a novel configuration of the apportionment formula, consisting of sales, costs of employees, tangible and intangible assets, this paper estimates proportional weights of apportionment factors and concludes with policy recommendations.

Keywords: Corporate taxation, formulary apportionment, correlated random effect

JEL Classification: H25, C23, K34

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1. Introduction

This study focuses on formulary apportionment (FA) methodology to be used within the European Union (EU) as outlined in the Communication from the European Commission[1], indicating a proposal for Business in Europe: Framework for Income Taxation (BEFIT proposal). The core concept of the FA methodology is the distribution of the consolidated profits of multinational companies across the EU Member States through a quantitative allocation mechanism. The design of the allocation formula bears significant consequences not only for the allocation of the tax base across different tax jurisdictions, but also for the potential emergence of novel profit-shifting strategies employed by multinational companies and the ensuing tax competition between jurisdictions.

Currently, the default method for income allocation of multinational companies within the EU is the separate accounting (SA) methodology. Under the SA methodology, each subsidiary of a multinational company is treated as a separate entity and its profits are determined on a standalone basis, based on the profits attributable to that specific subsidiary. Even though the SA is a solid status quo, it has been increasingly subjected to challenges stemming from the continuous economic integration and digital transformation within the EU internal market.

In particular, the SA methodology enables multinational companies to pursue tax optimization to minimize their tax obligations resulting in corporate tax revenue losses. Scholars have suggested that short-term losses of the total corporate income tax revenue are between 5 and 10% (Cobham and Janský, 2018; Crivelli *et al.*, 2016). In addition, many authors have argued that the status quo favours multinational companies over purely domestic companies, resulting in the overall tax burden borne by multinational and purely domestic companies being significantly different (*e.g.*, Solilová and Nerudová, 2019; Hulya and Hodžić, 2017; Hansson *et al.*, 2017; Egger *et al.*, 2010; Azémar and Corcos, 2009). Reflecting the digitalized context, the European Commission[2] estimated the difference in the tax burden borne by traditional and digital multinational companies. According to the results, digital multinational companies are subject to an effective tax rate of 10.1%, whilst traditional multinational companies are subject to an effective tax rate of 23.2% (*ibid.*). Considering the concerns raised, it is pertinent to explore and discuss alternatives to the existing status quo, the SA methodology, to address its limitations. One such alternative is the studied FA methodology.

Under the FA methodology, in accordance with pertinent theory (Hundsdoerfer and Wagner, 2020; Krchnivá and Nerudová, 2018; Nerudová and Krchnivá, 2016; Roggeman *et al.*, 2012;

1 COM (2021) 251 final, 18 May 2021.

2 COM (2017) 547 final, 21 September 2017.

Hines, 2008), it is highly desirable for the allocation formula to effectively capture and mirror the profit generation process of companies. Nevertheless, Weiner (2006) contended that explanatory power alone does not encompass all desired attributes[3]. This paper examines various configurations of the formula under the FA methodology from the perspective of the explanatory power of the variability in profitability of multinational companies with the aim to identify the best-performing formula based on analytical evidence of panel microeconomic data. The considered compositions of the formula are based on the novel composition of the allocation formula indicated under the BEFIT proposal, preceding Proposal for a Council Directive on a Common Consolidated Corporate Tax Base[4] (CCCTB proposal), and traditionally used formulas, at the sub-national level, in Canada and the United States (USA). Drawing upon empirical findings and theoretical outcomes of the literature, this paper devises an alternative formula configuration.

This paper is structured as follows: Section 2 reviews the literature focused on the composition and factors of the FA methodology and the FA explanatory power of the variability in profitability; Section 3 describes the data and methodology applied; Section 4 presents results; Section 5 concludes with a list of contributions, potential limitations, and policy recommendations.

2. Literature Review

The theoretical concept of the FA is based on the idea of allocating profits of multinational companies among different tax jurisdictions where the company performs economic activity. The consolidated corporate tax base is distributed according to selected variables, factors, reflecting the value creation of multinational companies, hence explaining the variability in profitability. Traditionally, countries with subnational FA systems have relied on a combination of (proxies for) production factors based on immaterial sources, such as tangible assets, labour and third-party sales (Matheson *et al.*, 2021). The European Commission builds on the Massachusetts formula and by extending the labour factor with the number of employees (reflecting the relatively lower wages especially in Central and Eastern European countries) presented the CCCTB proposal, consisting of tangible fixed assets, sales by destination, number of employees and costs of employees (as a labour factor). Intangibles and financial assets were generally excluded from the FA methodology due to their mobile nature and the risk of circumvention of the system (Roggeman *et al.*, 2012; Mintz, 2008). Considering the importance of intangible assets in global value chains, the European Commission indicated the inclusion of intangible assets in the formula

3 Weiner (2006) asserted that the preferred formula should not be solely based on performance superiority, but rather prioritize characteristics of simplicity, comprehensibility, feasibility and acceptability to individual states.

4 COM (2016) 683 final, 25 October 2016.

of the impending BEFIT proposal. The ensuing subsections encompass a literature review focused on the composition and factors of the FA methodology and its explanatory power of the variability in profitability of companies.

2.1 Composition and factors of FA methodology

The composition and choice of factors of the apportionment formula has been addressed by a large number of authors, pursuing various aims and achieving miscellaneous results. Despite the inherent heterogeneity in the existing literature on this topic, the key findings are summarized below.

The significance of the FA composition was highlighted by Pirvu *et al*. (2011), who primarily investigated the effect of the FA on tax revenues. Altshuler and Grubert (2010) stated that the general problem with the FA is the potential asymmetry between the determinants of taxable income and the factors that enter the FA. Roggeman *et al*. (2013) studied several configurations of the FA, concluding that to create an efficient FA and reduce multinational companies' incentive to profit shifting, more factors with more equal weights should be included. McLure (1981) argued that the FA methodology largely transforms the corporate income tax into a direct tax on the factors applied in the FA. In the same vein, Goolsbee and Maydew (2000) confirmed that the use of payroll in the FA turns the corporate income tax at least partially into a payroll tax.

The labour factor was addressed by Eberhartinger and Petutschnig (2017) who pointed out that based on the number of employees, the payroll factor can be used to analyse the impacts of different levels of costs of employees on the allocation of consolidated corporate tax base. The relative importance of wages for the allocation of taxes was addressed by, *e.g.*, Fox *et al*. (2005), Anand and Sansing (2000), Shackelford and Slemrod (1998) and McLure (1981). Goolsbee and Maydew (2000) concluded that inclusion of payroll in the FA has an important effect on state-level employment. Merriman (2015) replicated the results of Goolsbee and Maydew (2000) on a newer data set and stated that the econometric evidence to support the conclusions of Goolsbee and Maydew (2000) is rather weak.

