FAT

Finance · Accounting · Taxes

Working Paper No. 14-001

ASSERT - Assessing the effects of reforms in taxation - a micro-simulation approach

Andreas Oestreicher/Reinald Koch/
Dorothea Vorndamme/Stefan Hohls

GEORG-AUGUST-UNIVERSITÄT
GÖTTINGEN

Faculty of Economic Sciences
Finance · Accounting · Taxes

FAT
Finance · Accounting · Taxes

Working Paper No. 14-001

ASSERT - Assessing the effects of reforms in taxation - a micro-simulation approach

Andreas Oestreicher/Reinald Koch/
Dorothea Vorndamme/Stefan Hohls

ASSERT - Assessing the effects of reforms in taxation - a micro-simulation approach

Andreas Oestreicher, Reinald Koch, Dorothea Vorndamme and Stefan Hohls*

September 2013

*Georg-August-Universität Göttingen, Faculty of Economic Sciences - Tax division, Platz der Göttinger Sieben 3, 37073 Göttingen, Tel. (Fax): +49 551 - 39 7308 (7874), E-Mail: andreas.oestreicher@wiwi.uni-goettingen.de, reinald.koch@wiwi.uni-goettingen.de, dorothea.vorndamme@wiwi.uni-goettingen.de, stefan.hohls@wiwi.uni-goettingen.de

1 Introduction

In light of a government's need to balance its budget, it is important for legislators to be able to ex ante assess the potential consequences of prospective tax reforms on tax revenue. The same holds for individual and corporate taxpayers with regard to the impact of such reforms on their tax burden. In both cases, micro-simulation models can provide appropriate answers. Micro-simulation models have been used for many years to assess the consequences of possible tax reforms with regard to housholds' tax burden. In more recent years, such models have increasingly been employed with respect to company taxation (Oestreicher & Koch, 2011, Bach et al., 2008, Reister et al., 2008, Creedy & Gemmell, 2007, Oropallo & Parisi, 2005, Castellucci et al., 2003). Existing micro-simulation models for the corporate sector usually refer to a single country and a specific period in the past and are designed to capture as much detail as possible about the specific country's tax rules ("standard approach"). To determine tax liability, such models usually take as their starting point the pre-tax earnings reported in financial statements. These earnings are translated into estimators for taxable income both under prevailing tax law and under a possible reform scenario. The resulting differences in tax burdens then serve as an indicator of the impact of a tax reform.

In addition to having advantages, this standard approach for company micro-simulation has certain shortcomings. Given the increasing complexity of company tax legislation, limiting the model to a single country allows for a detailed representation of that country's tax law. However, such a single-country approach disregards the importance of cross-border business structures, which are of increasing relevance for company decisions. In contrast to the standard approach, we therefore examine not only the consequences of tax reforms from the perspective of a single country but also the cross-border effects of tax reforms. Assuming that multinational groups respond to changes in tax law when they allocate investments and tax bases, tax reforms in one member state are expected to have knock-on effects on tax revenue in all other member states. These indirect inter-nation effects can best be incorporated into a model that captures the taxation of important trading-partner states. To this end, in the current version of our model, we incorporate 19 countries that belong to the European single market.

Similarly, estimating tax liability directly, based on financial statements for a specific period in the past, also has drawbacks. Although an advantage of this backward-looking method is that it is based on realized company data and therefore avoids any measurement error that may result from forecasting future company performance, it relies on the questionable assumption that the future effects of tax reforms correspond to the effects that would have resulted had the reform been implemented in the past. We, therefore, employ a forward-looking method that uses forecasting techniques to derive a fair representation of future company performance. This outlook appears to us to offer a superior basis for assessing the potential effects of future tax reforms. Additionally, forward-looking methods facilitate the incorporation of behavioral responses to tax reforms, since they do not have to be incorporated in already realized data.

Based on these considerations, our micro-simulation model, ASSERT, is designed to capture the taxation of corporations in 19 European member states. It is intended to evaluate the impact of corporate tax reforms proposed at the EU level and to take into account the indirect internation effects of domestic tax reforms. ASSERT takes into account only the key tax regulations with respect to the tax base determination, i. e., tax depreciation, tax treatment of corporate dividends and inter-period and intra-group loss-offsets. Furthermore, in our model, tax liability is determined based on forecasts of future earnings, enabling us to predict changes in future tax revenue and to incorporate business responses to tax reforms.

2 General approach and underlying data

2.1 General approach

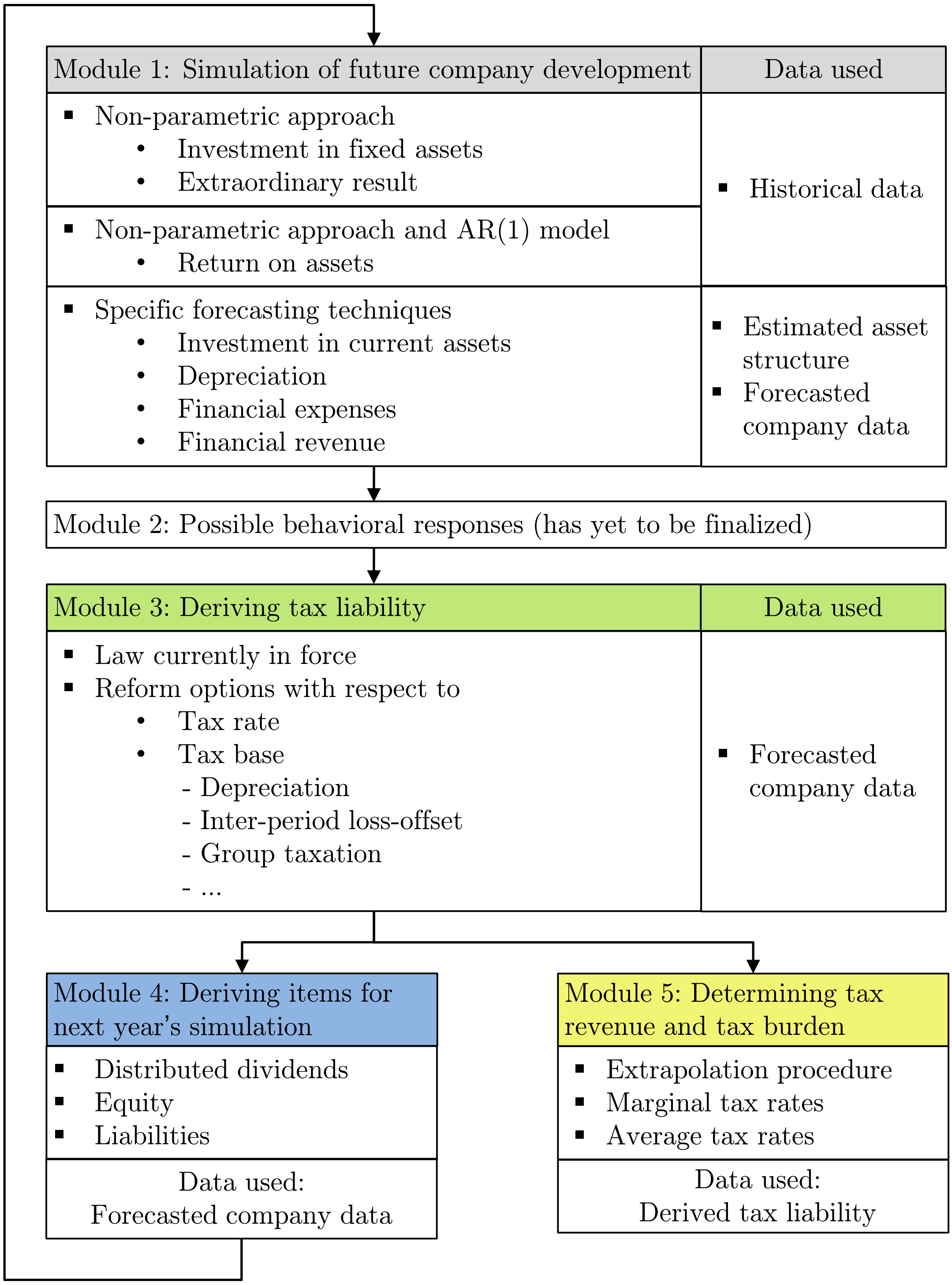
The micro-simulation model ASSERT is built upon five integrated modules covering (1) the simulation of future company development, (2) the possible behavioral responses of companies, (3) the determination of tax liability, (4) the derivation of items for next year's simulation and (5) the assessment of the possible tax outcomes for fiscal authorities and businesses. Our starting point is a set of financial company data that are taken from databases provided by the service company Bureau van Dijk. Application of comprehensive data preparation and data transformation procedures, which are described in detail in Annex 1, yields the dataset that is described in Section 2.2.

The first module of ASSERT translates the historical data into a forecast of future company development over a period of four years. The forecast is primarily based on a non-parametric simulation approach following the procedure applied by Blouin et al., 2010. The second module accounts for possible behavioral responses (this module has yet to be finalized), and the third module translates the forecasted earnings into tax liability. To this end, our model is capable of deriving tax liability both under the law that is currently in force and under possible reform scenarios. In the fourth model, items necessary for the next year's simulation are determined.

Finally, the fifth module is designed to derive aggregate outcomes from the perspectives of both businesses and the fiscal authorities. The module computes company tax burdens and extrapolates the possible consequences for tax revenue.

Figure 1 outlines the basic structure of our model. The functionality of the different modules is described in detail in the following sections.

Figure 1: Structure of the micro-simulation model ASSERT



Source: Own diagram.

2.2 Data requirements and structure of the data

The objectives of our micro-simulation model set out above imply that we have certain data requirements, which are outlined briefly in the current section. Ideally, we would model ASSERT to draw on a European panel of company micro-data that includes original tax data. This is not feasible, however, since access to confidential tax data is strongly restricted in most member states. Therefore, we rely on the information that is contained in publicly available, unconsolidated financial statements for European corporations, which is made available by Bureau van Dijk.

The simulation procedure requires data for (a) companies for which the forecasting procedure is carried out and (b) comparable enterprises whose past development is applied for forecasting purposes. Information on the companies that are selected for the simulation process is required for one or two years prior to the simulation period, depending on the variable. In particular, the following items of information are required and taken up in our dataset:

(1) Industry sector classification: Information is necessary to calculate certain undisclosed data, which we assume to depend on the industry sector, e. g., the asset structure.

(2) Shareholding information and group structure: Determining dividend flows, which are tax exempt in most countries, requires information on direct shareholdings. Knowledge of corporate group structures is necessary, in particular, to take into account the tax consequences of group taxation regimes.

(3) Structure of assets: An accurate estimation of tax depreciation necessitates detailed knowledge of the structure of assets, with respect to both the type of asset and the year of acquisition. To this end, our dataset distinguishes between intangible fixed assets (with the subordinated items patents and goodwill), tangible fixed assets (with the subordinated items land, buildings and machinery), other fixed assets (with the subordinated items shares and interest-bearing securities) and current assets. For each of the different types of fixed assets, our dataset includes detailed information on the amount acquired in each year.

(4) Structure of equity and liabilities: Information on the structure of equity and liabilities is required as a starting point to determine future interest and dividend flows. In particular, our dataset incorporates equity (with the subordinated items capital and other shareholders' funds) and liabilities.

(5) Profit situation: Forecast of future profits requires information on the profit situation in the preceding year. In particular, our dataset includes EBITDA (earnings before interest, taxes, depreciation and amortization).

(6) Company-specific interest rates: To forecast financial revenue and financial expenses, company-specific credit and debt interest rates are determined. Our dataset includes the ratio of interest revenue to interest-bearing securities and the ratio of interest expenses to average liabilities.

(7) Loss carry-forwards: To be able to apply tax regulations for inter-period loss-offset, our dataset includes the amount of tax loss carry-forwards for each company at the beginning of the simulation period.

(8) Items required for the simulation of possible tax reforms: In addition, our dataset includes information that is required for the simulation of possible tax reforms. To simulate the tax consequences of a CCCTB, for example, we add sales, cost of employees and number of employees to our dataset.

The information that is required for the comparable enterprises that are used to forecast the future development of the simulation companies differs from that listed above with regard to both the items themselves and the reference period. For these companies, information for the eight years prior to the simulation period is required. Our dataset consists of the following items of information:

(1) Assets: Information on assets for comparable companies is restricted to the book values of total assets, fixed assets and other fixed assets.

(2) Profit situation: With regard to the profit situation, our dataset includes, similarly to the dataset for the companies that are included in our simulation, EBITDA, defined as operating profit/loss plus depreciation.

(3) Extraordinary result: In contrast to the dataset of simulation companies, our dataset of comparable companies includes information on the extraordinary result.

(4) Items required for the simulation of possible tax reforms: Similar to the dataset of simulation companies, our dataset of comparable enterprises incorporates information that is required for the simulation of possible tax reforms (e. g., sales, number of employees and cost of employees).

2.3 Definitions and notations

In this section, we present the most important definitions and notations that are used throughout this paper. As in standard mathematical and econometric text books, Δ refers to the change of a variable from year t-1 to year t, μ denotes the mean value, and σ represents the standard deviation. With regard to regression equations, β denotes the regression coefficient, and ϵ denotes the regression residuals. In addition, the following indexes are applied in the remainder of the paper:

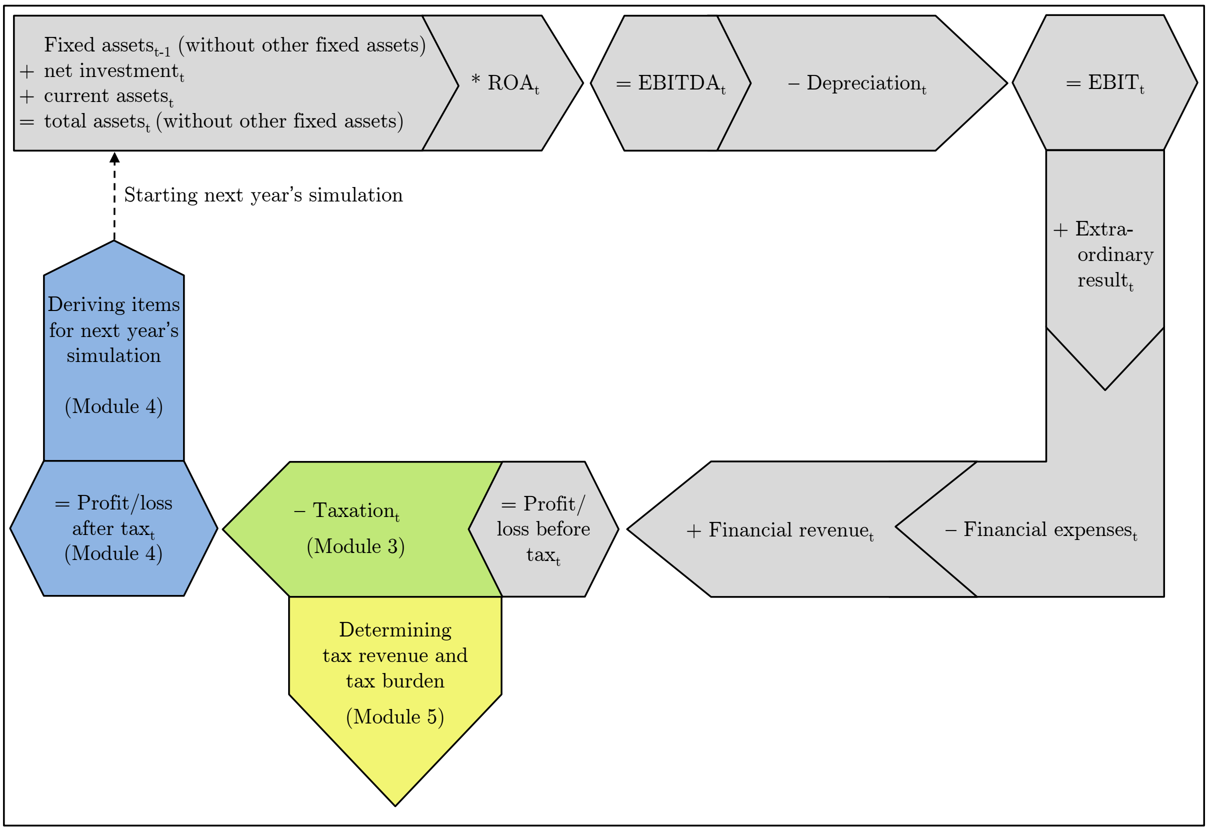
Indexes	
a	Asset type index
c	Country index
i	Company index
t	Year index referring to simulation years (i. e., years with no historical data available)
x	Year index referring to years in the past (i. e., years for which historical data are available)
fy	Index referring to the 'first year' with historical data available
ly	Index referring to the 'last year' with historical data available

3 Module 1: Simulation of future company development

3.1 Structure of the module

The general structure of Module 1 and its interaction with the other modules is illustrated in Figure 2. The forecasting process starts with the forecast of net investment, which is used to determine both current and total assets. In a second step, return on assets is forecasted and multiplied by total assets (without other fixed assets), as determined in the first step to derive EBITDA. The third step consists of deducting depreciation and hence calculating EBIT. To derive profit/loss before tax, EBIT is complemented by the extraordinary result, and financial expenses (revenue) are deducted (added). The resultant data form the basis of Module 3, where tax liability is assessed, and, subsequent to this calculation, of Module 5, which determines the tax revenue and tax burden. In addition, after estimating profit/loss before tax, the data are further processed in Module 4 to derive the required input data for next year's simulation. To this end, distributed dividends, equity and liabilities are determined, before the simulation of next year's development starts. The applied forecasting procedures for the corresponding items of Module 1 are described in detail below, following the structure of Figure 2.