Another group of authors has focused on the sales factor and its proportionate weight in the FA. The FA exclusively based on sales as an income-generating factor was considered by Llopis (2017) and Swenson (2015). Swenson (2015) found that switching to a single sales factor FA has an economically insignificant effect on aggregate employment due to employment gains occurring only for locally based firms. Besides the single sales factor FA, Llopis (2017) considered an alternative based on assets and labour as productive factors. The author concluded that although both alternatives are far from being perfect, the single sales factor FA offers many advantages and is an efficient method to fight against profit shifting of multinational companies (*ibid*.). Eichner and Runkel (2008) suggested that FA with a sales factor would best mitigate fiscal externalities caused by tax competition. Edmiston and del Granado (2006), Edmiston (2002) and Goolsbee and Maydew (2000) suggested that increased sales factor weight (and therefore lower weights on productive factors) should have a positive impact on the utilization of productive factors in the acting state. Coincidently, Fox *et al*. (2005) recommended to increase the weight of the sales factor with the aim to reduce origin-based taxation. Hundsdoerfer and Wagner (2020) agreed that an adjustment of the apportionment weights with a considerably higher weight on the sales factor would somewhat increase the performance of the FA; however, a considerable profit deviations would not be eliminated.

Some authors have considered the increasingly digitalized and globalized economy and focused on alternatives to traditionally applied factors. For instance, the contribution of intangible assets to the creation of economic value in some industries, such as information technology, is considerable and the intangible assets are indisputably an important production input. McLure (2000) addressed the choice of FA factors with regard to digitalized economy based on new types of value-creating assets and problematic application of the traditional nexus. Roggeman *et al*. (2012) discussed and empirically tested the inclusion of intangible assets in the FA. Later, Martins and Taborda (2022) debated the recognition of intangible assets and concluded that they should, in principle, be introduced in the FA. The authors further distinguished between four categories of intangible assets and specified that only intangible assets developed internally by group members that meet the accounting recognition criteria and intangible assets acquired by third (independent) parties should be reflected in the FA (*ibid*.).

2.2 FA explanatory power of variability in profitability of companies

The FA explanatory power of the variability in profitability of companies significantly depends on the choice of factors implemented in the FA and their relative weights. The CCCTB FA was addressed by Hundsdoerfer and Wagner (2020), Krchnivá and Nerudová (2018), Nerudová and Krchnivá (2016) and Roggeman *et al*. (2012). Said empirical studies investigated microeconomic data and based on a regression analysis estimated the percentage of explained variability in profitability. Roggeman *et al*. (2012) concluded that the CCCTB FA explains 28% of variability in profitability. A detailed study of the explanatory power of the CCCTB FA was performed by Nerudová and Krchnivá (2016), who concluded that it is able to explain almost 35% of variability in profitability. Krchnivá and Nerudová (2018) stated that the CCCTB FA explains 26.32% of variability in profitability. Finally, Hundsdoerfer and Wagner (2020) compared how accurately the CCCTB FA allocates profits in comparison to the SA methodology. The authors showed huge income misallocations and systematic distortions caused by the FA (*ibid*.). Nevertheless, the above studies have agreed that when compared to alternative compositions of the FA, the CCCTB FA is the best-performing formula, significantly explaining the highest percentage of variability in profitability. In addition, Roggeman *et al*. (2012) tested the inclusion of intangible assets and concluded that it does not enhance the explanatory power of the FA.

3. Methodology

3.1 Data

The systematic literature review of empirical literature in this field revealed that some scholars, such as Krchnivá and Nerudová (2018), Nerudová and Krchnivá (2016), Roggeman *et al*. (2012) and Hines (2008) have employed analysis of cross-sectional data to investigate the ability of the FA to explain the variability in profitability of companies. However, congruently with Clausing and Lahav (2011), Pirvu *et al*. (2011), Oestreicher and Koch (2011), Fuest *et al*. (2007) and Shackelford and Slemrod (1998), this paper employs panel data analysis. The application of panel data over cross-sectional data has been suggested by many scholars. Baltagi (2021) found that panel data models have higher efficiency and power compared to cross-sectional models. Moreover, Greene (2018) claimed that panel data models can control for unobserved heterogeneity and provide more accurate estimates of the effects of independent variables. Despite particular advantages of panel data over cross-sectional, it is necessary to consider several limitations, such as the potential for endogeneity and sample selection bias. The present paper seeks to leverage the benefits of panel data analysis while duly acknowledging its inherent limitations.

The empirical analysis is based on secondary microeconomic panel data obtained from the Orbis database. Based on the maximum data availability, the period 2011–2020 was investigated. The analysis considers active companies[5] operating within the EU internal market[6] during the observed years. Multiple cumulative qualifying criteria, in accordance with the CCCTB proposal, were applied within the search strategy. A particular member of the company is qualified as the parent company or qualifying subsidiary. According to article 3 of the CCCTB proposal, a “qualifying subsidiary” means every immediate and lower-tier subsidiary in which the parent company has a right to exercise more than 50% of the voting rights; and has an ownership right amounting to more than 75% of the subsidiary’s capital or owns more than 75% of the rights that give entitlement to profit. In addition, at least one known value for the profit/loss before tax over the examined time period was requested to include the company in the initial data set. According

5 An active company is understood as a legal entity whose passive income (i.e., dividends, interest income, rents and royalties) accounted for less than 50% of gross income for the previous calendar year.

6 The search strategy took into consideration the current 27 EU Member States.

to article 2 of the CCCTB proposal, only companies belonging to a parent company with a total consolidated turnover that exceeded EUR 750 million during the financial year preceding the relevant financial year should be considered.[7] During the initial download of the dataset, the prescribed threshold was not enforced, as the subsequent imputation regression of missing values was performed on the entire dataset without being constrained by the turnover threshold.

The qualifying search strategy identified[8] 712,572 subsidiaries affiliated with 320,216 parent companies[9]. Besides information on profit/loss before tax, proxies for the factors of the FA were obtained from the Orbis database for qualified entities. The anchorage of formula factors is coined below.

The labour factor, according to articles 32 and 33 of the CCCTB proposal, is calculated from the total amount of the payroll and the number of employees. As in Krchnivá and Nerudová (2018), Roggeman *et al*. (2012) and Hines (2008), this paper employs the number and costs of employees as a proxy variable. The sales factor, according to article 37 of the CCCTB proposal, is the proceeds of all sales of goods and supplies of services after discounts and returns, excluding value added tax and other taxes and duties. As in Krchnivá and Nerudová (2018), Roggeman *et al*. (2012) and Hines (2008), the operating revenue turnover is used as a proxy variable for the sales factor. It has to be noted that the CCCTB proposal referred to sales by destination as an apportionment factor. Due to database limitations, the sales factor was interpreted as sales by origin (approached similarly by Hundsdoerfer and Wagner, 2020). The factor tangible assets, according to article 34 of the CCCTB proposal, is defined as the average value of all tangible fixed assets owned, rented or leased by the company. As in Krchnivá and Nerudová (2018), Roggeman *et al*. (2012) and Hines (2008), the fixed tangible assets are applied as a proxy variable. Reflecting the envisaged intention of the European Commission and following the theoretical conclusions reached by Martins and Taborda (2022), discussing the recognition of intangible assets in the BEFIT FA, this paper employs a novel FA factor, the intangible assets. The empirical analysis, as in Roggeman *et al*. (2012), employs a proxy variable, the intangible fixed assets. For comprehensibility, the following Table 1 summarizes the abbreviations for proxy variables used further in the empirical analysis.

7 For the year 2011, to prevent significant loss of information, the threshold of 750 million EUR was assessed in the same year.

8 To be noted, the obtained dataset of 712,572 subsidiaries affiliated with 320,216 parent companies was further processed before being utilized in the empirical analysis.

9 Further in the text referred to as entities when not differentiating between subsidiary and parent company.

Table 1: Variables, proxies and abbreviations used

Variable	Proxy variable	Abbreviation
Tax base	profit before tax	*pbt*
Labour factor – number of employees	number of employees	*noe*
Labour factor – payroll	costs of employees	*coe*
Sales	operating revenue turnover	*ort*
Tangible assets	tangible fixed assets	*tfa*
Intangible assets	intangible fixed assets	*ifa*

Source: Author's own preparation

3.2 Imputation of missing values

Any analytical endeavour aiming to estimate the effects of a policy change, on a grand scale, is prone to encounter several challenges, particularly in terms of data quality. The obtained short panel data set was, as expected, unbalanced due to true missing values and observations that are not available in the database. A high number of missing values for factors of the FA (*ort*, *noe*, *coe*, *tfa* and *ifa*) was detected. The missing values can be a problem in data analysis as they may lead to biased results, reduced statistical power and inaccurate conclusions. Moreover, it can be more difficult to make accurate predictions or, as relevant in this study, to identify patterns and relationships between variables. Therefore, it is important to address missing values appropriately.

Nerudová and Solilová (2018 and 2015) and Nerudová *et al*. (2020) imputed the missing values for operating revenue turnover, number of employees and costs of employees using a simple imputation based on the direct and/or indirect relation with the volume of tangible fixed assets. Differently, Hundsdoerfer and Wagner (2020) excluded observations with missing values for the factors of the FA. In this study, the glitch was addressed through an imputation technique, in particular multiple regression imputation of a logarithmic function. For the sake of completeness, only observations with a known *pbt* (in a particular year) for a qualifying subsidiary were included in the analysed dataset; thus, no imputation of missing values for the dependent variable of the analysis was carried out. Moreover, the imputation only works with data originally obtained from the Orbis database; hence, no cumulation of imputation steps occurred. Finally, the imputation was calculated based on all companies, *i.e.*, the qualifying criterion of total consolidated turnover exceeding EUR 750 million during the financial year preceding the relevant financial year was not enforced in the performed imputation analysis. Hence, the imputation was made with the total amount of 712,572 subsidiaries affiliated with 320,216 parent companies. Subsequently, the qualifying criterion of total consolidated turnover was applied on the filled dataset to identify companies for further empirical analysis.

3.3 Final panel dataset

To summarize the performed processing of the initial dataset, first the imputation of missing values was conducted and only companies with complete information on all variables were kept. Afterwards, the dataset was restricted to companies with consolidated turnover above EUR 750 million. The final dataset consisted of 77,087 subsidiaries affiliated with 2,283 parent companies observed from 2011 to 2020.

3.4 Method

To fulfil the main objective of the paper and based on the systematic review of the empirical literature in this field, a regression analysis of microeconomic panel data was performed to analyse the relationship between profitability and various factors. Based on the theoretical framework, verified by Krchnivá and Nerudová (2018), Roggeman *et al.* (2012) and Hines (2008), profit before tax (*pbt*) was used as a proxy variable for company profitability. Thus, the dependent variable in the regression models is *pbt*, the explanatory variables are proxies for FA factors as coined earlier, *i.e.*, *ort*, *coe*, *noe*, *tfa* and *ifa.*

The examined regression models encompass two presently employed formulas, two propositions put forth by the European Commission and an alternative approach proposed by this study. Firstly, countries with subnational FA systems have relied on a combination of factors, based on immaterial sources, such as tangible assets, labour and third-party sales (Matheson *et al*., 2021). This study delves into the configuration of the formula used in Canada and the USA (Massachusetts). Secondly, the European Commission built on the Massachusetts formula and extended the labour factor with the number of employees (reflecting the relatively lower wages especially in Central and Eastern European countries) in its CCCTB proposal. Afterwards, the European Commission published the BEFIT proposal. Based on the hypothesized significance of intangible assets in value creation, the European Commission suggested inclusion of intangible assets in the impeding BEFIT formula to reflect the digitalized context and related changes of the economy. Thirdly, drawing upon partial empirical findings and theoretical outcomes from scholarly literature in this domain, the present study investigates the performance of an additional formula, referred to as the "study proposal", in conjunction with other existing models.

Table 2: Comparison of different configurations of FA methodology

Model	Factors of FA
Canada	*ort*, *coe*
Massachusetts (USA)	*ort*, *coe*, *tfa*
CCCTB proposal	*ort*, *coe*, *tfa*, *noe*
BEFIT proposal	*ort*, *coe*, *tfa*, *noe*, *ifa*
Study proposal	*ort*, *coe*, *tfa*, *ifa*

Source: Author's own preparation

In panel data analysis, the Hausman test is traditionally performed to determine the appropriate type of panel data regression: pooled ordinary least squares (pooled OLS), fixed effects (FE) or random effects (RE) model. Even though it is commonly applied, there are certain limitations of the Hausman test, as highlighted by Baltagi (2021). The author stressed that even though the Hausman test is a powerful tool for model selection in panel data analysis, it should be used with caution (*ibid*.). The author pointed out its sensitivity to small departures from the assumptions of the RE and FE models and the importance of interpreting the results in conjunction with other diagnostic tests and model selection criteria, such as the Akaike information criterion (AIC) and/or the Bayesian information criterion (BIC), (*ibid*.). Baltagi (2021) suggested that researchers should use a combination of these methods for a more comprehensive approach that considers multiple criteria and diagnostic tests to select the appropriate model for their data.

Based on the results of a computed Hausman test, the FE estimation should be applied, though, as usual especially with large panel data sets, it is important to distinguish between a statistical rejection and economically important differences (Wooldridge, 2012). To perform a complex analysis, first, the FE estimator is used based on the results of the Hausman test as suggested by Baltagi (2021); similarly to first differencing, it uses a transformation to remove the unobserved effect prior to estimation. Afterwards, mainly following the recommendations by Wooldridge (2012), we apply a correlated random effects (CRE) approach, which provides a synthesis of FE and RE methods. Both methodologies are expounded upon in the following subsections.

3.5 Fixed effects approach

Following Wooldridge (2012), a pooled OLS estimator that is based on the time-demeaned variables is called the FE estimator. The author refers to FE or within transformation (*ibid*.). This approach accounts for any unobserved time-invariant heterogeneity within the data. The following Table 3 shows the algorithm (time-demeaning) of variables included in the regression model. First, the share of each subsidiary (i) affiliated with the parent company (guo) is calculated, denoted by a subscript (SHR). Then, all the variables are time-demeaned to account for any unobserved time-invariant heterogeneity. The described procedure of time-demeaning is achieved by subtracting the group mean, represented by a superscript (¯). To enhance clarity, abbreviations are introduced for variables that will be utilized in the subsequent empirical analysis. The conventional notation introduced by Wooldridge (2012) in the form of a superscript (¨) is employed to indicate the time-demeaned variables.