Figure 2: Simplified structure of Module 1



Source: Own diagram.

3.2 Forecasting procedures

3.2.1 Forecasting approaches suggested by the literature

Two parametric approaches and one non-parametric approach to forecasting earnings are currently a matter of debate in tax literature. Shevlin, 1990, Graham, 1996a and Graham, 1996b, use a random-walk approach to forecast earnings, assuming that a corporation's taxable income follows a random walk with drift. The random-walk approach incorporates a company-specific mean and standard deviation of changes in taxable income that are both held constant over time. Because companies' assets are (on average) expected to grow over time, this company-specific stationarity may underestimate the standard deviation of changes in taxable income (see also Blouin et al., 2010), which is expected to correlate positively with the companies' assets. In addition, previous research documents that earnings, or profitability, are mean reverting (see, for example, Fama & French, 2000), which is not accounted for in the random-walk approach.

A second approach to forecasting earnings is introduced by Graham & Kim, 2009. They presume that part of a corporation's change in return can be explained by the previous year's return, leading the authors to estimate return on assets by using a first-order autoregression model. The autoregressive approach allows for mean reversion and incorporates company-specific information (at least with regard to corporations where a minimum of four historic firm-year observations is available). Nevertheless, with this approach, the problem of stationarity with regard to a single company also arises.

In contrast, Blouin et al., 2010, apply a non-parametric approach (hereinafter referred to as the bin approach). They assume that the best forecast for a corporation's future development is the past development of comparable corporations. The bin approach implicitly allows for mean reversion and is stationary only with regard to the composition of bins and not with regard to the development of single companies. However, as the bins are held constant over time, the underlying economic development is the same over the whole forecasting period. Furthermore, Graham & Kim, 2009, point out that the bin approach ignores company-specific information that is relevant to income forecasting by treating all companies in a given bin identically.

Thus far, the literature has not demonstrated conclusively which approach is most suitable for forecasting taxable income. We therefore apply both a slightly modified bin approach and an autoregressive model. In order to forecast return on assets as described in Section 3.2.4, we apply a combination of the bin approach and an autoregressive model. Since the bin approach enables us to forecast not only return on assets but also other balance sheet or income statement items that are required for determining tax liability, we use this approach to forecast investment in fixed asset and the extraordinary result (for a detailed description of the approach, see Section 3.2.2). Investment in current assets, depreciation, financial expenses and financial revenue are determined based on company-specific information on the asset structure and other (forecasted) company data.

3.2.2 Investment in tangible and intangible fixed assets

3.2.2.1 Formation of performance-size bins To forecast investment, we apply a slightly modified version of the bin approach.[1] In a first step, we generate country-specific, performance-size bins that are held constant over the simulation period. The choice of cluster variables is based on the findings of Blouin et al., 2010, as well as our own calculations demonstrating that investment and return on assets depend in particular on prior-year performance and company size. In contrast, a company's industry and other company characteristics have only a minor influence on performance (see also Fairfield et al., 2009, with regard to the impact of industry

[1]The same approach is also applied to forecast sales, number of employees and cost of employees.

on company profitability).

In building these bins, we consider all three-year datasets that are available for corporations throughout the last eight years of our historical data.[2] To qualify as a three-year dataset, the following information must be available for three consecutive years: (1) the balance sheet items total assets, fixed assets and other fixed assets; (2) the income statement items operating profit/loss and depreciation; (3) extraordinary profit/loss; and (4) the additional items sales, number of employees and cost of employees. In the following analysis, we refer to the first of these three periods as x-2, the middle period as x-1 and the most recent period as x. Corporations with more than one available three-year dataset for the period under scrutiny may enter the data collection with more than one observation.

Based on the available information, we determine total assets and return on assets for years x and x-1 for each of the three-year datasets that are considered. To this end, return on assets (roa) is defined as follows:

$$roa_x = \max\left[-2; \frac{opl_x + depreciation_x}{(ta_x - ofa_x)\cdot 0.5 + (ta_{x-1} - ofa_{x-1})\cdot 0.5}\right] \tag{1}$$

where *opl* is operating profit/loss, ta is total assets and ofa refers to other fixed assets. Restricting return on assets to a minimum of negative two is based on the notion that more negative values may result from accounting errors.

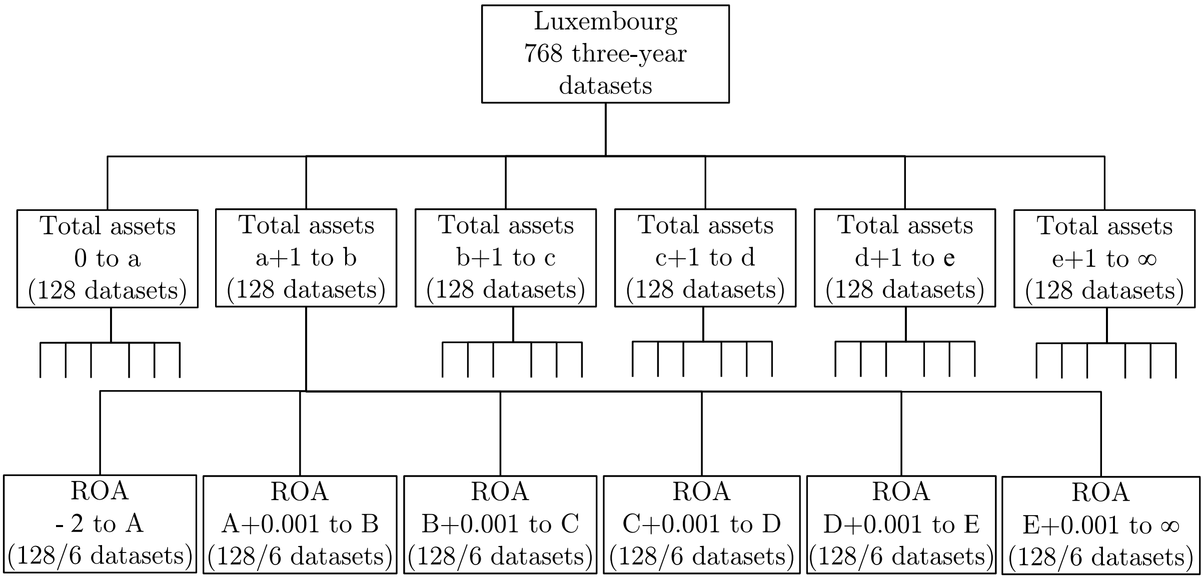
The universe of all three-year datasets is clustered according to the size (level one) and performance (level two) of the companies, determined as total assets and return on assets, respectively, in year x-1 (formation of equal-sized performance-size bins). This procedure is carried out per country and in such a way as to ensure that each bin contains approximately twenty three-year datasets (i. e., the number of bins per country is derived from the total number of available three-year datasets). The following example and Figure 3 show each of the calculations, with Luxembourg serving as an example:

- 768 three-year datasets are available for Luxembourg
- approximately 38 ($= \frac{768}{20}$) performance-size bins are needed
- $\sqrt{38} = 6.16$ bins per level

[2]Note that the approach that is applied here differs from the one proposed by Blouin et al., 2010, in that observations from different years are considered. In our opinion, using observations from different periods to define the bins has the advantage of allowing different economic environments to be considered.

- there are six groups on level one with 128 ($=\frac{768}{6}$) three-year datasets each and 36 groups at level two with approximately 21 ($=\frac{128}{6}$) three-year datasets each

Figure 3: Formation of performance-size bins



Source: Own diagram.

For each member state, we require a minimum of nine bins (three groups at the first level and nine groups at the second level). Therefore, all countries with less than 180 ($= 9 \cdot 20$) three-year datasets are excluded from our simulation.

To forecast future company development, we determine the change of net investment from year x-1 to year x (Δinv_x) for each bin company according to the following equation:

$$\Delta inv_x = inv_x - inv_{x-1} \tag{2}$$

$$\text{with } inv_x = (fa_x - ofa_x) \; - \; (fa_{x-1} - ofa_{x-1}) \tag{3}$$

where fa and ofa refer to the book value of fixed and other fixed assets, respectively. Δinv is condensed by determining the median values across all companies per bin. The median values form the basis for forecasting future company development of the companies in the sample, as described in the following section.

3.2.2.2 Forecasting based on the bins' development in the past The basic assumption underlying our forecasting procedure is that the best forecast of a company's next year development is the average development of comparable companies in the past. To simulate a company's development in year t, we therefore assign each company to the relevant performance-size bin, as determined in the previous section (based on total assets and return on assets for year t-1). We forecast company development over a period of four years. In this respect, in the following sections, the first simulated year is denoted as $first\ sim\ year$ and the last simulated year is denoted as $last\ sim\ year$, meaning that the allocation procedure is repeated for each $t \in [first\ sim\ year;\ last\ sim\ year]$. In doing so, we follow Blouin et al., 2010, by holding the bins constant over time. In contrast to their study, however, we include observations from different periods in the bins and therefore do not rely on the economic development of one specific year for our forecast.

Based on this allocation, we use the median values reflecting each bin's development from year x-1 to year x (determined as described in the previous section) to forecast the net investment of sample company i in year t ($\widehat{inv}_{i,\,t}$). The following equation formally describes this procedure:

$$\widehat{inv}_{i,\,t} = inv_{i,\,t-1} + \text{median}(\Delta inv^{bin}) \tag{4}$$

3.2.2.3 Derivation of gross investment and apportionment to different asset types

In order to determine the amount and structure of new investments, i. e., the distribution among the different types of assets (patents and goodwill in the case of intangibles; land, buildings and machinery in the case of tangibles), we derive gross investment by totaling overall net investment, as determined in the previous section, and overall current-year economic depreciation. To apportion gross investment to different asset types, we distinguish between three different cases:

(a) If gross investment in tangible and intangible fixed assets is positive and exceeds the amount of current-year economic depreciation of the existing assets, investments are allocated in a first step to each type of asset in the corresponding amount of economic depreciation. The remaining net investment is attributed proportionally to the acquisition costs of existing assets of each type.

(b) If gross investment is positive but smaller than the amount of current-year economic depreciation of the existing assets, gross investment is attributed to the different types of assets in proportion to their amount of current-year economic depreciation.

(c) If gross investment is negative, all asset-type/asset-age classes are reduced in proportion to their acquisition costs.

Investments are assumed to be carried out at the end of the corresponding fiscal year.

3.2.3 Investment in other fixed assets and current assets and determination of total assets

Total assets are defined as the total of tangible and intangible fixed assets, other fixed assets and current assets. Application of the bin approach yields a forecast of current-year net investment in tangible and intangible fixed assets ($\widehat{inv}_{i,\,t}$), which is allocated to the different asset types, as described in the previous section. The book value of current-year tangible (tfa) and intangible fixed assets (ifa) is determined as follows:

$$tfa_{i,\,t} + ifa_{i,\,t} = tfa_{i,\,t-1} + ifa_{i,\,t-1} + \widehat{inv}_{i,\,t} \tag{5}$$

The bin approach's prediction of (net) investments in tangible and intangible fixed assets also forms the basis for determining other fixed assets. In this respect, we assume that investments in other fixed assets are carried out in proportion to investments in tangible and intangible fixed assets. However, we assume that shares held in other companies are constant over time, meaning that changes in the book value of other fixed assets refer exclusively to interest-bearing securities.

Current assets of year t are defined as current assets in year t-1 multiplied by a company-specific growth rate. The growth rate is the minimum of the growth factor as defined below (GF_i) and the growth of fixed assets in the current year. In particular, current assets of company i in year t are defined as follows (fa refers to fixed assets without financial fixed assets):

$$current\ assets_{i,\,t} = current\ assets_{i,\,t-1} \cdot \min\left(GF_i;\ \frac{fa_{i,\,t} - fa_{i,\,t-1}}{fa_{i,\,t-1}} + 1\right) \tag{6}$$

$$\text{with } 1 \leq GF_i \leq 5 \tag{7}$$

The constant, company-specific growth factor is based on the compound annual growth rate (the geometric mean) in the past and is applied in different modules of the model, where it is limited to certain maximum values depending on the area of application. The growth factor of company i is determined according to the following equation (as above, fa refers to fixed assets without financial fixed assets):

$$growth\ factor_i = GF_i = \left[\frac{fa_{i,\,ly}}{fa_{i,\,fy}}\right]^{\frac{1}{ly-fy}} \tag{8}$$

3.2.4 Return on assets and determination of EBITDA

To forecast return on assets, we apply a combination of the bin approach and an autoregressive model. In a first step, return on assets is forecasted using the bin approach, similar to the procedure described above. For each of the companies in the bins, the change in return on assets (Δroa) from year x-1 to year x is determined according to the following equation:

$$\Delta roa_x = \frac{roa_x - roa_{x-1}}{roa_{x-1}} \tag{9}$$

The resultant variables are condensed by determining the median values and standard deviations across all companies per bin.[3] After allocating each simulation company to a specific bin based on its total assets and return on assets in year t-1, return on assets is forecasted under uncertainty by applying a Monte Carlo simulation (50 iterations) based on the median and standard deviation determined for the corresponding bin.[4] The forecasting procedure follows Equations 10 and 11 below.

$$\widehat{roa}_{i,\,t} = roa_{i,\,t-1} \cdot (1 + \widehat{\Delta roa}^{bin}) \tag{10}$$

$$\text{with } \widehat{\Delta roa}^{bin} \overset{iid}{\sim} \mathcal{N}(\text{median}(roa^{bin}); \sigma^2(roa^{bin})) \tag{11}$$

In a second step, return on assets is forecasted using an autoregressive approach. To this end, we estimate the following regression equation:

$$roa_{i,\,t} = \mu_i + \rho_i \cdot roa_{i,\,t-1} + \beta_i \cdot GDP_t + \epsilon_{i,\,t} \tag{12}$$

$$\text{with } \epsilon \overset{iid}{\sim} \mathcal{N}(0; \sigma_i^2) \tag{13}$$

In this respect, μ_i is the drift, ρ_i is the autoregressive parameter, β_i is the regression coefficient of GDP and $\epsilon_{i,\,t}$ are the residuals. To determine the regression coefficients, all available historic observations are taken into account. Equation 12 is estimated for each company and for panels of firm-year observations (cluster), which are formed by using six income classes (two for loss-making companies and four for profitable companies) and 13 industry classes, meaning that we estimate μ, ρ, β and ϵ for a total of 78 different bins. In order to preserve the micro-analytic character of our simulation to the greatest extent possible, the coefficients resulting from the

[3] For bins that include observations with previous year's *roa* close to zero, we refer to the absolute instead of the relative change to avoid influential outliers.

[4] To determine the standard deviation, we drop influential outliers.

cluster-specific regressions are (only) applied if either the number of observations per company is smaller than four or at least one of the following conditions is met for the company-specific regression: $|\rho_i| > 0.8$, $\sigma_i^2 > 0.8$ or $\mu_i/(1-\rho_i) > 0.6$. In applying these criteria, we generally follow Graham & Kim, 2009. Employing the estimated regression coefficients, we define return on assets as follows:

$$\widehat{roa}_{i,\,t} = \mu_i + \rho_i \cdot roa_{i,\,t-1} + \beta_i \cdot GDP_t + rn \cdot \sigma(\epsilon_{i,\,t}) \tag{14}$$

$$\text{with } rn \overset{iid}{\sim} \mathcal{N}(0;1) \tag{15}$$

As with the bin approach, a Monte Carlo simulation with 50 iterations is applied; rn is a standard normally-distributed random number between zero and one.