Table 3: FE model

Variable	Algorithm	Abbreviation
pbt	$\frac{pbt_{i,t}}{pbt_{guo,t}} - \left(\overline{\frac{pbt_{i,t}}{pbt_{guo,t}}}\right)$	$\ddot{pbt}_{SHR}$
ort	$\frac{ort_{i,t}}{ort_{guo,t}} - \left(\overline{\frac{ort_{i,t}}{ort_{guo,t}}}\right)$	$\ddot{ort}_{SHR}$
coe	$\frac{coe_{i,t}}{coe_{guo,t}} - \left(\overline{\frac{coe_{i,t}}{coe_{guo,t}}}\right)$	$\ddot{coe}_{SHR}$
noe	$\frac{noe_{i,t}}{noe_{guo,t}} - \left(\overline{\frac{noe_{i,t}}{noe_{guo,t}}}\right)$	$\ddot{noe}_{SHR}$
tfa	$\frac{tfa_{i,t}}{tfa_{guo,t}} - \left(\overline{\frac{tfa_{i,t}}{tfa_{guo,t}}}\right)$	$\ddot{tfa}_{SHR}$
ifa	$\frac{ifa_{i,t}}{ifa_{guo,t}} - \left(\overline{\frac{ifa_{i,t}}{ifa_{guo,t}}}\right)$	$\ddot{ifa}_{SHR}$

Source: Author's own preparation

Moreover, a time-specific effect (τ) able to account for any unobserved company-invariant heterogeneity (such as geopolitical situation, economic or epidemiological crises) was included in the model. The formal model specification of a regression model (only the formula corresponding to BEFIT FA with all factors included is outlined here and further in subsequent equations of this section) estimated by the FE estimator on time-demeaned data, is compiled as follows:[10]

10 The remaining formula configurations are composed in an analogous manner.

$$p\ddot{b}t^{FA}_{SHR,i,t} = \beta_0 + \beta_1\, o\ddot{r}t_{SHR,i,t} + \beta_2\, c\ddot{o}e_{SHR,i,t} + \beta_3\, n\ddot{o}e_{SHR,i,t} + \beta_4\, t\ddot{f}a_{SHR,i,t} + \\ + \beta_5\, i\ddot{f}a_{SHR,i,t} + \tau_t + \varepsilon_{i,t} \,. \tag{1}$$

In the described model, *pbt* stands for profit before tax, *ort* for the operating revenue turnover, *coe* for costs of employees, *noe* for the number of employees, *tfa* for the tangible fixed assets, *ifa* for the intangible fixed assets, τ for the time-specific effects, *t* for the time, *i* for the subsidiary, and ε is the error term. As delineated earlier, the variables are incorporated in their time-demeaned format, following the approach outlined by Wooldridge (2012).

Considering extreme values in the dataset and following the approach justified by Wooldridge (2012), additionally, logit transformation of data was performed as shown in the following Table 4. Given that this subsection pertains to the FE estimator, the application of the logit transformation on time-demeaned data is expounded upon.

Table 4: FE_logit model transformation

Variable	Algorithm	Abbreviation
pbt	$\text{logit}\frac{pbt_{i,t}}{pbt_{guo,t}} - \left(\overline{\text{logit}\frac{pbt_{i,t}}{pbt_{guo,t}}}\right)$	$\text{logit}\,p\ddot{b}t_{SHR}$
ort	$\text{logit}\frac{ort_{i,t}}{ort_{guo,t}} - \left(\overline{\text{logit}\frac{ort_{i,t}}{ort_{guo,t}}}\right)$	$\text{logit}\,o\ddot{r}t_{SHR}$
coe	$\text{logit}\frac{coe_{i,t}}{coe_{guo,t}} - \left(\overline{\text{logit}\frac{coe_{i,t}}{coe_{guo,t}}}\right)$	$\text{logit}\,c\ddot{o}e_{SHR}$
noe	$\text{logit}\frac{noe_{i,t}}{noe_{guo,t}} - \left(\overline{\text{logit}\frac{noe_{i,t}}{noe_{guo,t}}}\right)$	$\text{logit}\,n\ddot{o}e_{SHR}$
tfa	$\text{logit}\frac{tfa_{i,t}}{tfa_{guo,t}} - \left(\overline{\text{logit}\frac{tfa_{i,t}}{tfa_{guo,t}}}\right)$	$\text{logit}\,t\ddot{f}a_{SHR}$
ifa	$\text{logit}\frac{ifa_{i,t}}{ifa_{guo,t}} - \left(\overline{\text{logit}\frac{ifa_{i,t}}{ifa_{guo,t}}}\right)$	$\text{logit}\,i\ddot{f}a_{SHR}$

Source: Author’s own preparation

The formal model specification is compiled as follows:

$$\text{logit}\, p\ddot{b}t^{FA}_{SHR,i,t} = \beta_0 + \beta_1 \text{logit}\, \ddot{o}rt_{SHR,i,t} + \beta_2 \text{logit}\, c\ddot{o}e_{SHR,i,t} + \beta_3 \text{logit}\, n\ddot{o}e_{SHR,i,t} + \beta_4 \text{logit}\, t\ddot{f}a_{SHR,i,t} + \\ + \beta_5 \text{logit}\, \imath\ddot{f}a_{SHR,i,t} + \tau_t + \varepsilon_{i,t} \quad . \tag{2}$$

The relevant groups of variables are defined in a coincidental way with the above defined model presented in Equation 1.

3.6 Correlated random effects approach

Following Wooldridge (2012), the CRE is a RE model with a group mean of the explanatory variables. Thus, the CRE is like the usual equation underlying RE estimation with the important addition of the time-averaged explanatory variables. Basically, adding the time-averaged explanatory variables and using RE estimation is the same as subtracting the time averages and using pooled OLS on time-demeaned data (FE estimation). Consequently, the estimate of the within-group effect is equal to the FE estimate.

The mean captures the contextual effect and the between-group effect. If the RE assumption is not met, the CRE model is consistent and unlike FE it can estimate the contextual effect (Wooldridge, 2012). The CRE model is mainly used to analyse data with hierarchical or nested structures, where observations are grouped within larger units or clusters. Moreover, they can handle unbalanced designs, missing data and different numbers of observations within each cluster, as is the case in the analysed dataset.

According to Wooldridge (2012), in applications where it makes sense to view the α_i (unobserved specific effects of a subsidiary) as being random variables, along with the observed variables drawn here, CRE is an alternative to FE that still allows α_i to be correlated with the observed explanatory variables. The author further claims that the rationale to utilize the CRE approach is that it provides a way to include time-constant explanatory variables. Even though time-constant variables cannot be included by themselves in FE model, they can be interacted with variables that change over time and, in particular, with year dummy variables. CRE allows coefficients on time-constant variables to be estimated while preserving the FE nature of the analysis. In this study, utilising the capabilities of the CRE approach, the economic activity, classified by NACE codes and EU Member State jurisdiction of the company, are included in the CRE model as time-constant variables.

In line with the FE approach, first the share of each subsidiary (i) without further transformation is modelled. The variables are not time-demeaned as time averages are included in the CRE approach separately. To exploit the CRE model capabilities, time-constant variables, the economic sector classified by NACE codes and tax jurisdiction are added.