In a last step, the two forecasts of return on assets (one resulting from the bin approach and one resulting from the AR(1) approach) are combined. In cases in which the coefficient β of Equation 12 is statistically significant, at least at the 20 percent level, we use the mean value of the two estimates and employ an additional country-specific modification to account for the general economic development. If GDP exerts no significant influence, we rely exclusively on the value that is forecasted by the bin approach.

EBITDA is derived by multiplying return on assets by the forecasted value of total assets without financial fixed assets.

3.2.5 Depreciation

Depreciation is calculated based on the company-specific structure of depreciable assets, which are clustered with respect to the asset type (we differentiate between land, buildings, machinery, goodwill and patents) and the acquisition year. In determining depreciation expense, we assume book depreciation to equal tax depreciation. To this end, depreciation rates are derived and applied for each of the asset-type/asset-age clusters, thereby taking into account country-specific tax depreciation regulations regarding the depreciation method (straight-line method versus declining-balance method) and the asset's useful life. For each asset type, the depreciation rate is determined by assuming acquisition costs of 100 and calculating the corresponding depreciation expense for every year of the asset's useful life. For each year of the asset's useful life, the depreciation rate is defined as the ratio of depreciation expense to the acquisition costs. Hence, for a declining balance depreciation of 30 percent, the depreciation rate amounts to 0.3 (=30/100) in the first year, 0.21 (=21/100) in second year and so forth.

Company-specific depreciation expense is then determined as the total of all products of an asset cluster and depreciation rate, where an asset cluster includes the acquisition costs of all assets of type a that were acquired in year x of the assets' useful life. Equation 16 illustrates the determination of tax depreciation, where X refers to the useful life of the different asset types.

$$depreciation_{i,\,t} = \sum_{a=1}^{5}\sum_{x=1}^{X} acquisition\ costs_{i,\,a,\,x} \cdot depreciation\ rate_{a,\,x} \tag{16}$$

3.2.6 Extraordinary result

The extraordinary result is forecasted under uncertainty, applying a Monte Carlo simulation with 50 iterations. To this end, we define the bins as described above and allocate the simulation companies to these bins. To determine whether the extraordinary result of a simulation company differs from zero, we draw a uniformly distributed random number between zero and one for each company. This random number is compared to the percentage of companies in the corresponding bin that report an extraordinary profit or loss that is different from zero. In cases in which the random number is larger than this percentage, an extraordinary result of zero is assumed. In cases in which the random number is smaller, the amount of the extraordinary result (epl) is determined according to the following equations:

$$epl_{i,\,t} = \Big(\mu(epl^{bin}) + rn \cdot \sigma(epl^{bin})\Big) \cdot (ta_t - ofa_t + ta_{t-1} - ofa_{t-1})/2 \tag{17}$$

$$\text{with } \; epl^{bin} = \frac{epl_t}{(ta_t - ofa_t + ta_{t-1} - ofa_{t-1})/2} \qquad \text{and} \qquad rn \overset{iid}{\sim} \mathcal{N}(0,1) \tag{18}$$

As above, rn is a standard normally-distributed random number, and ta (ofa) denotes total assets (other fixed assets).

3.2.7 Financial expenses

Regarding financial expenses, we distinguish between interest expenses and other tax-deductible financial expenses, which may comprise, for example, amortization on financial assets. Our forecast of interest expenses relies on the notion that interest is charged on long- and short-term debt (liabilities), reported, on average, at the beginning and end of the financial year. Liabilities are derived as a residual item of the simulation process by deducting equity from total assets. However, forecasting equity refers to the after-tax profit and thus necessitates an assessment of financial expenses (see Section 6). Because of this circular reference, we are not able to use current-year liabilities to predict financial expenses. We account for this by adjusting the previous year's liabilities by a company-specific growth factor (GF, as defined in Equation 8), which is limited here to a value of 1.5.

The applicable debt interest rate is determined for each company based on items reported on the company's balance sheets and income statements in the past. It is defined as the ratio of interest paid to average liabilities in the two years prior to the simulation. To control for the general development of debt interest rates in the company's residence country, the company-specific interest rate is adjusted in two different ways, and we apply the maximum of the two resultant interest rates. The two interest rates are denoted by $ir1$ and $ir2$ and are defined according to Equations 19 and 20. Both interest rates are limited to 200 percent to mitigate a distortion of the results attributable to influential outliers; cir refers to the country-specific debt interest rate for corporations.[5]

$$ir1 = \min\left[2; \frac{interest\ paid_{ly}}{(liabilities_{ly} + liabilities_{ly-1})/2} - (cir_{ly} - cir_t)\right] \tag{19}$$

$$ir2 = \min\left[2; \frac{interest\ paid_{ly}}{(liabilities_{ly} + liabilities_{ly-1})/2} \cdot \frac{cir_t}{cir_{ly}}\right] \tag{20}$$

The determination of interest expenses is expressed in Equation 21:

$$interest\ expenses_t = \left[liabilities_{t-1} \cdot (1 + GF_i)\right]/2 \cdot \max(ir1; ir2) \tag{21}$$

To estimate other financial expenses, we determine the proportion of years in which overall financial expenses exceed interest paid, based on financial statements reported by the companies in the past. This share is compared to a company-specific, uniformly distributed, random number between zero and one. If this random number is smaller than the derived proportion, we calculate other financial expenses for the company as follows: First, we calculate the average company-specific ratio of the difference between financial expenses and interest paid to liabilities. This ratio is calculated from historical data and refers only to years in which $financial\ expenses > interest\ paid$. Second, this ratio is multiplied by the previous year's liabilities. Equation 22

[5]Country-specific debt interest rates are primarily taken from EUROSTAT. When interest rates were not available from EUROSTAT, the web pages of national central banks served as a data source.

formally expresses the determination of other financial expenses (ofe):

$$ofe = \sum_{t=fy+1}^{ly} \frac{financial\ expenses_t - interest\ paid_t}{(liabilities_t + liabilities_{t-1})/2} / (ly - (fy+1)) \cdot liabilities_{t-1} \tag{22}$$

3.2.8 Financial revenue

With regard to financial revenue, we differentiate (based on the structure of other fixed assets) between interest and dividend income.[6] To forecast interest income, we distinguish between companies with other fixed assets that are larger than zero and companies without other fixed assets in the current year.

For companies without other fixed assets, we determine the ratio of financial revenue to average total assets based on the last available financial statement and multiply this ratio by average total assets (ta). The resultant determination of financial revenue is expressed in Equation 23. Given that other fixed assets are equal to zero for some firms, these firms do not hold shares in other companies and therefore do not receive dividends. Financial revenue for these companies then consists only of interest income:

$$interest\ revenue_t = financial\ revenue_t = \frac{financial\ revenue_{ly}}{(ta_{ly} + ta_{ly-1})/2} \cdot (ta_t + ta_{t-1})/2 \tag{23}$$

For companies with other fixed assets that are larger than zero, interest income is determined as the difference between other fixed assets and shareholdings (i. e., equity investments), multiplied by a company-specific interest rate. The interest rate is derived from the last available financial statement and is determined as interest income divided by debt investments (i. e., the difference between other fixed assets and shareholdings). The determination of interest income for these companies is expressed by the following equation (as above, ofa refers to other fixed assets):

$$interest\ revenue_t = (ofa_{t-1} - shareholdings_{t-1}) \cdot \frac{financial\ revenue_{ly} - dividends_{ly}}{ofa_{ly} - shareholdings_{ly}} \tag{24}$$

Dividends received are determined by multiplying the dividends that the subsidiary dis-

[6] Profits received from partnerships are disregarded because ASSERT is limited to the taxation of corporate income. Because partnerships account for only 4.62 percent of all subsidiaries that are included in our data, this assumption should not affect our results to any significant extent. In the case of cross-shareholdings, circular calculations may arise. We therefore assume that distributions of the company holding the smaller share are zero. If both companies hold the same share, zero distributions are assumed for both companies.

tributed by the corresponding parent company's shares. To this end, distributed dividends are calculated as described in the next section.

However, because ASSERT does not provide a full coverage of subsidiaries, the dividends that are estimated by this direct approach are likely to underestimate the dividends that are actually received. We account for this by adding a so-called "baseline dividend" in specific cases. As will be described in Section 10.3.2, dividend distributions for the pre-simulation period are determined by applying an indirect approach, which avoids this underestimation of received dividends. We therefore determine received dividends for the last year with available historical data (ly) using both the indirect approach ($div^{ind}_{i,\,ly}$; see Section 10.3.2) and the direct approach ($div^{dir}_{i,\,ly}$; see above). If positive, the difference between indirectly and directly calculated dividends is the "baseline dividend" for company i. The "baseline-dividend" increases the received dividends of company i in every simulation year and is adjusted for the general economic development according to the following equation (gdp is the gross domestic product growth):

$$base\ dividend_{i,\,t} = \max\left[0; div^{ind}_{i,\,ly} - div^{dir}_{i,\,ly}\right] \cdot \left(1 + \frac{gdp_{t-1} + gdp_t}{2} - \frac{gdp_{ly-1} + gdp_{ly}}{2}\right) \tag{25}$$

4 Module 2: Possible behavioral responses

The second module accounts for possible behavioral responses. This module has yet to be finalized and aims to determine company responses to changes in tax regulations. In particular, companies may adjust their capital structure and their investment behavior in response to tax reforms. However, since the micro-simulation model is based on data for existing corporations, it will not be possible to account for decisions with regard to legal form, which may also be influenced by taxation.

5 Module 3: Deriving tax liability

5.1 Tax liability under law in force

5.1.1 General approach

The tax liability of company i in year t is determined according to the following general equation:

$$Tax_{i,\,t} \;=\; \tau_{c(i),\,t} \cdot \overbrace{(\overbrace{\overbrace{plbt_{i,\,t} - \textit{tax-free dividends}_{i,\,t}}^{inc1_{i,\,t}} + gt_{i,\,t}}^{inc2_{i,\,t}} + \textit{loss-offset}_{i,\,t}}^{inc3_{i,\,t}}) \tag{26}$$

where $\tau_{c,\,t}$ is the statutory tax rate in country c and year t, $plbt_{i,\,t}$ is profit/loss before taxation, as derived in Module 1, $gt_{i,\,t}$ represents increases or decreases in income resulting from an applicable group taxation regime and $\textit{loss-offset}_{i,\,t}$ denotes the consequences of inter-period loss-offset, if available. We refer to *plbt* as a starting point, because this item already accounts for tax depreciation, as described in Section 3.2.5. As shown by the brackets above Equation 26, *inc*1 refers to profit/loss before tax less tax-free dividends, *inc*2 is taxable income before loss-offset, and *inc*3 refers to taxable income after loss-offset. The determination of tax-free dividends and the implementation of group taxation regulations and inter-period loss-offset provisions are described in detail in the following sections.

5.1.2 Determination of tax-free dividends

Financial revenue (and therefore also profit/loss before tax) comprises both interest revenue and received dividends. Thus, it is necessary to deduct tax-free dividends from profit/loss before tax to derive taxable income. As distributed dividends can only be determined *after* tax liability is derived, we base our determination of received (and tax-free) dividends on the previous year's distributions to avoid circular references. We therefore assume that dividends that are distributed at the end of the year are received at the beginning of the next year.

In determining tax-free dividends, we refer to the regulations that are currently prevailing in the different EU member states. However, in the case of "baseline dividends" (see Section 3.2.8), we are not able to identify the dividend's country of origin, making it impossible to determine the amount of a potential tax credit. We therefore assume, for the purpose of our simulation, that the consequences of a tax credit are equal to a 100-percent tax exemption if tax law provides for a full tax credit for (domestic or foreign) taxes on distributed profits. This simplifying assumption affects tax liability only in cases in which the tax rate in the dividend's country of origin is smaller than the tax rate in the country of destination. Otherwise, the use of exemption method and the use of credit method result in the same tax payments. Potentially resulting inaccuracies should therefore not affect our results to any significant extent.

5.1.3 Group taxation

5.1.3.1 Application requirements Currently, 18 out of the EU 28 member states provide for special regulations regarding the taxation of corporate groups. In determining whether a group taxation regime applies, we assume that companies opt to apply the regime whenever the relevant legal requirements are met. These requirements include a minimum holding condition, the threshold of which ranges between 50 percent and 95 percent. Further cross-country differences arise depending on whether indirect shareholdings are considered and how they are determined (on an additive or multiplicative basis). These regulations are considered in our model.

The German tax group regulation ("Organschaft") differs from the regimes that are codified in other European member states insofar as a profit-and-loss transfer agreement is a prerequisite for the formation of a tax group (a similar requirement was also applied in Austria until 2005). The existence of a profit-and-loss transfer agreement can be observed in our data, as the related transfers of profits and losses are reported in the subsidiary's profit and loss statement as extraordinary income. Thus, we assume that an "Organschaft" exists if both the relevant minimum participation requirement is met and the profit/loss of a subsidiary is transferred completely to its parent company (i. e., the subsidiary reports a profit/loss for period of zero, whereas the profit/loss after tax is different from zero).

5.1.3.2 Tax consequences Codified group taxation regimes also differ with regard to the tax consequences. All available systems provide for an intra-group loss-offset, whereas some member states additionally allow for a full or partial elimination of profits from intra-group transactions. As our data do not include any information on these transactions, we cannot take the latter consequences into account, meaning that the consideration of group taxation regimes in ASSERT is limited to the offset of losses. In this respect, the available regimes can be classified into the following three types: pooling onto parent, group contribution and group relief.

In the case of pooling onto parent, the income of the subsidiaries is attributed to and taxed at the level of the parent company, as expressed by Equations 27 and 28. gt_t stands for the amount that must be added/deducted from the parent's or subsidiary's taxable income as a consequence of applying the group taxation regime. The term $inc1_{i,\,t}$ refers to the preliminary taxable income (profit/loss before taxation less the tax-free dividends of company i in year t, as also noted in Equation 26), whereas $\sum_{i=1}^{n} inc1_{i,\,t}$ refers to the preliminary definition of taxable income of all companies i belonging to a common tax group k (including the parent company). $inc1_{p,\,t}$ is the preliminary taxable income of the parent company. For Germany, it is additionally taken into account that the transfer of income for tax purposes is accompanied by a transfer of cash in the same amount.

$$\text{Parent company: } gt_t = \sum_{i=1}^{n} inc1_{i,\,t} - inc1_{p,\,t} \tag{27}$$

$$\text{Subsidiary: } gt_t = inc1_{i,\,t} \cdot (-1) \tag{28}$$

In case of the group-relief and group-contribution systems, all results of a tax group are aggregated and proportionally divided between the group members. If an overall loss is incurred, it will be shared only by the loss-making companies. Similarly, overall profits are only shared by the profitable companies. The tax consequences of the group-relief system are determined based on the following set of equations. The term $inc1_{i,\,t}$ refers to the preliminary taxable income of company i in year t, whereas $inc1_{k+,\,t}$ ($inc1_{k-,\,t}$) refers to the overall positive (negative) preliminary taxable income of all n companies i belonging as a subsidiary or parent to a common tax group k. The term $gt_{i,\,t}$ denotes the amount that must be added/deducted from company i's preliminary taxable income in order to account for the effects of the group-relief or group-contribution system. For countries that apply the group-contribution system, it is additionally taken into account that the transfer of income for tax purposes is accompanied by a transfer of cash in the same amount.

$$inc1_{k+,\,t} = \sum_{i=1}^{n} \max(inc1_i; 0) \tag{29}$$

$$inc1_{k-,\,t} = \sum_{i=1}^{n} \min(inc1_i; 0) \tag{30}$$

$$\text{if } inc1_{k+,\,t} \geq -inc1_{k-,\,t}: \quad gt_{i,\,t} = \max\left(\frac{inc1_{i,\,t}}{inc1_{k+,\,t}}; 0\right) \cdot (inc1_{k+,\,t} + inc1_{k-,\,t}) - inc1_{i,\,t} \tag{31}$$

$$\text{if } inc1_{k+,\,t} < -inc1_{k-,\,t}: \quad gt_{i,\,t} = \max\left(\frac{inc1_{i,\,t}}{inc1_{k-,\,t}}; 0\right) \cdot (inc1_{k+,\,t} + inc1_{k-,\,t}) - inc1_{i,\,t} \tag{32}$$