The formal model specification is compiled as follows:

$$pbt^{FA}_{SHR,i,t} = \beta_0 + \beta_1 ort_{SHR,i,t} + \beta_2 coe_{SHR,i,t} + \beta_3 noe_{SHR,i,t} + \\ + \beta_4 tfa_{SHR,i,t} + \beta_5 ifa_{SHR,i,t} + \beta_6 \overline{ort}_{SHR,i,t} + \beta_7 \overline{coe}_{SHR,i,t} + \beta_8 \overline{noe}_{SHR,i,t} + \\ + \beta_9 \overline{tfa}_{SHR,i,t} + \beta_{10} \overline{ifa}_{SHR,i,t} + \tau_t + \vartheta_{i(j)} + \delta_i + \alpha_i + \varepsilon_{i,t}\,. \quad (3)$$

In the model, *pbt* stands for profit before tax, *ort* for operating revenue turnover, *coe* for costs of employees, *noe* for number of employees, *tfa* for tangible fixed assets, *ifa* for intangible fixed assets, τ for time-specific effects, ϑ for jurisdiction-specific effect, δ for NACE-specific effect, α for the specific effect of a subsidiary, *t* for the time, *i* for subsidiary, *j* for jurisdiction of the subsidiary *i*, ε is the error term, the group averages are denoted by a superscript ($\bar{\ }$), time-demeaned variables are not included as the time averages are included in the CRE approach separately.

Coincidently with the FE approach, a logit transformation accounting for extreme values in the dataset was applied and the CRE estimator was conducted. The variables are identical to Equation (3) above, and the formal model specification is compiled as follows:

$$\text{logit}pbt^{FA}_{SHR,i,t} = \beta_0 + \beta_1 \text{logit}\, ort_{SHR,i,t} + \beta_2 \text{logit}\, coe_{SHR,i,t} + \beta_3 \text{logit}\, noe_{SHR,i,t} + \\ + \beta_4 \text{logit} tfa_{SHR,i,t} + + \beta_5 \text{logit} ifa_{SHR,i,t} + \beta_6 \overline{\text{logit} ort}_{SHR,i,t} + \\ + \beta_7 \overline{\text{logit} coe}_{SHR,i,t} + \beta_8 \overline{\text{logit}\, noe}_{SHR,i,t} + \beta_9 \overline{\text{logit}\, tfa}_{SHR,i,t} + \\ + \beta_{10} \overline{\text{logit}\, ifa}_{SHR,i,t} + \tau_t + \vartheta_{i(j)} + \delta_i + \alpha_i + \varepsilon_{i,t}\,. \quad (4)$$

4. Results

The empirical analysis was designed to investigate the ability of different formula designs to explain the variability in profitability of companies as one of the desired attributes of the FA. As theoretically coined earlier, models were designed based on the composition of formula indicated for the BEFIT proposal, formula of the preceding CCCTB proposal, currently/traditionally applied formulas in the USA (Massachusetts) and Canada and a novel composition proposed in this study.

The empirical analysis employed two distinct approaches, as explained in Section 3, namely the FE and CRE estimators. The subsequent presentation of results is organized into four subsections, delineated as follows: (1) FE estimator applied to the original data, (2) FE estimator applied to the logit transformed data, (3) CRE estimator applied to the original data, and (4) CRE estimator applied to the logit transformed data.

The findings of the regression analysis are presented in the subsequent tables, which entail the regression coefficients, standard errors[11] (in parentheses), the number of observations, and supplementary information criteria and/or coefficients of determination. The choice of reported statistics is based on suggestions by Baltagi (2021), Greene (2018) and Wooldridge (2012). The reported within R^2 quantifies the proportion of the total variation in the dependent variable that can be explained by the independent variables in the FE model, accounting for time-invariant characteristics of the entities. The least squares dummy variable (LSDV) R^2 considers the overall fit of the FE model, accounting for both within-entity and between-entity variation. In addition, various information criteria are reported in the results section, as metrics to compare the fit of different regression models. The primary purpose of information criteria is to strike a balance between model fit and complexity, thus used for model selection as they measure how well the models fit the given data. The model with the lowest value of the information criterion is considered the best-fitting and most parsimonious model. The specific details of the applied estimator determine the inclusion of the aforementioned criteria. Finally, the stars flag levels of significance, $* p < 0{,}05$, $** p < 0{,}01$, $*** p < 0{,}001$; two-tailed tests were applied.

11 Heteroskedasticity and autocorrelation consistent (HAC).

Table 5: FE estimator on original data

	Study proposal	**BEFIT proposal**	**CCCTB proposal**	**Massachusetts**	**Canada**
$\ddot{ort}_{SHR}$	0.526*** (0.0163)	0.526*** (0.0163)	0.528*** (0.0161)	0.528*** (0.0161)	0.550*** (0.0160)
$\ddot{coe}_{SHR}$	0.089*** (0.0148)	0.101*** (0.0185)	0.103*** (0.0185)	0.092*** (0.0148)	0.124*** (0.0147)
$\ddot{noe}_{SHR}$		−0.014 (0.0133)	−0.014 (0.0133)		
$\ddot{tfa}_{SHR}$	0.071*** (0.0088)	0.072*** (0.0089)	0.074*** (0.0089)	0.072*** (0.0088)	
$\ddot{ifa}_{SHR}$	0.008* (0.0046)	0.008* (0.0046)			
Intercept	0.028*** (0.0060)	0.028*** (0.0005)	0.029*** (0.0060)	0.029*** (0.0060)	0.030*** (0.000)
τ	yes	yes	yes	yes	yes
Within R^2	0.245	0.245	0.245	0.245	0.243
LSDV R^2	0.890	0.890	0.890	0.890	0.890
Akaike criterion	−1,254,182.00	−1,254,195.00	−1,254,151.00	−1,254,139.00	−1,252,738.00
Schwarz criterion	−418,007.00	−418,009.10	−417,976.70	−417,975.30	−416,585.2
Hannan–Quinn criterion	−1,014,712.00	−1,014,722.00	−1,014,682.00	−1,014,673.00	−1,013,275.00
Corrected quasi likelihood under independence model criterion	568.13	570.12	568.18	566.20	566.22
No. of observations	379,013	379,013	379,013	379,013	379,013