5.1.4 Inter-period loss-offset

In determining the consequences of inter-period loss-offset, we take into account the general availability of loss carry-forward and carry-back as well as restrictions with regard to time or amount, if applicable in the member state. Equations 33 to 35 express the incorporation of loss-offset regulations into our calculation of taxable income in an exemplary manner. We differentiate between years with negative (i. e., a loss carry-back may apply) and positive taxable income before loss-offset (i. e., existing loss carry-forwards may be used). $inc2_{i,\,t}$ denotes taxable income before loss-offset (i. e., profit/loss for before taxation less tax-free dividends, considering the group taxation system), $inc3_{i,\,t}$ refers to taxable income after loss-offset (see also Equation 26), *limit* is the amount that the loss carry-forward/carry-back is restricted to and $lcf_{i,\,t}$ denotes the amount of existing tax loss carry-forwards of company i in year t. For the loss-offset regulations that are most commonly applied in the EU member states, *loss-offset* is defined as follows:

(a) $inc2 \leq 0$, no loss carry-back:

$$\textit{loss-offset}_{i,\,t} = inc2_{i,\,t} \cdot (-1) \tag{33}$$

(b) $inc2 \leq 0$, loss carry-back with a restriction regarding both time and amount

$$\textit{loss-offset}_{i,\,t} = inc2_{i,\,t} \cdot (-1) - \max(0; \min(-inc2_{i,\,t};\ inc3_{i,\,t-1};\ limit)) \tag{34}$$

(c) $inc2 > 0$, loss carry-forward with a restriction regarding both time and amount

$$\textit{loss-offset}_{i,\,t} = \min(inc2_{i,\,t};\ lcf_{i,\,t};\ limit) \cdot (-1) \tag{35}$$

To determine the tax loss carry-forwards existing in year t ($lcf_{i,\,t}$), possible time restrictions are taken into account. That is, in countries in which tax loss carry-forward is limited to a certain number of years, loss carry-forwards are forecasted in separate "baskets", depending on their year of occurrence. When determining taxable income, loss carry-forwards for early years are used first and loss carry-forwards are eliminated if they are older than the number of years that the carry-forward is restricted to.

5.2 Determining the consequences of tax reforms

The main objective of applying tax-related micro-simulation models is to assess the consequences of possible tax reforms. Therefore, ASSERT is designed to allow for the incorporation of amendments to all the tax provisions that are considered, including amendments to provisions regarding tax depreciation, dividend tax treatment, intra-group and inter-period loss-offset, cross-border taxable income allocation (direct versus indirect methods) and applicable tax rates. Furthermore, the modular design of ASSERT also allows for an extension of the model by incorporating additional (and possibly new) tax regulations.

In determining the consequences of tax reforms, we leave the forecast of next year's earnings and investments unaffected, at least as long as we do not consider behavioral responses. Rather, we solely amend the procedures that translate these forecasted earnings into tax liabilities. Changes in the tax liability resulting from a tax reform are associated with liquidity effects. We account for these effects by adjusting distributed dividends and the resultant capital structure.

6 Module 4: Deriving items for next year's simulation

To determine the amount and structure of next year's equity and liabilities, we start by determining possible injections of equity capital. In this regard, each of the following three steps is carried out separately, depending on whether the total of the previous year's shareholders' funds and current-year profit/loss for period is smaller than zero.

In a first step, we determine the likelihood of an equity capital injection based on historical balance sheet data. In this respect, we assume a capital increase when the total of the previous year's shareholders' funds and current-year profit/loss for period is smaller than current-year shareholders' funds. The probability of a capital injection is then determined as the frequency of years with a capital increase over the total number of years with historical data per firm.

In a second step, we draw a uniformly distributed random number between zero and one. This random number is compared to the likelihood for a capital increase. If the random number is smaller than or equal to the determined probability of a capital injection, the amount of the capital increase is determined in a third step, expressed by Equations 36 and 37:

$$capital\ increase_{i,\,t} = total\ assets_{i,\,t} \cdot capital\text{-}increase\text{-}ratio \tag{36}$$

$$\text{with} \qquad capital\text{-}increase\text{-}ratio = \frac{shf_t - (shf_{t-1} + pl_t)}{total\ assets_t} \tag{37}$$

The *capital-increase-ratio* is determined as the country-specific average for all years and companies included in the set of historical data. shf refers to shareholders' funds, and pl refers to profit/loss for period. The ratio can take values between zero and one and is determined only for firm-year observations that are characterized by a capital increase.

As a second source of changes in equity, we determine dividend distributions for each of the simulation companies. Dividend distributions are estimated for all companies of a corporate group by employing a bottom-up approach. That is, we start with the lowest-tier subsidiary that is distributing dividends to the direct parent company, which distributes dividends to the next-tier company and so forth. We use two different approaches to determine distributed dividends and choose the maximum of the two resultant values.

According to the first approach, we compare the sum of previous-year shareholders' funds and current-year profit/loss after tax to current-year total assets. If the sum of the first two items is larger, the dividend distribution is assumed to be equal to shareholders' funds plus profit/loss after tax minus total assets.

According to the second approach, dividends are determined by applying a company-specific payout ratio, calculated on the basis of the most recent historical financial statement data. In this respect, profit/loss after tax is denoted as $plat$, and the following payout ratio is calculated separately for years with $plat > 0$ (index pos) and for years with $plat \leq 0$ (index neg); osf stands for other shareholders' funds.

$$\textit{payout-ratio}_i = \sum_{t=ly-2}^{ly} \frac{plat_t - (osf_t - osf_{t-1})}{plat_t + osf_{t-1}} / number\ of\ years \tag{38}$$

To determine the dividend distributions, we differentiate between three different situations, as shown in the following equations:

(a) $plat > 0$

$$distributed\ dividends = \textit{payout-ratio}_i^{pos} \cdot (plat_t + osf_t) \tag{39}$$

(b) $plat \leq 0$ and $shareholders\ funds + plat - capital > 0$

$$distributed\ dividends = \textit{payout-ratio}_i^{neg} \cdot (plat_t + osf_t) \tag{40}$$

(c) $plat \leq 0$ and $shareholders\ funds + plat - capital \leq 0$

$$distributed\ dividends = 0 \tag{41}$$

Subsequent to the determination of dividend distributions, we estimate the equity of company i in year t as the previous year's equity plus the current year's after tax profit (or loss) minus any dividend distributions. Liabilities then are the residual between total assets and equity.

7 Module 5: Determining tax revenue and tax burden

7.1 Determination of revenue impacts

In determining the revenue consequences of tax reforms, three issues have to be considered. First, appropriate indicators for tax revenue have to be determined. Second, the results from all simulation runs have to be condensed, and third, the condensed simulation results have to be extrapolated in an adequate manner.

Tax revenue is determined in ASSERT using three different definitions. First, we define gross tax revenue as the total of all tax liabilities. That is, tax loss carry-forwards prevailing at the end of the simulation period are disregarded and are only reported as a separate item. Second, net tax revenue is determined, defined as gross tax revenue minus the tax value of unused loss carry-forwards at the end of the simulation period. Our third measure considers timing effects when defining tax revenue and is defined as the net present value of net tax revenue. The measure is determined by discounting tax revenue at a uniform rate, assuming that loss carry-forwards at the end of the simulation period are utilized in subsequent periods at a constant rate that differs across the member states. The member-state-specific average ratio of utilized losses to loss carry-forwards is calculated based on the outcome of our simulation. The present value of tax loss carry-forwards that are remaining at the end of the simulation period is then determined as the present value of the reduction of tax liabilities caused by these loss carry-forwards.

By applying these different definitions of tax revenue, we aim to more clearly show the possible effects of provisions that affect the distribution of the tax base over time (e. g., loss carry-forwards). More restrictive loss-offset provisions may have a permanent effect on tax revenue, if losses carried forward from earlier periods are ultimately lost. As a consequence, a higher aggregate net tax revenue is observed, whereas gross revenue increases only to the extent that these unused losses could be utilized if less restrictive provisions were applied. The net present value of tax revenue also reflects mere timing effects.

Since tax liability is estimated under uncertainty, the resultant tax liabilities for each corporation and year have to be condensed into one single number. Hence, for each corporate group and each stand-alone company, we choose one simulation run as the basis for extrapolation.[7] The following steps are carried out to determine the appropriate simulation run:

(1) Adding up tax liabilities for each corporate group, year and simulation run.

(2) Determining the median value of the aggregated tax liabilities for each corporate group and each year.

(3) Calculating the absolute differences between aggregated tax liabilities and its median for each observation and adding up these differences for each corporate group and simulation run over all years.

(4) Choosing the simulation run with the smallest total of absolute differences.

Forecasting tax revenue in ASSERT bears the problem that although the applied database covers a large proportion of the universe of all existing corporations (see also Table 5 for the general data coverage of Amadeus), it lacks complete balance sheet information for a significant share of these companies. Relative changes in tax revenue determined on this basis are not distorted, as long as the simulation companies constitute a representative sample of all existing corporations. However, since the requirements for being included in the simulation process are more frequently fulfilled by large companies, this is presumably not the case. To overcome possible distortions that may result from an underrepresentation of small and medium-sized corporations, we account for this imbalance by applying the following extrapolation procedure. First, all corporations that are included in the simulation process are allocated to different clusters according to their country of residence, organizational structure (i. e., whether the corporation belongs to a corporate group) and size (in terms of total assets); each cluster is defined to consist of 200 corporations. Second, all companies that are included in Amadeus are allocated to these clusters, and we determine expansion factors by dividing the sum of the total assets of all companies in a cluster by the sum of the total assets of all simulation companies in their cluster. These factors are adjusted to account for an underrepresentation of unprofitable companies in Amadeus, using national tax statistics. The resultant expansion factors are used

[7] Another possibility would be to use the mean value of all estimated tax liabilities. However, several robustness tests showed that this procedure may be heavily influenced by outliers, which is why we decided against using this approach.

to extrapolate both tax liability and existing tax loss carry-forwards at the end of the simulation period.

7.2 Determination of tax burden

In determining the tax burden, we distinguish between marginal and average tax rates, both of which are determined at the individual company level and at group level. To determine marginal tax rates, we rely on the method proposed by Graham, 1996a, Graham, 1996b and Shevlin, 1990, which was also applied in the studies by Blouin et al., 2010 and Graham & Kim, 2009. In these studies, "the marginal tax rate is defined as the present value of current and expected future taxes paid on an additional dollar of income earned today" (Graham, 1996a, page 44).

In contrast, no common standard has emerged in the existing literature with respect to the definition of average tax rates. From an economic point of view, the average tax burden should be defined as the ratio of discounted future tax liability to discounted future economic earnings. The latter cannot be derived from financial statements and must therefore be approximated (Collins & Shackelford, 1995). Common definitions set tax liability (or tax payments) in relation to a profit figure, assets employed, operating revenue or the operating cash flow. Any specification with a numerator that depends on underlying (tax) accounting principles determines a statutory tax burden rather than an average tax burden (Plesko, 2003). Furthermore, international comparisons might be biased because of international differences in the accounting provisions (Nicodème, 2001, Collins & Shackelford, 1995). If tax liability refers to operating revenue or assets employed, a bias is created with respect to international differences in profitability. Using operating cash flow to determine the average tax rate enhances the comparability across countries, but induces a bias of the average tax rates with respect to the capital intensity. Companies with high capital intensity should, other things being equal, have a lower average tax rate (Schratzenstaller, 2004, Nicodème, 2001, Zimmerman, 1983).

For the purposes of our analysis, we measure the average (company/group) tax rate as the reduction of the present value of cash flow to equity. The cash flow is derived indirectly from the financial statements and is defined as the total of operating cash flow, cash flow from debt financing and cash flow from investments ($ltl_{i,\,t}$ are long-term liabilities, which are composed of debt and provisions, and $plbt_{i,\,t}$ refers to profit/loss before taxation of company i in year t):

$$\begin{aligned} cash\ flow_{i,\,t} &= operating\ profit/loss_{i,\,t} + depreciation_{i,\,t} \\ &\quad + \Delta ltl_{i,\,t} + interest\ revenue_{i,\,t} - interest\ expenses_{i,\,t} \\ &\quad - (\Delta fixed\ assets_{i,\,t} + depreciation_{i,\,t}) \qquad (42) \\ \Leftrightarrow\ cash\ flow_{i,\,t} &= plbt_{i,\,t} + \Delta ltl_{i,\,t} - \Delta fixed\ assets_{i,\,t} \qquad (43) \end{aligned}$$

In order to determine the average tax rate (atr), cash flows and tax liabilities ($tax_{i,\,t}$) are discounted at a uniform rate r. The average tax rate is defined in Equation 44. Loss carry-forwards that remain at the end of the simulation period ($lcf_{i,\,t}$) are assumed to be utilized in subsequent periods at a constant rate that differs across the member states ($utilization\ rate_{c(i)}$), with the present value of the related tax advantage denoted by LCF ($\tau_{c(i)}$ is the country-specific tax rate, and n refers to the number of years within which loss carry-forwards are, on average, utilized; n is determined from historical data).

$$atr_{i,\,t} = \frac{\sum_{t=1}^{10} tax_{i,\,t} \cdot (1+r)^{-t} - LCF_{i,\,t}}{\sum_{t=1}^{10} cash\ flow_{i,\,t} \cdot (1+r)^{-t}} \qquad (44)$$

$$\text{with}\ \ LCF_{i,\,t} = \sum_{x=1}^{n} \frac{lcf_{i,\,t} \cdot utilization\ rate_{c(i),\,x} \cdot \tau_{c(i)}}{(1+r)^{x}} \qquad (45)$$

The applied cash-flow definition should avoid a biased mismatch between the numerator and the denominator of the average tax burden as long as the total of tax depreciation equals the capital expenditure during the period under consideration.[8] The same applies to borrowings and settlement of debts.

In addition to determining the average tax rate of the individual company/group, we determine country averages that reflect the attractiveness of each country as an investment location. To this end, we exclude from our analysis companies/groups with a total cash flow that deviates by more than 100 percent from the total of profits and losses before tax over the period under consideration (owing to the possible inaccuracies addressed above). In order to avoid errors due to outliers in the sample, we also exclude companies/groups with an average tax rate that differs by more than 100 percent from the median average tax rate of the member state. The average

[8] As companies were, on average, growing during the simulation period, net investments should, on average, slightly exceed total depreciation during the simulation period. This results in a slight overestimation of the average tax rate.

tax rate for the member states is then assessed as the mean of the average tax rates for the remaining companies/groups in the sample.

In order to determine country averages, we introduce one further distinction. We distinguish the average tax rate of companies/groups with a positive total cash flow over the simulation period (atr^+) from the average tax rate of companies/groups with negative total cash flows (atr^-). This distinction is necessary, because the average tax rates for companies/groups with positive cash flows must be interpreted differently from the average tax rates for companies/groups with negative cash flows. In the first case, the average tax rate has to be interpreted as a tax burden (i. e., the lower the tax rate is, the more attractive the country is as an investment location from a pure tax perspective). In the second case, the average tax rate has to be interpreted as a tax relief (i. e., the higher the tax rate is, the more attractive the country is as an investment location). Both measures (atr^+ and atr^-) are accommodated to create a combined average tax rate, which takes into account both the tax burden on profits (atr^+) and the additional tax burden resulting from the tax discrimination for losses (atr^-), weighted by the number of companies/groups in the sample with negative total cash flows over the simulation period ($\frac{n^-}{n^+ + n^-}$). The following equation for the combined average tax rate results:

$$atr_{i,\,t} = atr^+_{i,\,t} + \frac{n^-}{n^+ + n^-} \cdot (atr^+_{i,\,t} - atr^-_{i,\,t}) \tag{46}$$

8 Accuracy of the model

To evaluate the forecasting quality of ASSERT, we calculate the mean and median values as well as standard deviations of the forecasted items and compare them to the values actually realized, as reported in an updated version of the AMADEUS database (AMADEUS update 196). Moreover, we determine correlations between simulated and realized items. In particular, we evaluate the forecasting quality of the items total assets, liabilities, depreciation and operating profit/loss (EBIT). Results relating to all countries covered in ASSERT are shown in Table 1. The results of country-specific evaluations can be found in Appendix 3 in Tables 8 to 17. These tables are provided for those ten countries with the most firm-year observations available in both ASSERT and AMADEUS update 196. Forecasted and realized data refer to the years 2008 to 2010. It is not possible to evaluate simulation results of 2011, since the respective data are not included in the latest available AMADEUS update. Besides, the number of observations in Table 1 is smaller than the number of corporations included in the simulation process, because Table 1 is restricted to companies, which are included in both the simulation process and Amadeus update 196.

Table 1: Forecasting quality of ASSERT

Year		2008	2009	2010
Total assets	Number of observations	410,501	389,552	97,470
ASSERT	Mean	12,097	12,757	17,689
	Median	1,675	1,755	1,481
	Standard deviation	193,958	201,568	282,866
Amadeus	Mean	13,249	13,486	21,086
	Median	1,816	1,832	1,682
	Standard deviation	251,250	261,674	410,911
Comparison	Correlation	0.909	0.889	0.918
Liabilities	Number of observations	410,503	389,550	97,470
ASSERT	Mean	7,922	8,629	11,8033
	Median	1,061	1,136	950
	Standard deviation	131,171	143,657	201,688
Amadeus	Mean	8,200	8,122	12,083
	Median	1,082	1,053	927
	Standard deviation	139,716	140,776	228,371
Comparison	Correlation	0.870	0.832	0.875
Depreciation	Number of observations	407,190	384,899	96,395
ASSERT	Mean	392	425	529
	Median	45	52	48
	Standard deviation	8,049	8,712	9,851
Amadeus	Mean	368	381	465
	Median	43	45	43
	Standard deviation	6,443	6,427	7,158
Comparison	Correlation	0.903	0.879	0.878
Operating profit/loss	Number of observations	410,387	389,471	97,453
ASSERT	Mean	676	589	955
	Median	95	82	100
	Standard deviation	12,532	17,777	16,793
Amadeus	Mean	646	534	933
	Median	95	73	103
	Standard deviation	18,598	14,910	17,049
Comparison	Correlation	0.603	0.215	0.469

As can be seen from Table 1, the forecasting quality of ASSERT is very satisfying. The statistical measures are sufficiently similar to each other, especially when it is taken into account that the results are not corrected for outliers.[9] The correlation between realized and simulated values is around ninety percent for total assets and depreciation. Similarly, the correlation with regard to liabilities is between eighty and ninety percent for the three years considered. The correlation with regard to the operating profit/loss is around 43 percent, on average. The smaller correlation observed for this item comes as no surprise, since forecasting profitability covers more than just growth effects. In addition, it can be observed that the correlation of operating profit/loss is smallest in 2009. This is reasonable, as results in 2009 were heavily influenced by the global financial and economic crisis, which made accurate forecasting more difficult. When looking at the development of the forecasting quality over time, it becomes apparent that it decreases only slightly, if at all. We therefore assume sufficient forecasting quality for the whole simulation period of four years and do not expect a significant decline in the forecasting quality in 2011 as compared to the years 2008 to 2010.

We also analyze, to what extent differences in the mean value of realized and forecasted items are statistically significant. We apply a country and year specific t-test and compare the mean values of the items forecasted in ASSERT to the mean values of the realized items in Amadeus update 196. The corresponding p-values are reported in Tables 8 to 17 in Appendix 3. In more than 60 percent of all cases, we do not find a difference in the mean value that is statistically significant at the one- or five-percent level.

Since ASSERT aims at determining revenue consequences of tax reforms, estimating the resultant tax revenue with sufficient precision is the main objective of the simulation, while a correct estimation of the underlying components is only secondary, given that tax revenue is determined correctly. We therefore compare tax revenue estimated in ASSERT with realized tax revenue in Germany between 2008 and 2011 (see Oestreicher et al., 2012). The comparison revealed that forecasted and realized tax revenue are very similar to each other and that they developed analogously over time (with the exception of the year 2011). As the primary objective of ASSERT is the determination of relative revenue consequences of tax reforms rather than forecasting tax revenue over time, estimating the correct amount of tax revenue is not as important as avoiding systematic over- or underestimations of tax revenue. Based on the preceding analyses, it does not appear as if ASSERT is subject to such miscalculations.

[9]Two firm-year observations were disregarded for this analysis, which probably include erroneous information in Amadeus update 196.

9 Summary

The micro-simulation model described in this paper, ASSERT, is designed to quantify the tax consequences of a corporate tax reform in the EU member states on the tax revenue and tax burden of the companies concerned. In doing so, ASSERT differs from existing similar micro-simulation models in that it includes 19 EU member states instead of being limited to one specific country and that it uses forecasting procedures to simulate future company performance and tax liability. Accordingly, ASSERT allows us to assess the tax consequences of tax reforms regarding the taxation of multinational groups (e. g., the introduction of a CCCTB), to incorporate behavioral responses and to estimate revenue with respect to the cross-country second-round effects of national tax reforms in one member state.

10 Appendix 1 - Generation of database

10.1 Database and data selection

ASSERT draws primarily on company micro-data that are included in the AMADEUS database. AMADEUS is a comprehensive pan-European database that contains financial information on about nine million public and private companies in 38 European countries and is made available by the private database provider Bureau van Dijk.[10] The database contains standardized (consolidated and unconsolidated) annual accounts, financial ratios, and information on the legal forms, industry and ownership of the companies that are included in the database. It is the policy of Bureau van Dijk to include all companies for which plausible and up-to-date information is available. Consequently, AMADEUS provides neither a complete sample nor a randomly chosen sample of companies, and this must be taken into account whenever simulation results are discussed. In AMADEUS, balance sheets and profit and loss accounts are presented in an aggregated, standardized layout that is outlined in Table 2 and Table 3.

Table 2: Balance sheet items available in AMADEUS

Assets	**Equity and Liabilities**
Fixed assets	Shareholders' funds
- Intangible fixed assets	- Capital
- Tangible fixed assets	- Other shareholders' funds
- Other fixed assets	Non-current liabilities
Current assets	- Long-term debt
- Stocks	- Other non-current liabilities
- Debtors	Current liabilities
- Other current assets	- Loans
- Thereof cash and cash equivalents	- Creditors
	- Other current liabilities
Total assets	Total shareholders' funds and liabilities

According to the data description that is provided by Bureau van Dijk, the item other fixed assets primarily consists of financial fixed assets. On the right-hand side of the balance sheet, the item capital reports subscribed capital, whereas other shareholders' funds comprises capital reserves, profit reserves and retained earnings.

With regard to the profit and loss account, sales is restricted to earnings from the core business activity, whereas operating revenue/turnover also includes other operating earnings. In addition to the items covered in Tables 2 and 3, export turnover, material costs, cost of

[10]For a discussion of the advantages and disadvantages of AMADEUS in comparison to other sources of company micro-data, see Poppe, 2007.

Table 3: Income statement items available in AMADEUS

1	Operating revenue/turnover
2	Sales
3	Costs of goods sold
4	**Gross profit** (1 - 3)
5	Other operating expenses
6	**Operating profit/loss** (4 - 1)
7	Financial revenue
8	Financial expenses
9	**Financial profit/loss** (7 - 8)
10	**Profit/loss before tax** (6 + 9)
11	Taxation
12	**Profit/loss after tax** (10 - 11)
13	Extraordinary and other revenue
14	Extraordinary and other expenses
15	**Extraordinary and other profit/loss** (13 - 14)
16	**Profit/loss for period** (12 + 15)

employees, number of employees, depreciation and interest paid are reported.

Furthermore, AMADEUS includes information on the companies' legal form, industry and shareholders. However, this information is reported only for one specific point in time in each update, which is, in most cases, the date of the last available financial statement. We use legal forms and industry codes (primary NACE codes) from the last available update as well as ownership information taken from four different updates of AMADEUS (the mapping of corporate group structures and the identification of corporate groups' industries are described in Sections 10.2.2 and 10.3.4).

The taxation of a company depends on its legal form. Therefore, each company in our sample must be classified as either a corporation or a partnership for tax purposes. To this end, we rely on the legal form as provided in AMADEUS and the list of legal forms falling under the Parent-Subsidiary Directive to classify companies as corporations.[11] Whereas corporations constitute a separate subject to tax in all member states, the income of partnerships is taxed in the hands of the individual partners in most member states ("pass-through taxation" or "transparency principle"). As the information provided in AMADEUS does not allow for a reliable estimation of individual income tax, ASSERT is restricted to the taxation of corporations.

In selecting relevant sample companies, in a first step, we include all unconsolidated annual accounts, given that a company has its legal seat in one of the EU 28 member states and operates in the legal form of a corporation. In order to qualify as a simulation company, further data

[11] See the annex of the Parent-Subsidiary Directive for this list.

requirements have to be met, which are briefly summarized and substantiated below (see also Section 2.2 in this respect):

(1) Industry sector classification

(2) Shareholding information and corporate group structure

(3) Tangible fixed assets, intangible fixed assets, other fixed assets and total assets for the last two reported years; asset structure (i. e., the subordinated items of tangible fixed assets, intangible fixed assets and other fixed assets as well as the corresponding years of acquisition)

(4) Equity (with the subordinated items capital and other shareholders' funds) and liabilities for the last two reported years

(5) Operating profit/loss and depreciation for the last two reported years

(6) Company-specific credit and debt interest rates, i. e., financial revenue and financial expenses for the last reported year

(7) Tax loss carry-forwards for the last reported year

(8) Sales, number of employees and cost of employees for the last two reported years

(9) At least 180 three-year datasets per country to be able to apply the bin approach (see Section 3.2.2); a comprehensive number of observations per country to allow for a realistic estimation of revenue consequences.

The resultant data sample in its current version is illustrated in detail in Section 11.

10.2 Preparation of the original data

10.2.1 Financial data

10.2.1.1 Elimination of erroneous data The accuracy of a micro-simulation model depends essentially on the quality of the underlying data. We therefore apply comprehensive data preparation procedures in order to eliminate erroneous and implausible information and (where possible) supplement missing values. To this end, we (a) assess the balance sheet for differences between total assets and total equity and liabilities, (b) eliminate (subject to certain exceptions) negative items in the balance sheet and income statement, (c) insert missing values and (d) eliminate erroneous information in the balance sheet and income statement in the case of differences between totals/subtotals and the sums of subordinated items.

In applying step (a), no financial statement appeared to show discrepancies between total assets and total equity and liabilities. With regard to step (b), we observed 931 financial statements with negative balance-sheet totals as well as a number of financial statements with negative subordinated items in either the balance sheet or the income statement. Because the data are processed and aggregated automatically by the database provider, negative items would normally be attributable to accounting errors and therefore would lead us to delete the balance sheet or income statement. However, we accept negative values for the balance sheet items other fixed assets (negative book values are related to investments in partnerships), stocks (negative values are possible if stocks are netted against advance payments), cash/other current assets (negative values are possible if bank account balances are negative) and other shareholders' funds (negative values are possible if loss carry-forwards exceed reserves). With regard to capital, negative values are accepted for partnerships, as equity is not always reported in separate items for these companies. In contrast, in the case of corporations, negative values for capital are assumed to be the consequence of accounting errors. As far as the income statement is concerned, negative values should only exist with regard to totals and subtotals. We therefore delete income statements completely if negative values are observed for one of the income statement items operating revenue/turnover, sales, costs of goods sold or other operating expenses. If negative values occur only in items (other than (sub)totals) that are reported in the income statements below operating profit/loss, we delete the income statement except for the items sales and operating revenue. In step (c), we insert missing values. The calculation of missing values is limited to cases in which the supplementation can be carried out unambiguously on the basis of totals, subtotals and/or subordinated items. The supplementation of missing values in other cases would require reference to industry and/or country averages, which would curtail the individuality of the micro-data. Finally, in step (d), we verify both the totals and the subtotals in the balance sheets and income statements for mathematical correctness. Any differences below a value of two (values are reported in thousands of euro) are accepted as rounding differences. Larger differences lead to the deletion of the smallest possible (defective) section of the corresponding balance sheet or income statement.

10.2.1.2 Imputation of missing values Inserting missing values as described in the previous section is limited to cases in which this supplementation could be made free of ambiguity. As an exception to this general rule, we estimate missing values for the items sales and cost of employees if the related items operating revenue/turnover and number of employees are reported in AMADEUS and vice versa. Two arguments support the calculation of values for these items. First, the values of these items can be expected to be strongly correlated with the values of the related items, indicating that estimating missing values for these items should be possible with sufficient accuracy. Second, for a number of countries, AMADEUS provides values for only one of the related items, meaning that calculating values for missing items is necessary to avoid excluding all companies from these countries.

Our approach to calculating these missing items aims to consider the characteristics of the individual companies to the greatest extent possible but, at the same time, to avoid any substantial impact of influential outliers. Based on this notion, we apply the following five-step procedure to determine missing values for sales and operating revenue (cost of employees and number of employees) based on the median ratios for sales to operating revenue (cost of employees to number of employees). We use (a) ratios of the same corporation over all years if at least three values are available. Otherwise, we rely on (b) ratios of the same industry in the same country in the same year, (c) ratios of the same country in the same year over all industries, (d) ratios of the same industry in the same country over all years or (e) ratios of the same country over all industries and years. To apply one of the ratios for (b) to (d), we require a minimum of ten values.

10.2.1.3 Elimination of implausible data In addition to eliminating financial statements with information that is obviously erroneous owing to either discrepancies or negative items, we use a second algorithm that identifies and eliminates mathematically correct but implausible information. To this end, we examine both the relations of different financial statement items within one year and the development of certain items over time. To test the plausibility of information reported within a single financial statement, we apply the following set of conditions (*cempl* refers to cost of employees and *depr* refers to depreciation):

$$sales \leq operating\ revenue \tag{47}$$

$$export\ turnover \leq operating\ revenue \tag{48}$$

$$material\ costs \leq cost\ of\ goods\ sold + \Delta stocks \tag{49}$$

$$material\ costs + cempl + depr \leq cost\ of\ goods\ sold + operating\ expenses + \Delta stocks \tag{50}$$

$$interest\ expenses \leq financial\ expenses \tag{51}$$

$$number\ of\ employees < cost\ of\ employees \tag{52}$$

If condition 47 is not met, we delete the entire income statement; if condition 52 is not satisfied, we eliminate only the items number of employees and cost of employees. If one of the remaining conditions is violated, we delete the income statement and all other financial statement items that are included in the equation with the exception of operating revenue and sales. In addition, we examine the items total assets, sales, operating revenue, cost of employees, number of employees and the ratio of cost of employees to number of employees over time. In particular, we eliminate the whole balance sheet (income statement) if the relative change in total assets (sales, operating revenue) from year x to year x+1 is larger than 10,000 percent or smaller than -99 percent. To this end, the second criterion is only applied if the item is of considerable size in year t (i. e., larger than 100,000).

10.2.1.4 Currency conversion Original financial statement information is extracted from the Amadeus database in euro. This may create inaccuracies in countries with local currencies if balance sheet or income statement items are compared over time (as, for example, in the case of investment in fixed assets). A positive value for investment in this case may reflect both real activities and mere exchange rate changes. Before starting the simulation procedure, we therefore convert data from all non-euro countries (i. e., Bulgaria, Czech Republic, Denmark, United Kingdom, Hungary, Poland, Romania, Slovakia and Sweden) into local currency.[12]

Company-year-specific exchange rates depend on the account date and are available in the database for most company years. In cases in which the account date but no exchange rate is available in Amadeus, we refer to the mean exchange rate over all companies in the same

[12]Only dividend distributions are converted again into the parent company's local currency to avoid inconsistencies between the distributing and the receiving company.

country and year with the same account date. In cases in which neither the account date nor the exchange rate is available, we refer to the country and year specific average exchange rate.

10.2.2 Ownership data and corporate group structures

Shareholder information is reported only with reference to one specific point in time in each Amadeus update. We are therefore not able to consider ownership information and group structures on a year-by-year basis. Incorporating all available information, we use four different updates of Amadeus (update 64 for 1994 to 1999; update 100 for 2000 to 2002; update 125 for 2003 to 2005; update 172 for 2006 to 2007) and assume that ownership data and group structures are unchanged between different reporting dates.