Note: Dependent variable: $\ddot{pbt}_{SHR}$

Source: Author's own calculations

Table 6: FE estimator on logit transformed data

	Study proposal	BEFIT proposal	CCCTB proposal	Massachusetts	Canada
logit $o\ddot{r}t_{SHR}$	0.492*** (0.0084)	0.491*** (0.0084)	0.491*** (0.0084)	0.492*** (0.0084)	0.496*** (0.0083)
logit $c\ddot{o}e_{SHR}$	0.022*** (0.0051)	−0.019** (0.0072)	−0.019** (0.0072)	0.022*** (0.0051)	0.024*** (0.0051)
logit $n\ddot{o}e_{SHR}$		0.058*** (0.0068)	0.058*** (0.0068)		
logit $t\ddot{f}a_{SHR}$	0.008*** (0.0015)	0.008*** (0.0015)	0.008*** (0.0015)	0.008*** (0.0015)	
logit $\imath\ddot{f}a_{SHR}$	0.001 (0.0005)	0.001 (0.0005)			
Intercept	0.712*** (138.3979)	0.691*** (0.0739)	0.692*** (0.0739)	0.714*** (0.0419)	0.718*** (0.0756)
τ	yes	yes	yes	yes	yes
Within R^2	0.157	0.157	0.157	0.157	0.156
LSDV R^2	0.917	0.917	0.917	0.917	0.917
Akaike criterion	1,118,722.00	1,118 560.00	1,118,561.00	1,118,723.00	1,118,841.00
Schwarz criterion	1,954,897.00	1,954,746.00	1,954,735.00	1,954,887.00	1,954,993.00
Hannan–Quinn criterion	1,358,192.00	1,358,033.00	1,358,030.00	1,358,190.00	1,358,304.00
Corrected quasi likelihood under independence model criterion	282,938.34	282,804.46	282,804.64	282,939.06	283,029.67
No. of observations	379,013	379,013	379,013	379,013	379,013

Note: Dependent variable: $p\ddot{b}t_{SHR}$

Source: Author's own calculations

Table 7: RE estimator on original data

	Study proposal	BEFIT proposal	CCCTB proposal	Massachusetts	Canada
ort_{SHR}	0.525*** (0.003)	0.525*** (0.003)	0.527*** (0.003)	0.527*** (0.003)	0.549*** (0.003)
coe_{SHR}	0.088*** (0.004)	0.100*** (0.005)	0.103*** (0.005)	0.091*** (0.003)	0.123*** (0.003)
noe_{SHR}		−0.014 (0.004)	−0.014 (0.004)		
tfa_{SHR}	0.071*** (0.002)	0.072*** (0.002)	0.073*** (0.002)	0.072*** (0.002)	
ifa_{SHR}	0.008* (0.001)	0.008* (0.001)			
$\overline{ort}_{SHR}$	0.030 (0.006)	0.024 (0.006)	0.028 (0.006)	0.034* (0.006)	0.042** (0.006)
$\overline{coe}_{SHR}$	0.035* (0.006)	0.101*** (0.011)	0.111*** (0.011)	0.044** (0.006)	0.091*** (0.006)
$\overline{noe}_{SHR}$		−0.069*** (0.009)	−0.070*** (0.010)		
$\overline{tfa}_{SHR}$	0.049*** (0.004)	0.057*** (0.004)	0.060*** (0.004)	0.053*** (0.004)	
$\overline{ifa}_{SHR}$	0.016** (0.003)	0.016** (0.003)			
Intercept	0.039* (0.004)	−0.003 (0.001)	0.040 (0.004)	0.039* (0.004)	−0.002 (134.057)
δ	yes	yes	yes	yes	yes
ϑ	yes	yes	yes	yes	yes
τ	yes	yes	yes	yes	yes
Akaike criterion	−979,937.40	−980,410.00	−979,735.30	−979,242.60	−970,708.90
Schwarz criterion	−979,568.60	−980,019.50	−979,366.50	−978,895.60	−970,383.60
Hannan–Quinn criterion	−979,831.80	−980,298.20	−979,629.70	−979,143.30	−970,615.80
No. of observations	379,013	379,013	379,013	379,013	379,013

Note: Dependent variable: pbt_{SHR}

Source: Author's own calculations

Table 8: CRE estimator on logit transformed data

	Study proposal	BEFIT proposal	CCCTB proposal	Massachusetts	Canada
$\text{logit}ort_{SHR}$	0.491*** (0.003)	0.490*** (0.003)	0.490*** (0.003)	0.491*** (0.008)	0.495*** (0.008)
$\text{logit}coe_{SHR}$	0.021*** (0.003)	−0.018** (0.005)	−0.018** (0.005)	0.021*** (0.005)	0.023*** (0.005)
$\text{logit}noe_{SHR}$		0.055*** (0.005)	0.055*** (0.005)		
$\text{logit}tfa_{SHR}$	0.008*** (0.001)	0.007*** (0.001)	0.008*** (0.001)	0.008*** (0.002)	
$\text{logit}ifa_{SHR}$	0.001 (0.000)	0.001 (0.000)			
$\overline{\text{logit}ort_{SHR}}$	0.022 (0.007)	0.049*** (0.007)	0.052*** (0.007)	0.020* (0.012)	0.011 (0.012)
$\overline{\text{logit}coe_{SHR}}$	0.201*** (0.007)	−0.093*** (0.012)	−0.089*** (0.012)	0.210*** (0.011)	0.203*** (0.001)
$\overline{\text{logit}noe_{SHR}}$		0.325*** (0.011)	0.326*** (0.011)		
$\overline{\text{logit}tfa_{SHR}}$	−0.018*** (0.002)	−0.021*** (0.002)	−0.019*** (0.001)	−0.020*** (0.002)	
$\overline{\text{logit}ifa_{SHR}}$	0.009*** (0.001)	0.006*** (0.001)			
Intercept	−2.126*** (2825.968)	−1.303*** (0.101)	−1.326*** (0.101)	−2.144*** (0.056)	−2.122*** (0.056)
δ	yes	yes	yes	yes	yes
ϑ	yes	yes	yes	yes	yes
τ	yes	yes	yes	yes	yes
Akaike criterion	1,544,555.00	1,540,237.00	1,540,519.00	1,544,871.00	1,544,939.00
Schwarz criterion	1,544,989.00	1,540,692.00	1,540,952.00	1,545,283.00	1,545,329.00
Hannan–Quinn criterion	1,544,679.00	1,540,367.00	1,540,643.00	1,544,989.00	1,545,050.00
No. of observations	379,013	379,013	379,013	379,013	379,013

Note: Dependent variable: logit pbt_{SHR}

Source: Author's own calculations

With the aim to select the best-performing formula based on analytical evidence, the initial focus in evaluating the statistical results aligns with theory: allocation factors should exhibit a positive and statistically significant relationship with profitability. This is pivotal for the allocation factor to be included in the formula. Based on the results, we can state that the labour factor appears to be problematic. The component representing the number of employees, and in the logit transformation the costs of employees, show a negative relation to profitability. Based on the statistical results, the costs of employees better explain variance in profit than the number of employees; thus, omission of the number of employees from the formula should be considered. Based on the estimated regression coefficients, the factors sales by destination and tangible assets are statistically significant, with the former being the dominant factor that explains the generation of profits. Conversely, intangible assets play a minor role, lacking statistically significant impact on value creation. Furthermore, the reported coefficients of determination, within R^2 and LSDV R^2 have a constrained interpretative role in the panel data analysis. Thus, as per the recommendations by Baltagi (2021), various information criteria were compared as metrics of the fit of different regression models. As stated earlier, the lowest value of the information criterion is considered the best-fitting model.