Table 4: Preparation of ownership data

Database information				**Level of adjustment**			
				I	**II**		**III**
Information in Amadeus	Meaning	Absolute number	Percentage	Adjustment	Variable	Number	> 100 percent
X	known	10,808,015	75.99%	no			$\sum$ of shareholdings >100%
-	unknown	2,139,937	15.06%	0.00	yes	1,925,878	
<X	smaller X	2,452	0.02%	X-0.01	yes	14	
>X	greater X	112,902	0.79%	X+0.01	yes	112,733	
CQPI	50%+1 share	7	0.00%	50.01			
G	error in database	86	0.00%	100.00			
MO	controlling interest	1,465	0.01%	50.01	yes	1,455	
+/-X	+/- X	329	0.00%	X			
NG	under 1%	1,714	0.01%	0.01			
WO	above 98%	1,155,526	8.12%	98.01			
Sum		14,222,433	100.00%	3,414,418		2,040,080	2.418

Again, we apply a data preparation algorithm to eliminate erroneous information, particularly if the overall participation of all reported shareholders for a company exceeds 100 percent, and to impute missing information or specify reported shareholdings.[13] The procedure for preparing ownership data is described in Table 4. The numbers reported in this table refer to

[13] See also Koch, 2010 and, in detail, Poppe, 2007, for a slightly adjusted description of this step.

the shareholders of all companies that are included in AMADEUS; thus, a company held by five different shareholders is included five times in Table 4. Participation is reported to be free of ambiguity in 75.99 percent of the cases (coded in AMADEUS as X and CQPI).[14] For the remaining entries, the participation rate is unknown or is reported only in terms of a minimum or maximum value. Ownership information that is not reported with a precise participation quota is amended using a three step approach: First, each of the entries is assigned an exact participation rate. It equals zero if the actual participation rate is completely unknown; otherwise, the reported minimum or maximum value is attributed (column I). Second, the participation rate of all of these entries is increased (entries with unknown or minimum participation) or decreased (entries with maximum participation) to ensure that the participation rates that are reported for all companies add up to 100 percent (column II). To this end, the following equation is applied:

$$p_a = p_b + (100\% - \sum p_b)/n_s \tag{53}$$

where p_a is the participation rate after amendment, p_b is the participation rate before amendment and $\sum p_b$ is the known overall participation rate of all shareholders before amendment, all reported as a percentage; n_s is the number of shareholders whose participation is amended. Finally, we eliminate all companies with an overall participation rate (p_a) that exceeds 100 percent (column III).

Group companies differ from stand-alone companies with respect to both the applicable tax provisions (e. g., applicability of group taxation regimes) and the options for shifting profits to low-tax countries. To consider these differences in our simulation, we assign a distinct group ID to each group company that is equal to the Bureau van Dijk ID number of the parent company. AMADEUS includes information on both direct and top-level shareholders ("ultimate owner"). For both types of shareholders, the shareholder's name, identification number, country and participation rate as well as the type of shareholder is reported. The following categories are used for type of shareholder:

(a) Banks and financial companies
(b) Insurance companies
(c) Industrial companies
(d) Mutual and pension funds/nominees/trusts/trustees
(e) Foundations/research institutes
(f) Public authorities/states/governments

[14] All values refer to AMADEUS update 172.

(g) One or more named individuals or families

(h) Employees/managers/directors

(i) Public unnamed private shareholders

(j) Other unnamed shareholders

With regard to the reported percentage of participation, direct shareholdings are distinguished from total shareholdings in AMADEUS. A direct shareholding includes only shares that are directly held in a specific corporation, whereas the total shareholding reflects both directly and indirectly held shares. The latter is only included in AMADEUS if it can be extracted directly from an available information source (i. e., Bureau van Dijk does not calculate total shareholdings based on the available information regarding direct shareholdings). Accordingly, the calculation method for total shareholdings (additive or multiplicative) depends on the information source; it may therefore involve inconsistencies and is disregarded for our purposes.

To identify parent companies, we do not rely directly on the "ultimate owner", as reported in AMADEUS. Bureau van Dijk used a minimum participation threshold of 24.9 percent to define the ultimate owner in earlier updates of AMADEUS; this threshold deviates from the 50-percent threshold that is usually applied to define corporate groups for accounting and tax purposes. We therefore refer to the information on direct shareholdings. Based on this information, we combine all corporations that are controlled by a common European or non-European parent corporation to form one corporate group. Financial control is assumed if the controlling company directly or indirectly holds a share of at least 50 percent in the controlled company. To this end, all direct and indirect shareholdings are summed up, given that, for the indirect shareholdings, the controlling company holds (directly or indirectly) a share of at least 50 percent in the intermediary company. Indirect shareholdings are considered irrespective of whether the intermediary company operates in the legal form of a corporation or partnership.[15]

10.3 Modification of the original data

10.3.1 Structure of non-financial fixed assets

10.3.1.1 General approach Determining future tax depreciation necessitates detailed information on the structure of assets, with respect to both the asset type and the acquisition date. This information, however, is not provided first hand in AMADEUS, since the subdivision of fixed assets is limited to the items intangible fixed assets, tangible fixed assets and other fixed assets (composing, in particular, financial fixed assets). In addition, information on the

[15] This step is described in detail in Poppe, 2007.

acquisition dates of these assets is lacking. This makes it necessary to combine the AMADEUS data with more detailed information from other sources and/or to apply algorithms to impute missing information, based on the available data.

Indications for the imputation of missing asset structure information may be taken from three different sources. First, external sources of information can provide additional guidance with regard to the type of assets. Such information would (at best) include EU-wide, disaggregated, company-specific accounting data that can be matched with AMADEUS based on an unambiguous identifier. Possible data sources include the database OSIRIS, a number of country databases provided by Bureau van Dijk and the BACH database, published by the European Commission's Directorate for General Economic and Financial Affairs. However, none of these databases entirely meets the requirements outlined above. Most only partly cover the EU member states (i. e., BACH and country databases of Bureau van Dijk), refer to consolidated rather than unconsolidated accounts (OSIRIS) and/or include aggregated information instead of company-specific micro-data (BACH). Altogether, it appears that OSIRIS best serves our purposes, as it includes micro-data for companies in all EU member states.

Second, company age and average company growth may serve as possible indicators for the age structure of assets. Assuming that (a) companies purchase a complete first set of new assets in the year of foundation, (b) companies replace these assets in subsequent years in accord with the amount of economic depreciation and (c) capital-widening investments are constant over time and over different types of assets, the age structure of currently available assets can be modeled based on a simple aging algorithm.

Third, the ratio of depreciation expense to the book value of fixed assets may serve as an indicator for the asset structure, even though depreciation expense is reported only in terms of an overall value in AMADEUS. Nonetheless, high values for this ratio arise if fixed assets consist, ceteris paribus, to a larger extent of assets with a short overall expected useful life and with a short remaining useful life. If a distinct depreciation method can be assigned to each type of asset in each of the considered countries (for a similar approach, see Devereux & Griffith, 1999), then the ratio of depreciation expense to book value of fixed assets describes the entirety of all possible asset-age/asset-type combinations.

The specific approach that is applied in our simulation model is selected because it meets the following three requirements: First, the resultant asset structure should be among the possible ones, i. e., the depreciation expense that is determined based on the resultant asset structure should match the depreciation expense that is reported in AMADEUS. Second, the applied approach should ensure a maximum of company individualism with a minimum of arbitrariness. Third, the applied approach should minimize errors with respect to both the asset type and the asset age. To meet these requirements, we determine (in a first step) starting values for the ratio of each asset-type/asset-age combination. These starting values are (in a second step) modified on a step-by-step basis in order to ensure conformity with the actual depreciation expense that is reported in AMADEUS. During the simulation period, the resultant asset structure is applied to determine tax depreciation and to allocate investments to different asset types.

10.3.1.2 Starting values for the book values of different types of assets Starting values for the proportion of each asset type are taken from the OSIRIS database. OSIRIS is a worldwide database that is provided by Bureau van Dijk that includes consolidated financial statements for large listed and not listed companies. In contrast to those in AMADEUS, financial statements in OSIRIS are not reported in an aggregated format. This allows us to determine country- and/or industry-specific averages for the proportion of different types of assets. To limit the arbitrariness of the resultant asset structure, we restrict the disaggregation of tangible fixed assets to the items land, buildings and machinery, whereas intangible fixed assets are disaggregated into goodwill and patents. In particular, we determine the following ratios:

(1) Land to land and buildings (p_{land}): As this ratio differs across countries rather than across industries, we determine it as a simple country average. For countries with less than ten observations in OSIRIS, we refer to the average across all countries.

(2) Machinery to land, buildings and machinery ($p_{machinery}$): We determine this ratio as an average within country-industry clusters. As this ratio differs across industries rather than across countries, we refer to the industry-average over all countries if a country-industry cluster comprises less than ten observations in OSIRIS.

(3) Goodwill to goodwill and patents ($p_{goodwill}$): This ratio is also calculated as country- and industry-specific average. Again, this ratio differs across industries rather than across countries; therefore, we also refer to the industry average over all countries for country-industry clusters with less than ten observations in OSIRIS.[16]

All three ratios are additionally adjusted to account for size effects. To this end, we distinguish between seven different size classes that are defined according to total assets.[17] Multiplying the

[16] The applied industry clusters are reported in Table 7 in Appendix 2.

[17] We calculate the mean of the three ratios for every size class across all industries and all countries. In addition, we calculate the mean of the three ratios for all corporations. For each size class, the three ratios are then

resultant ratios with the book value of tangible fixed assets (bv_{tfa}) or intangible fixed assets (bv_{ifa}) yields our starting values for the book values of each type of asset (see Equations 54 to 58).

$$bv_{land} = bv_{tfa} \cdot p_{land} \cdot (1 - p_{machinery}) \tag{54}$$

$$bv_{buildings} = bv_{tfa} \cdot (1 - p_{land}) \cdot (1 - p_{machinery}) \tag{55}$$

$$bv_{machinery} = bv_{tfa} \cdot p_{machinery} \tag{56}$$

$$bv_{patents} = bv_{ifa} \cdot (1 - p_{goodwill}) \tag{57}$$

$$bv_{goodwill} = bv_{ifa} \cdot p_{goodwill} \tag{58}$$

10.3.1.3 Starting values for the age structure of fixed assets A starting point for the age structure of assets (i. e., the proportion of each type of asset purchased in a specific year) is obtained from a simple company-specific aging model. This model is based on the assumption that, for each company i, assets of each type a are purchased in the year of foundation (t=0, year of foundation is reported first hand in Amadeus) in the amount of 100.

$$ac_{i,\, a,\, t=0} = 100 \tag{59}$$

$ac_{i,\, a,\, t}$ refers to the acquisition costs of company i of asset type a in year t. In subsequent years, new assets of each type are purchased either as a replacement investment or as a capital-widening investment. Replacement investments are considered for each company and each asset type in the amount of economic depreciation, which is determined linearly over the economic useful life of the asset. The economic useful life is assumed to be fifteen years for goodwill, five years for patents, seven years for machinery and forty years for buildings. The economic useful life of land is assumed to be unlimited.

In addition to replacement investments, capital-widening investments are determined by multiplying the company-specific growth rate (GF_i, as defined in Section 2.3, minus one) by the remaining economic value of assets. In this respect, the GF_i is limited to a value of five, and the remaining economic value of assets is determined as accumulated acquisition costs less accumulated economic depreciation. Altogether, the acquisition costs of company i with regard

multiplied by the ratio of the mean for the specific size class to the mean for all corporations.

to asset type a in year $t > 0$ ($ac_{i,\,a,\,t}$) are defined as follows:

$$ac_{i,\,a,\,t} = \sum_{x=t-eul}^{t-1} ac_{i,\,a,\,x} \cdot depr_{a}^{ec} + \sum_{x=t-eul}^{t-1} \left(ac_{i,\,a,\,x} - \sum_{x=t-eul}^{t-1} depr_{a,\,x}^{ec} \right) \cdot (GF_i - 1) \tag{60}$$

where eul denotes the economic useful life. This process is repeated until t corresponds to the most recent year with available historical data (ly). In this respect, assets are assumed to leave the company at the end of their economic useful life. We therefore determine the proportion of asset type a acquired in year t from company i ($p_{i,\,a,\,t}$) according to the following equation:

$$p_{i,\,a,\,t} = \frac{ac_{i,\,a,\,t}}{\sum_{x=t-eul}^{t} ac_{i,\,a,\,x}} \tag{61}$$

10.3.1.4 Adjustment to ensure conformity with the actual depreciation expense

Conformity with the actual depreciation expense is tested by comparing the estimated tax depreciation to the depreciation expense that is reported in AMADEUS. To this end, we combine the starting values for the asset structure with regard to both asset type and asset age. Since the ratios for the asset-age clusters (see Equation 61) refer to acquisition costs rather than to book values, the ratios are adjusted to correspond to book values (resulting in $p(bv)_{i,\,a,\,t}$).

Depreciation is estimated by multiplying the book value that is estimated for each asset-type/asset-age cluster by the corresponding ratio of tax depreciation to book value, which is derived by applying tax regulations of the different countries and years. This determination of tax depreciation (which is assumed to equal book depreciation) is formally expressed in Equation 62. $ratio_{c,\,a,\,x}$ denotes the ratio of tax depreciation to book value for country c, asset type a and year x. Index a ranges from one to five and represents the five considered types of assets (land, buildings, machinery, goodwill and patents); $bv_{i,\,a,\,t}$ is the book value of asset type a in year t in company i.

$$depreciation_{i,\,t} = \sum_{a=1}^{5} \sum_{x=t-eul}^{t} bv_{i,\,a,\,t} \cdot p(bv)_{i,\,a,\,x} \cdot ratio_{c(i),\,a,\,x} \tag{62}$$

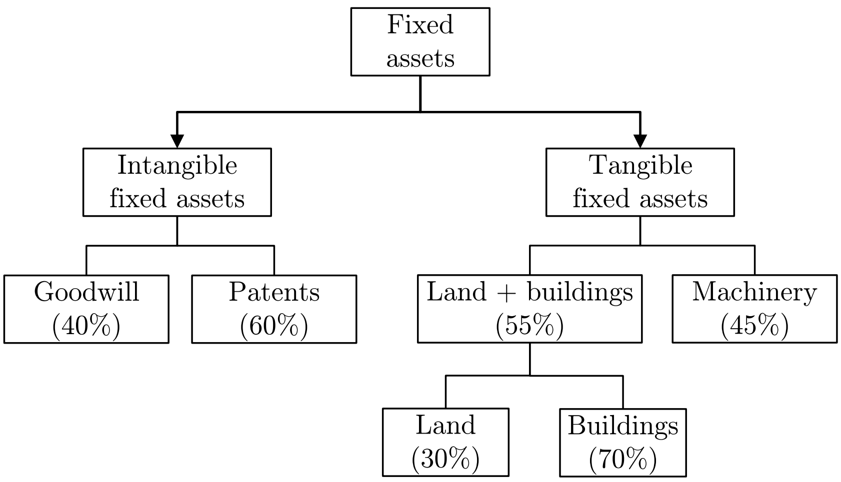
Depending on whether estimated depreciation exceeds or falls below actual depreciation, the asset-type structure and asset-age structure are adjusted stepwise in one or the other direction. This modification involves the following two adjustments, which are carried out simultaneously.

(1) **Modification of the asset-type structure:** The ratios of goodwill to goodwill and patents, of land to land and buildings and of machinery to machinery, land and buildings

are adjusted in one-percent increments. According to the depreciation schedules applied in Germany, patents are depreciated over a shorter useful life than goodwill, whereas the depreciation of machinery is faster than that of land and buildings. This leads, in the case of Germany, to the following modifications (see also Figure 4):

- If the simulated ratio of depreciation expense to book value falls below the corresponding ratio in Amadeus, the ratio of goodwill to overall intangible fixed assets is reduced by one percent from 40 to 39.6 percent (see Figure 4), meaning that the share of patents is correspondingly increased to 60.4 percent. In the same manner, the ratios for the different types of tangible fixed assets are modified (land and buildings, 54.45 percent; machinery, 45.55 percent; land to land and buildings, 29.7 percent; buildings to land and buildings, 70.3 percent).
- If the simulated ratio of depreciation expenses to book value exceeds the ratio of actual expenses in Amadeus, the different ratios are modified as follows: goodwill to intangible fixed assets, 40.4 percent; patents to intangible fixed assets, 59.6 percent; land and buildings to tangible fixed assets, 55.55 percent; machinery to tangible fixed assets, 44.45 percent; land to land and buildings, 30.3 percent; and buildings to land and buildings, 69.7 percent.

Figure 4: Example of asset-type structure determination - initial situation



Source: Own diagram.

(2) **Modification of the asset-age structure:** The age structure of fixed assets is modified in a corresponding manner.

- If the simulated ratio of depreciation expense to book value turns out to be too low, the age of the assets is, on average, underestimated. In this case, the share of "old" assets (i. e., assets that are currently in the second half of their expected useful life) is increased by one percent, whereas the share of "new" assets (i. e., assets in the first half of their expected useful life) is decreased correspondingly.

- If the simulated ratio of depreciation expense to book value is above the actual value taken from Amadeus, modifications are made in the opposite direction.
- If either all the "old" or all the "new" assets are reduced to zero, the remaining part of assets is further split into two halves, and the procedure is repeated.
- Further adjustments are made to avoid a disproportionately high allocation to the clusters of recently acquired assets.

Both steps are repeated simultaneously until the estimated depreciation equals the actual depreciation that is reported in Amadeus.[18] The resultant weights that are determined for the different asset-type/asset-age classes are multiplied by the overall book values of tangible and intangible fixed assets, and the results are translated into acquisition costs and stored in our database.

10.3.2 Structure of financial fixed assets and financial revenue

Financial fixed assets, as well as financial returns, are reported in Amadeus on an aggregated basis (i. e., without differentiating between equity and debt investments). Differentiating between these two types of financial assets is particularly important, as the resultant interest and dividend payments are treated differently in most countries for tax purposes. Such differentiation is thus required for both the period that is considered for the estimation of tax loss carry-forwards (as described below) and the forecast of future financial revenue (as described in Section 3.2.8).

To provide an accurate assessment of existing tax loss carry-forwards, past financial revenue as reported in Amadeus must be disaggregated into returns from equity investments in corporations, returns from equity investments in partnerships and returns from debt investments. Available information in general offers three different approaches to disaggregating financial returns. As a first and very simple approach, received dividends could be determined as a fixed proportion of financial returns. Such proportions would have to be determined at least on a per-country basis, given that the capital structure differs internationally and should depend (among other factors) on the applicable tax system. In addition, differentiation according to industry classes would be feasible. The required information could be taken either from the Bach

[18]In extreme cases, the iterative process was ended after 5,000 iterations.

database or from country- and industry-specific FDI statistics, neither of which are available for all EU member states, however. In addition, the generality of this approach would diminish the advantages of applying company micro-data and would result in obvious measurement errors for companies with no equity investment (reducing dividends to zero for these companies would result in an underestimation of the average amount of dividends over the whole sample of companies). Based on these shortcomings, we decided against using this first approach.

As a second approach, received dividends may be determined by summing up the profit distributions from all subordinated companies in proportion to the corresponding share in equity. Equation 63 shows the determination of dividends received by company i in year t. In this respect, sh_s denotes the percentage of shareholding in subsidiary s, and S refers to the number of subsidiaries.

$$received\ dividends_{i,\,t} = \sum_{s=1}^{S} sh_s \cdot distributed\ dividends_{s,\,t} \tag{63}$$

Profit distributions may be estimated based on the available Amadeus data as the (positive) difference between the current year's earnings ($profit_{s,\,t}$) and the change in other shareholders' funds ($osf_{s,\,t}$) of subsidiary s, as shown in Equation 64:

$$distributed\ dividends_{s,\,t} = \max\left[0; profit_{s,\,t} - \Delta osf_{s,\,t}\right] \tag{64}$$

This method provides an accurate assessment of the current year's dividends if other shareholders' funds are affected solely by annual profits or losses and dividend distributions. However, measurement errors arise if capital injections or capital reductions occur. Assuming that these measures are not regularly used, we do not believe that this should distort our estimates of dividends to any significant extent. More important, received dividends are systematically underestimated if Amadeus does not cover all the subsidiaries of all companies (or their balance sheets). Thus, the amount of dividends that is included in financial returns is systematically underestimated in countries for which financial statements are captured only to a small extent (e. g., Germany and Austria). As a third source of measurement error, dividends may be misrepresented if group structures change over time.

Because of these sources of possible measurement errors, we decided to apply a third approach, which is similar to the second one in that it is an indirect approach based on the accounts of the subsidiaries. In contrast to the second approach, however, we disaggregate (in a first step) financial assets into equity investments in corporations, equity investments in partnerships and debt investments. To this end, we sum up the products of equity of each subsidiary that is included in Amadeus and the share held by the corresponding parent company. To define the relevant equity of the subsidiary, we refer to subscribed capital (Amadeus item shareholders' funds: capital). For subsidiaries in the legal form of a corporation, subscribed capital should equal the book value of the participation in the balance sheet of the parent (at least in the absence of participation write-downs or capital injections/capital reductions). For subsidiaries in the legal form of a partnership, the participation book value may be increased by retained profits, depending on the corresponding accounting treatment of such participation. Owing to the small amount of participation in partnerships in our sample (only 4.62 percent of all subsidiaries in our sample operate in the legal form of a partnership), this should not significantly distort our estimation.

If shareholders' funds: capital is not available for a specific company-year observation, we proceed as follows:

(1) If capital is not reported for a year but is reported for a previous (or later) year, capital is determined by referring first to the previous year, second to the immediately following year, third to the second previous year and so forth.

(2) If capital is not reported in any year for a company, but total assets are reported in at least one year, we determine capital by multiplying total assets by the capital-to-total-assets ratio, determined with reference to other subsidiaries that are included in Amadeus. To this end, we refer primarily to the capital-to-assets ratio that is reported for subsidiaries of the same parent company (a) in the same year, (b) in the previous year, (c) in the immediately following year, (d) in the second previous year and so forth. If the capital-to-asset ratio is not reported for any of the subsidiaries of the corresponding parent company, we refer, in a similar manner, to all other subsidiaries that are located in the same country.

(3) If capital cannot be determined with either of the two previous approaches, we use operating revenue instead of total assets and determine capital using the same procedure.

Equity investments are allocated to the corresponding shareholders in proportion to the participation rates that are reported in Amadeus. As the shareholding information is not reported on a yearly basis, we employ shareholding data taken from four different updates of Amadeus and assume that the shareholding structure is unchanged between the updates. In particular, we use the shareholding information that is taken from the following updates to allocate equity investments for the corresponding period:

- Update 64 for the years 1994 to 1999
- Update 100 for the years 2000 to 2002
- Update 125 for the years 2003 to 2005
- Update 172 for the years 2006 to 2007

If no shareholding information is available in one of the earlier updates, we refer to the shareholding information from the next update.

Based on this estimate of equity investments, we determine the overall amount of equity investment of company i in year t as

$$shares\ in\ subsidiaries_{i,\,t} = \sum_{s=1}^{S} sh_{s,\,t} \cdot capital_{s,\,t} \tag{65}$$

where sh_s represents the percentage of shareholding in subsidiary s and S refers to the number of subsidiaries. Debt investments are then determined as the residual value. To differentiate between received dividends and interest returns in our historical data (which is required to accurately determine existing amounts of tax loss carry-forwards), we assume that debt investments yield a return equal to the return of ten-year government bonds in the corresponding EU member state. Dividends then are the residual, i. e., overall financial revenue minus interest payments received. This procedure ensures that the advantages of micro-simulation are maintained by determining company-specific values and that our results are not biased by a systematic underestimation of dividends in certain countries. To avoid an underestimation of received dividends, we determine dividend payments according to the second approach described above and use this result as a minimum value for simulated dividends.

10.3.3 Existing tax loss carry-forwards

The amount of tax loss carry-forwards resulting from the pre-simulation period is essential for simulating tax revenue and tax burden. According to the German corporate tax statistics, German corporations reported, in 2004, a positive taxable income before loss-offset of € 106 billion; used loss carry-forwards amounted to € 17 billion. A simulation that completely disregards existing tax loss carry-forwards at the beginning of the simulation period would thus overestimate tax revenue by about 19 percent (= 17/(106-17)). The aim is therefore to identify existing tax loss carry-forwards at the beginning of the simulation period to provide a realistic simulation of tax revenue and tax burden for subsequent years.

Tax loss carry-forwards cannot be observed directly in published annual accounts and thus have to be estimated by using a direct or an indirect approach. A possible point of reference for a direct determination of existing tax loss carry-forwards could be the ratio of taxation to profit/loss for period that is reported in unconsolidated income statements. If profit/loss for period is greater than zero and either no taxes have been paid or the ratio of taxation (i. e., tax liability) to profit/loss for period is substantially below the statutory tax rate, this could serve as an indication for an existing tax loss carry-forward at the beginning of the period. However, this conclusion is not without doubt, as the calculated tax ratio could also be reduced by tax-free income (such as dividends). Moreover, this method only allows for an assessment of tax loss carry-forwards that do not result in deferred taxes in the income statement. Finally, the method is limited to determining whether a tax loss carry-forward has been used in a specific year, whereas no conclusions can be made regarding the amount of remaining tax loss carry-forwards at the end of that year.

Moreover, profits and losses from previous years that are reported on the balance sheet could serve as a point of reference for a direct determination of tax loss carry-forwards. Possible concerns regarding this approach, however, are that (a) differences between book income and taxable income are not taken into account, (b) restrictions of inter-period tax loss-offset are ignored, (c) the impact of loss-offset through group relief may be ignored (at least if group relief does not require cash transfers) and (d) the amount of book profit/loss carried forward is significantly dependent on the companies' dividend policies. In addition, profits and losses from previous years are not shown as separate items in Amadeus but are included in the item other shareholders' funds together with (among others) capital and other reserves. For all of these reasons, we assume that defining tax loss carry-forwards to be equal to a negative value for other shareholders' funds would result in a substantial downward bias. This expectation is supported by calculations for German corporations. In 2004, the total of negative values reported in Amadeus for German corporations for the item other shareholders' funds was € 964 million, whereas the corresponding value in the corporate tax statistics amounted to about € 418 billion.[19]

[19]These numbers indicate a significant underestimation, even when it is considered that not all German companies are included in our data. Thus, the share of existing loss carry-forwards in our data (measured through the sum of negative values of other shareholders' funds) in comparison to the German corporate tax statistics amounts

For these reasons, we apply an indirect approach to determine tax loss carry-forwards. To this end, we apply loss-offset regulations to a proxy of taxable income that is derived from the financial statements for all years prior to the simulation. The item profit/loss for period (before taxation and considering the significant differences between book income and taxable income) serves as a reference point. Adjustments are made for the tax exemption of dividends (for details, see Section 10.3.2) as well as the consequences of group taxation systems (for details, see Section 5.1.3). These adjustments are based on country-specific tax regulations. Other tax features, such as differences between financial and tax accounting or restrictions to the deductibility of interest expenses, are not considered for reasons of simplification. Existing tax losses in the first year of the pre-simulation period are assumed to be zero. For all three steps, the tax regulations of all EU 28 member states are considered.

10.3.4 Identification of corporate groups' industries

As a general rule, Amadeus includes primary and secondary NACE codes (NACE rev. 2) that classify the primary and secondary line of business, respectively, that a company is operating in. To identify the main activity of a corporate group, one method is to rely immediately on the NACE code of the parent company. This option, however, is not considered to be useful because, in cases in which the parent serves as a pure holding company, the industry code of the parent company would not reflect the main activity of the subordinated group. Therefore, the group's industry is derived from the NACE codes of all group companies.

The starting point for determining the group industry is the first-level industry section of the group companies that is reported as an alphabetical code in Amadeus. These company-specific industry sections are weighted within each group according to the companies' sales (50 percent) and total assets (50 percent). The group's industry is then defined as the industry section with the highest share within the corresponding group. The distribution of industries among corporations and corporate groups is summarized in Table 7 in Appendix 2.

to 0.20 percent, whereas the shares of reported profits and losses in comparison to the German corporate tax statistics amount to 13.50 percent and 6.47 percent, respectively.

11 Appendix 2 - Database in its current version

In its current version, ASSERT is mainly based on unconsolidated financial data from Amadeus updates 172 (January 2009) and 125 (February 2005), including financial statements for the years 1994 to 2007. As already mentioned above, ASSERT is restricted to corporations with a legal seat in one of the EU 28 member states. After data preparation as described in Section 10.2, all eligible companies are selected by applying the criteria summarized in Section 10.1, resulting in the number of simulation companies per country shown in Table 5 (column 6). In addition, Table 5 shows the number of corporations in Amadeus with at least the item total assets (column 4). These corporations are used to determine extrapolation factors that are used to estimate tax revenue, as described in Section 7.1. Both the number of simulation companies and the number of corporations with the item total assets are compared to the number of corporations in the whole population as reported in Eurostat[20] and (for Germany) in the corporate tax statistics for the year 2007[21] (columns 5 and 7). In cases in which no information about the data coverage of Eurostat is available, we are not able to report the data coverage of ASSERT and Amadeus. With regard to the United Kingdom, the data coverage of ASSERT and Amadeus refers to the universe of all corporations (i. e., 1,333,100/0.53 = 2,515,283) rather than to the number reported in Eurostat.

Table 5 shows that the data coverage in Amadeus (when at least the item total assets is available) is between 18 and 188 percent. Even though the data coverage is not close to 100 percent in every country, we do not expect this to distort our (extrapolated) results to any significant extent. First, the coverage refers only to the number of companies rather than to the amount of profits or losses. As (especially in the case of Germany) large companies are overrepresented in Amadeus, the coverage of profits and losses is much higher than the coverage of corporations, and missing data on micro-enterprises should not have a large impact on estimated tax revenue. The "excess coverage" in the cases of Denmark, Hungary and Italy is most likely attributable to imprecise or unequal classifications of industry and legal form in Eurostat.[22]

The overall sample of simulation companies consists of 1,247,021 corporations from 19 different EU member states. Companies residing in the remaining nine EU member states are

[20]URL: http://epp.eurostat.ec.europa.eu/portal/page/portal/european_business/special_sbs_topics/business_demography and, for information on coverage, http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/Annexes/bd_esms_an1.pdf

[21] Destatis, 2011.

[22]See also Poppe, 2007, page 91.

Table 5: Data coverage in EUROSTAT, AMADEUS and ASSERT

Country	EUROSTAT/ DESTATIS	Coverage	AMADEUS	Share of population	Simulation companies	Share of population
BE	256,231	na	319,716	na	26,349	na
BG	120,345	∼100%	49,877	41.44%	2,750	2.29%
CZ	154,849	∼99%	85,949	55.51%	11,829	7.64%
DE	844,380	100%	473,485	56.07%	7,328	0.87%
DK	91,751	∼99%	173,211	188.78%	3,464	3.78%
ES	1,226,027	∼99%	696,260	56.79%	214,963	17.53%
FI	118,746	∼95%	79,787	67.19%	35,718	30.08%
FR	1,144,464	na	467,533	na	349,927	na
GB	1,333,100	∼53%	1,854,571	73.84%	16,112	0.64%
GR	na	na	28,039	na	13,105	na
HU	166,252	100%	267,387	160.83%	4,026	2.42%
IT	685,630	very good	813,942	118.71%	215,837	31.48%
LU	19,338	98-99%	6,896	35.66%	183	0.95%
NL	221,594	na	301,594	na	699	0.32%
PL	na	na	57,107	na	14,737	na
PT	312,660	na	196,850	na	107,449	na
RO	na	na	124,082	na	104,468	na
SE	252,498	∼99%	228,004	90.30%	115,383	45.70%
SK	75,280	∼99%	13,594	18.06%	2,694	3.58%
Total	7,359,151		6,237,884		1,247,021	

excluded for different reasons. Whereas no data on Croatian, Cypriot and Slovenian companies are available in AMADEUS, Estonian companies are not covered because the available data do not allow for an assessment of the asset structure. In addition (and as pointed out in Sections 3.2.2 and 3.2.4), at least 180 three-year datasets for the generation of bins of comparable companies have to be available for each country to apply the described forecasting approach. This requirement is not met by Austria, Ireland, Lithuania and Malta, as shown in Table 6. In the case of Latvia, more than 180 three-year datasets are available, but the number of simulation companies for Latvia is not comprehensive enough to guarantee a realistic estimation of the revenue consequences of tax reforms. Table 6 shows the number of three-year datasets per country; rows with gray background indicate that these countries are not included in the simulation procedure. Table 7 presents the distribution of industries within the simulation companies.