Based on the partial results of the regression analysis comparing the fit of all the investigated models, the best results, *i.e.*, the best-performing formulas, are the BEFIT proposal and the study proposal. To additionally assess and compare these two configurations, a correlation analysis comparing the profit distribution under the currently applied SA and both proposals was conducted. To ensure a comprehensive overview and facilitate the final decision regarding the selection of the best-performing model, a thorough analysis incorporating both the FE and CRE estimators, as well as a logit transformation, was undertaken. An evaluation of the model performance and suitability can be achieved by incorporating these multiple approaches. For the purpose of the correlation analysis, the obtained regression coefficients were normalized to one, which means that values of the estimated coefficients were adjusted in a way that the sum of all the coefficients in the formula equals one. This is imperative due to the requirement that all the generated profit needs to be distributed within the parent company. Subsequently, the *pbt* under each distribution was counted based on the respective formulas. Logarithmic transformation was employed to mitigate the influence of outliers in the data, which could have significantly biased the calculated correlation coefficients.

Table 9: Profit distribution under compared FA configurations

BEFIT proposal	$\log pbt^{BEFIT} = \log (pbt_{guo} \times (0.25ort_{SHR} + 0.125coe_{SHR} + 0.125noe_{SHR} + 0.25tfa_{SHR} + 0.25ifa_{SHR}))$
Study proposal	
FE	$\log pbt^{FE} = \log (pbt_{guo} \times (0.75785ort_{SHR} + 0.12389coe_{SHR} + 0.10225tfa_{SHR} + 0.01151ifa_{SHR}))$
LOGIT_FE	$\log pbt^{LOGIT\_FE} = \log (pbt_{guo} \times (0.94156ort_{SHR} + 0.04194coe_{SHR} + 0.01517tfa_{SHR} + 0.00133ifa_{SHR}))$
CRE	$\log pbt^{CRE} = \log (pbt_{guo} \times (0.75867ort_{SHR} + 0.12717coe_{SHR} + 0.10260tfa_{SHR} + 0.01156ifa_{SHR}))$
LOGIT_CRE	$\log pbt^{LOGIT\_CRE} = \log (pbt_{guo} \times (0.94242ort_{SHR} + 0.04031coe_{SHR} + 0.01536tfa_{SHR} + 0.00192ifa_{SHR}))$

Source: Author's own calculations

Table 10: Results of correlation analysis of profit distributions

Pearson	$\log pbt^{SA}$	$\log pbt^{BEFIT}$	$\log pbt^{FE}$	$\log pbt^{LOGIT\_FE}$	$\log pbt^{CRE}$	$\log pbt^{LOGIT\_CRE}$
$\log pbt^{SA}$	1.00					
$\log pbt^{BEFIT}$	0.683***	1.00				
$\log pbt^{FE}$	0.697***	0.963***	1.00			
$\log pbt^{LOGIT\_FE}$	0.698***	0.931***	0.991***	1.00		
$\log pbt^{CRE}$	0.697***	0.963***	1.000***	0.991***	1.00	
$\log pbt^{LOGIT\_CRE}$	0.698***	0.931***	0.991***	1.000***	0.991***	1.00

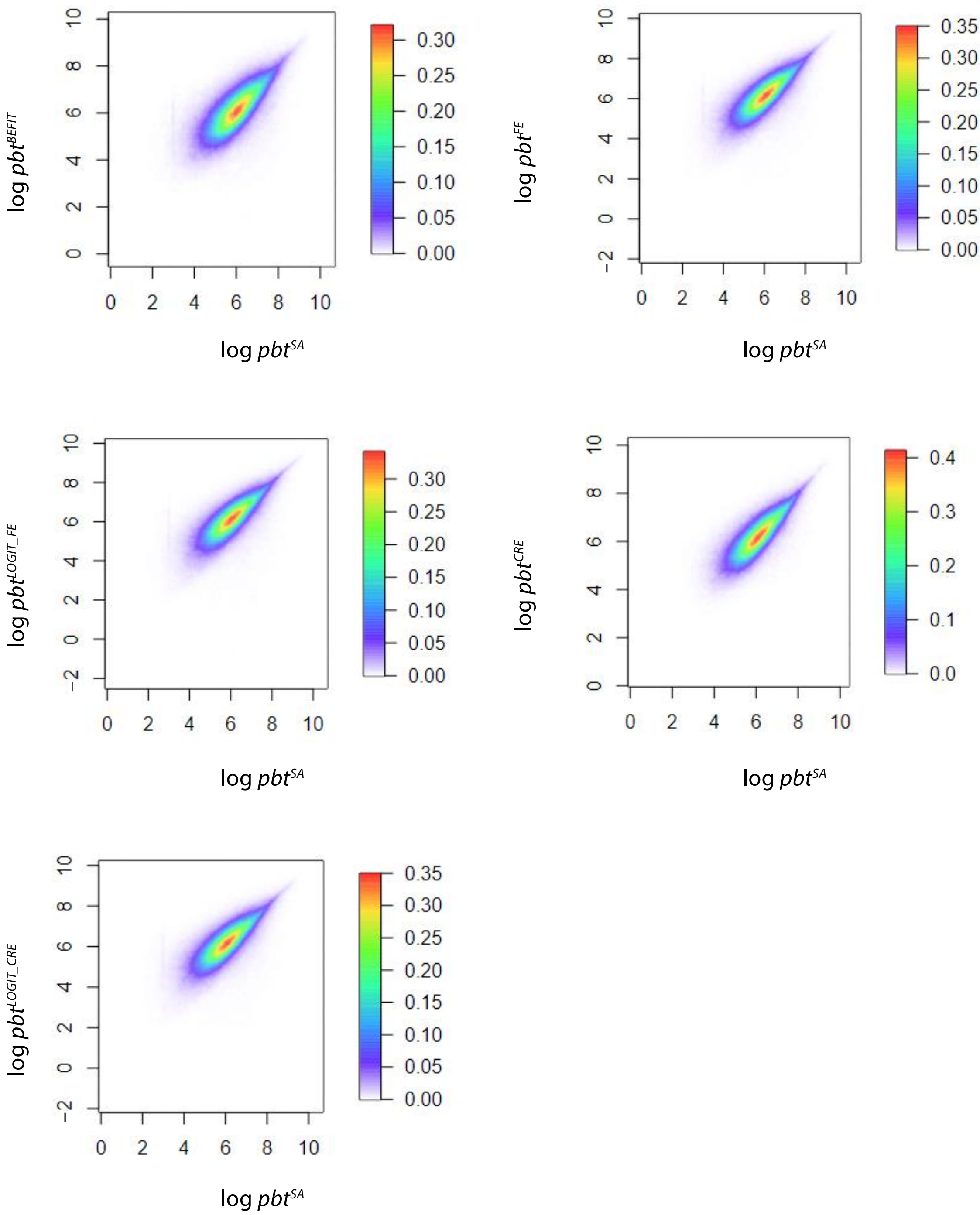
Spearman's rho	$\log pbt^{SA}$	$\log pbt^{BEFIT}$	$\log pbt^{FE}$	$\log pbt^{LOGIT\_FE}$	$\log pbt^{CRE}$	$\log pbt^{LOGIT\_CRE}$
$\log pbt^{SA}$	1.000					
$\log pbt^{BEFIT}$	0.703***	1.000				
$\log pbt^{FE}$	0.739***	0.961***	1.000			
$\log pbt^{LOGIT\_FE}$	0.740***	0.922***	0.989***	1.000		
$\log pbt^{CRE}$	0.739***	0.961***	1.000***	0.989***	1.000	
$\log pbt^{LOGIT\_CRE}$	0.740***	0.922***	0.989***	1.000***	0.989***	1.000

Note: $* \ p < 0.05$, $** \ p < 0.01$, $*** \ p < 0.001$; two-tailed tests.

Source: Author's own calculations

Additionally, a visual assessment utilizing density plots providing a visual representation of the probability density function of the data was conducted.

Figure 1: Density plots comparing distribution of profits under SA and compared proposals (BEFIT and study proposals)



Source: Author's own preparation

We based the final selection of the best-performing formula on a comprehensive evaluation of the model performance, taking into consideration parameter estimates and their statistical significance, informational criteria that evaluated the overall fit of the model, coefficients of determination, if applicable, and considerations regarding model complexity and the theoretical framework. Additionally, we performed a correlation analysis of profit distribution under the best-performing models and the profit distribution under SA, supported by visualization via density plots. Throughout this comprehensive evaluation process, the primary objectives and overarching purpose of the formula were consistently borne in mind to ensure the selection aligned with the desired outcomes and theoretical framework. The final model is the model estimated by CRE, based on the study proposal configuration, utilising data in their original form. The estimated coefficients of the final model, normalized to one, are as follows:

$$pbt^{Study\ Proposal} = pbt_{guo} \times \left(0.75867\, ort_{SHR} + 0.12717\, coe_{SHR} + 0.10260\, tfa_{SHR} + 0.01156\, ifa_{SHR}\right) \quad (5)$$

All the variables in the model are statistically significant, the contextual and the between-group effects are estimated, and time-constant explanatory variables such as the economic activity, classified by NACE codes and EU Member State jurisdiction of the company, are included in the model. The selection of a non-logit transformation over logit-transformed data is based on a more equitable distribution of weights among formula factors. It is essential to note that the original intention of the European Commission was to weight the factors equally in the formula. As shown by the results on microeconomic data, equal weights do not align with the actual profit generation of companies. However, as highlighted by Roggeman *et al*. (2013), using more equal weights distributes the common tax base more equally and could reduce the multinational companies' incentive to shift factors from high to low-tax countries.

The dominant factor that explains the generation of profits is sales by destination. As highlighted in the literature review, an increase in the sales factor weight has been recommended by many scholars, such as Hundsdoerfer and Wagner (2020), Edmiston and Granado (2006), Edmiston (2002) and Goolsbee and Maydew (2000). Coincidently, the model suggested in this paper counts with a higher weight of the sales factor.

As to the labour factor, with the aim to reflect differences in wage levels across the EU Member States and to allow for a fairer distribution of the consolidated tax base, the European Commission divided the labour factor into two components: payroll and the number of employees. Matheson *et al.* (2021) argued that headcount is independent of wage levels but may be easier to manipulate for tax reporting purposes, since nominal positions can be created without any significant associated labour costs. The overall research findings indicated an inverse relationship between the number of employees and profitability. It was determined that the costs of employees are a stronger predictor of profit variability, and the number of employees was found to have a negative impact on profit before tax. Hence, the factor reflecting the number of employees was deemed inappropriate and excluded from the proposed FA configuration.

A novel factor proposed by the European Commission, intangible assets, similarly to financial assets, was generally excluded from the FA due to its mobile nature and the risk of circumvention of the system (Roggeman *et al.*, 2012; Mintz, 2008). The hypothesised importance of intangible assets in value creation as per Martins and Taborda (2022), Corrado *et al*. (2009) was not confirmed by the empirical results. The results suggest that intangibles only play a rather minor role in the profit generation process and are not a dominant value creation factor that would have a statistically significant effect.

In this regard, it is important to distinguish between a statistical rejection and economical context and to initiate a discussion whether the statistical rejection arises from unavailability of data or other potential limitations inherent in the analysis. Roggeman *et al*. (2012) elaborated that the current accounting methods used under the International Financial Reporting Standards (IFRS) require most intangibles to be expensed and, as a consequence, capitalized intangibles do not reflect how valuable intangible assets are for many companies. Dancaková *et al*. (2022) argued that due to the persistent conservatism of the IFRS, the actual value of intangible assets cannot be fully recognized and disclosed in financial statements. Taking into consideration that various definitions of intangible assets are employed in the field of taxation, accountancy and transfer pricing of multinational companies, it is hypothesised that intangible assets are undervalued in financial statements.

The stated weaknesses of the current accountancy of intangible assets hypothetically generate bias in the empirical results. Alternatively, the result of the empirical analysis could also be interpreted as confirming the understatement of intangible assets in the financial statements of companies and outlining the need to adjust the rules of their reporting. We are of the opinion that intangible assets are principally value creation assets with increasing economic significance in the digitalized economy, and neglecting intangible assets in the FA would disregard a significant portion of total assets and one of the main sources of competitiveness. Hence, despite their marginal statistical importance, they should be included in the FA.

5. Conclusion

This paper stands out from previous studies in several distinct ways. Firstly, it employs up-to-date microeconomic data, providing a comprehensive and accurate representation of the current economic landscape, updating previous research efforts. Notably, this study is the only one to incorporate the CRE approach, which effectively estimates the contextual and the between-group effects, and accounts for time-constant explanatory variables. This analytical framework enables a more nuanced understanding of the complex interplay between variables, leading to robust and insightful findings. By combining these methodological advancements, this paper offers novel insights and a deeper understanding of the subject matter, making it a valuable addition to the existing literature and impending discussion of the FA in the BEFIT proposal.

However, it is important to acknowledge the limitations of this paper. The study aggregates intangible assets and does not reflect their division as described by Martins and Taborda (2022). The aggregation of intangible assets arises from two primary factors: the limited availability of data in the database and the acknowledged weaknesses in existing accounting standards, particularly when it comes to the treatment of intangible assets. A significant constraint in this study was the inadequate reporting of intangible assets in the financial statements of companies, which hindered the ability to analyse different types of intangible assets individually. It is worth noting that the reporting of intangible assets, such as digital data, lacks a standardized framework up to the present day, which restricts deeper empirical analysis focusing on distinct groups of intangibles. Despite those limitations, this paper represents an important step forward in understanding the subject matter and lays the groundwork for future research in this area.

Drawing from the empirical findings and existing literature, this study offers several policy recommendations. It is recommended to assign increased proportional weight to the sales factor within the policy framework, omit the factor reflecting the number of employees and include a novel factor reflecting intangible assets. The inclusion of intangible assets would require substantial adjustments to ensure that the tax framework is adequate and aligned with the evolving business landscape. It is important to recognize that the inclusion of intangible assets alone does not provide a comprehensive solution for the outlined conundrum. Rather, it represents one element within a larger framework of measures that are required to effectively tackle the challenges associated with intangible assets. In conclusion, considering the increasing economic importance of digital business models and the continuous influx of corporate investments in intangible assets, it is imperative to adapt the current international tax framework to accommodate these dynamic shifts. Additionally, the understatement of intangible assets in the financial statements of companies highlights the need to revise reporting rules, accordingly, as indicated by the empirical analysis.

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