Table 6: Three-year datasets available for the generation of bins (comparable companies)

State	2000 -2002	2001 -2003	2002 -2004	2003 -2005	2004 -2006	2005 -2007	Total
AT	-	-	-	4	41	106	(151)
BE	15,437	16,469	18,071	19,158	19,621	19,797	108,553
BG	2,450	2,947	3,539	5,574	6,042	7,998	28,550
CY	-	-	-	-	-	-	-
CZ	2,710	3,744	9,017	14,797	16,073	8,137	54,478
DE	837	1,963	3,496	5,907	6,845	4,439	23,487
DK	-	25	105	2,036	2,435	2,421	7,022
EE	9,170	5,565	5,589	5,671	7,178	9,872	(43,045)
ES	173,910	215,314	245,910	273,749	272,492	180,572	1,361,947
FI	21,522	23,711	24,708	26,904	28,840	28,773	154,458
FR	263,675	284,276	306,167	321,515	325,136	291,111	1,791,880
GB	6,998	7,212	8,096	8,754	9,853	9,855	50,768
GR	10,842	11,648	11,968	12,760	13,231	13,222	73,671
HR	-	-	-	-	-	-	-
HU	20	22	75	465	5,365	3,186	9,133
IE	-	-	-	-	-	-	-
IT	43,614	67,078	99,836	96,611	172,982	169,831	649,952
LU	33	54	87	197	278	119	768
LT	-	-	-	-	-	-	-
LV	24	48	58	71	67	67	(335)
MT	-	-	-	-	-	-	-
NL	242	281	476	599	666	451	2,715
PL	3,231	4,585	6,366	7,953	8,411	8,235	38,781
PT	8,674	10,280	16,550	25,012	31,000	90,706	182,222
RO	11,279	15,656	19,366	28,310	44,457	71,871	190,939
SE	69,540	74,403	80,472	87,993	94,827	99,915	507,150
SI	-	-	-	-	-	-	-
SK	377	610	1,006	1,932	2,389	1,282	7,596

Table 7: Distribution of industries among corporations and corporate groups

Industry	Name	Division in Nace Rev. 2	Number of corporations	Number of groups
A	Agriculture, forestry, fishing	01 - 03	21,400	671
B	Mining, quarrying	05 - 09	3,583	298
C	Manufacturing	10 - 33	190,611	15,087
D	Electricity, gas, steam, air conditioning supply; water supply; sewerage, waste management, remediation activities	35 - 39	2,393	580
E	Construction	41 - 43	167,679	7,168
F	Wholesale and retail trade; repair of motor vehicles and motorcycles	45 - 47	370,104	17,266
G	Accommodation and food service activities	55 - 56	82,772	1,790
H	Transportation, storage	49 - 53	64,024	3,244
I	Information, communication	58 - 63	46,257	3,106
J	Financial and insurance activities	64 - 66	16,443	2,855
K	Real estate activities	68	43,856	3,131
L	Professional, scientific, technical, administrative, support and other service activities	69 - 82, 94 - 96	182,390	8,832
M	Miscellaneous	remaining	55,509	2,217
Total			1,247,021	66,245

12 Appendix 3 - Accuracy of the model - country tables

Table 8: Forecasting quality of ASSERT - Belgium

Year		2008	2009	2010
Total assets	Number of observations	10,986	10,690	3,897
ASSERT	Mean	48,306	48,961	75,087
	Median	4,427	4,483	5,059
	Standard deviation	573,481	576,276	857,898
Amadeus	Mean	61,363	64,007	114,189
	Median	4,761	4,720	5,422
	Standard deviation	828,398	891,081	1,428,689
Comparison	Correlation	0.922	0.915	0.930
	P-value of two-tailed t-test	0.000	0.000	0.001
Liabilities	Number of observations	10,986	10,690	3,897
ASSERT	Mean	26,585	29,883	51,127
	Median	2,472	2,587	2,907
	Standard deviation	379,297	415,181	713,996
Amadeus	Mean	30,900	31,086	51,501
	Median	2,643	2,515	2,713
	Standard deviation	422,419	431,860	671,085
Comparison	Correlation	0.917	0.913	0.920
	P-value of two-tailed t-test	0.008	0.483	0.934
Depreciation	Number of observations	10,971	10,617	3,863
ASSERT	Mean	874	956	1,204
	Median	119	130	167
	Standard deviation	6,650	7,087	7,440
Amadeus	Mean	895	979	1,138
	Median	120	126	146
	Standard deviation	7,040	8,285	7,941
Comparison	Correlation	0.965	0.888	0.885
	P-value of two-tailed t-test	0.241	0.548	0.274
Operating profit/loss	Number of observations	10,986	10,690	3,897
ASSERT	Mean	1,678	1,796	2,091
	Median	231	220	266
	Standard deviation	19,540	21,223	17,903
Amadeus	Mean	1,477	1,266	2,054
	Median	201	152	240
	Standard deviation	15,585	18,893	20,492
Comparison	Correlation	0.747	0.711	0.751
	P-value of two-tailed t-test	0.106	0.000	0.865

Table 9: Forecasting quality of ASSERT - Czech Republic

Year		2008	2009	2010
Total assets	Number of observations	6,178	5,571	1,061
ASSERT	Mean	11,157	12,392	15,049
	Median	1,901	2,173	1,930
	Standard deviation	62,281	72,816	81,366
AMADEUS	Mean	10,946	11,705	14,596
	Median	2,006	2,085	1,747
	Standard deviation	55,933	63,992	74,249
Comparison	Correlation	0.927	0.925	0,973
	P-value of two-tailed t-test	0.481	0.065	0.446
Liabilities	Number of observations	6,180	5,572	1,061
ASSERT	Mean	5,845	6,738	7,230
	Median	1,001	1,178	1,112
	Standard deviation	35,327	39,097	32,902
AMADEUS	Mean	5,306	5,299	6,202
	Median	900	876	701
	Standard deviation	32,602	32,036	30,880
Comparison	Correlation	0.932	0.846	0.940
	P-value of two-tailed t-test	0.001	0.000	0.003
Depreciation	Number of observations	6,124	5,500	1,050
ASSERT	Mean	654	784	1,046
	Median	58	69	72
	Standard deviation	7,986	8,460	8,912
AMADEUS	Mean	619	670	839
	Median	53	62	60
	Standard deviation	8,947	8,145	7,420
Comparison	Correlation	0.976	0.943	0.980
	P-value of two-tailed t-test	0.194	0.003	0.003
Operating profit/loss	Number of observations	6,180	5,572	1,061
ASSERT	Mean	1,007	801	1,298
	Median	140	115	131
	Standard deviation	7,042	7,010	9,085
AMADEUS	Mean	832	686	1,011
	Median	130	83	109
	Standard deviation	6,564	7,169	5,736
Comparison	Correlation	0.740	0.213	0.658
	P-value of two-tailed t-test	0.005	0.335	0.172

Table 10: Forecasting quality of ASSERT - Finland

Year		2008	2009	2010
Total assets	Number of observations	10,065	9,839	6,825
ASSERT	Mean	11,811	11,822	14,215
	Median	1,132	1,147	1,079
	Standard deviation	229,775	232,247	278,152
AMADEUS	Mean	14,096	13,957	18,083
	Median	1,340	1,357	1,357
	Standard deviation	274,123	262,048	326,468
Comparison	Correlation	0.902	0.900	0.891
	P-value of two-tailed t-test	0.055	0.064	0.032
Liabilities	Number of observations	10,065	9,839	6,825
ASSERT	Mean	6,928	7,050	8,098
	Median	681	733	707
	Standard deviation	118,399	117,702	137,354
AMADEUS	Mean	7,633	7,417	9,157
	Median	627	607	610
	Standard deviation	138,006	129,234	158,405
Comparison	Correlation	0.921	0.916	0.869
	P-value of two-tailed t-test	0.195	0.483	0.265
Depreciation	Number of observations	9,985	9,700	6,694
ASSERT	Mean	324	321	381
	Median	44	41	45
	Standard deviation	5,508	5,709	6,978
AMADEUS	Mean	332	348	314
	Median	44	44	43
	Standard deviation	6,642	6,808	4,393
Comparison	Correlation	0.958	0.949	0.672
	P-value of two-tailed t-test	0.724	0.233	0.295
Operating profit/loss	Number of observations	10,065	9,839	6,825
ASSERT	Mean	358	263	445
	Median	123	104	113
	Standard deviation	13,882	9,292	5,785
AMADEUS	Mean	448	293	620
	Median	131	96	112
	Standard deviation	10,994	8,070	9,403
Comparison	Correlation	0.893	0.308	-0.142
	P-value of two-tailed t-test	0.161	0.768	0.217

Table 11: Forecasting quality of ASSERT - France

Year		2008	2009	2010
Total assets	Number of observations	111,999	104,469	34,738
ASSERT	Mean	8,376	8,357	7,403
	Median	1,288	1,284	1,115
	Standard deviation	147,750	150,887	103,069
AMADEUS	Mean	9,132	8,914	7,772
	Median	1,403	1,401	1,286
	Standard deviation	271,724	274,717	114,535
Comparison	Correlation	0.950	0.953	0.935
	P-value of two-tailed t-test	0.069	0.194	0.092
Liabilities	Number of observations	112,000	104,469	34,738
ASSERT	Mean	5,378	5,478	4,784
	Median	756	763	661
	Standard deviation	77,834	79,835	56,319
AMADEUS	Mean	5,570	5,287	4,564
	Median	814	783	696
	Standard deviation	117,982	119,472	78,092
Comparison	Correlation	0.935	0.932	0.862
	P-value of two-tailed t-test	0.227	0.250	0.318
Depreciation	Number of observations	111,597	103,680	34,426
ASSERT	Mean	239	245	235
	Median	32	33	33
	Standard deviation	4,769	4,902	4,187
AMADEUS	Mean	240	235	207
	Median	32	34	32
	Standard deviation	4,083	3,737	2,645
Comparison	Correlation	0.700	0.684	0.721
	P-value of two-tailed t-test	0.867	0.336	0.074
Operating profit/loss	Number of observations	112,000	104,469	34,738
ASSERT	Mean	566	538	610
	Median	98	86	84
	Standard deviation	8,908	12,557	15,521
AMADEUS	Mean	489	383	453
	Median	96	77	90
	Standard deviation	7,099	5,509	5,951
Comparison	Correlation	0.522	0.280	0.416
	P-value of two-tailed t-test	0.001	0.000	0.039

Table 12: Forecasting quality of ASSERT - Germany

Year		2008	2009	2010
Total assets	Number of observations	4,472	4,214	908
ASSERT	Mean	110,253	108,933	229,128
	Median	14,785	14,538	16,107
	Standard deviation	686,911	657,811	1,243,335
AMADEUS	Mean	120,937	118,685	275,149
	Median	16,404	15,317	17,618
	Standard deviation	729,638	745,345	1,592,774
Comparison	Correlation	0.975	0.972	0.956
	P-value of two-tailed t-test	0.000	0.001	0.011
Liabilities	Number of observations	4,472	4,214	908
ASSERT	Mean	69,317	67,646	146,258
	Median	8,691	7,728	9,422
	Standard deviation	445,057	413,704	790,483
AMADEUS	Mean	76,688	72,654	165,376
	Median	9,105	8,372	9,465
	Standard deviation	489,005	477,917	991,933
Comparison	Correlation	0.946	0.935	0.936
	P-value of two-tailed t-test	0.002	0.060	0.076
Depreciation	Number of observations	4,408	4,176	896
ASSERT	Mean	4,111	3,298	5,888
	Median	453	385	381
	Standard deviation	25,279	19,809	38,020
AMADEUS	Mean	4,080	3,786	6,809
	Median	462	451	441
	Standard deviation	22,988	21,807	44,207
Comparison	Correlation	0.980	0.973	0.988
	P-value of two-tailed t-test	0.691	0.000	0.002
Operating profit/loss	Number of observations	4,416	4,191	902
ASSERT	Mean	5,847	5,095	11,445
	Median	824	676	1,199
	Standard deviation	32,666	27,888	51,485
AMADEUS	Mean	5,190	4,633	10,814
	Median	688	479	745
	Standard deviation	38,655	37,771	60,711
Comparison	Correlation	0.613	0.741	0.767
	P-value of two-tailed t-test	0.170	0.238	0.629

Table 13: Forecasting quality of ASSERT - Italy

Year		2008	2009	2010
Total assets	Number of observations	98,124	94,377	21,333
ASSERT	Mean	7,557	7,849	9,220
	Median	2,114	2,180	2,139
	Standard deviation	66,016	67,201	104,329
Amadeus	Mean	8,195	8,321	10,045
	Median	2,368	2,392	2,420
	Standard deviation	65,511	77,712	139,090
Comparison	Correlation	0.967	0.945	0.951
	P-value of two-tailed t-test	0.000	0.000	0.019
Liabilities	Number of observations	98,124	94,377	21,333
ASSERT	Mean	5,522	5,711	6,464
	Median	1,569	1,593	1,491
	Standard deviation	47,608	48,454	72,946
Amadeus	Mean	5,681	5,659	6,526
	Median	1,692	1,690	1,611
	Standard deviation	45,285	49,031	83,776
Comparison	Correlation	0.942	0.928	0.923
	P-value of two-tailed t-test	0.002	0.384	0.781
Depreciation	Number of observations	97,626	93,670	21,223
ASSERT	Mean	256	278	372
	Median	54	56	63
	Standard deviation	3,227	3,569	6,122
Amadeus	Mean	251	261	304
	Median	54	57	57
	Standard deviation	3,071	3,169	3,863
Comparison	Correlation	0.961	0.882	0.934
	P-value of two-tailed t-test	0.095	0.002	0.001
Operating profit/loss	Number of observations	98,124	94,377	21,333
ASSERT	Mean	355	298	391
	Median	92	818	93
	Standard deviation	4,051	4,005	6,408
Amadeus	Mean	267	220	346
	Median	94	72	84
	Standard deviation	17,951	4,536	12,337
Comparison	Correlation	0.219	0.573	0.595
	P-value of two-tailed t-test	0.118	0.000	0.513

Table 14: Forecasting quality of ASSERT - Poland

Year		2008	2009	2010
Total assets	Number of observations	9,915	9,200	1,082
ASSERT	Mean	8,218	9,332	12,783
	Median	1,986	2,331	2,876
	Standard deviation	45,199	48,180	55,790
AMADEUS	Mean	8,737	9,320	12,546
	Median	2,029	2,161	2,499
	Standard deviation	49,106	54,375	66,493
Comparison	Correlation	0.972	0.933	0.923
	P-value of two-tailed t-test	0.000	0.956	0.765
Liabilities	Number of observations	9,913	9,198	1,082
ASSERT	Mean	4,596	5,679	7,958
	Median	1,055	1,302	1,678
	Standard deviation	25,039	35,405	38,242
AMADEUS	Mean	4,688	4,792	5,909
	Median	911	904	961
	Standard deviation	27,759	29,018	37,918
Comparison	Correlation	0.909	0.717	0.903
	P-value of two-tailed t-test	0.429	0.001	0.000
Depreciation	Number of observations	9,784	9,030	1,045
ASSERT	Mean	432	505	601
	Median	62	74	98
	Standard deviation	5,115	5,504	4,210
AMADEUS	Mean	416	454	492
	Median	59	66	69
	Standard deviation	4,625	5,054	3,852
Comparison	Correlation	0.980	0.992	0.982
	P-value of two-tailed t-test	0.155	0.000	0.000
Operating profit/loss	Number of observations	9,906	9,191	1,082
ASSERT	Mean	905	880	1,244
	Median	180	182	278
	Standard deviation	7,852	6,312	5,179
AMADEUS	Mean	870	808	1,007
	Median	163	135	180
	Standard deviation	7,596	7,201	4,869
Comparison	Correlation	0.855	0.702	0.343
	P-value of two-tailed t-test	0.400	0.191	0.176

Table 15: Forecasting quality of ASSERT - Spain

Year		2008	2009	2010
Total assets	Number of observations	72,304	67,375	292
ASSERT	Mean	9,824	10,697	288,772
	Median	2,090	2,241	24,732
	Standard deviation	132,216	137,361	1,095,405
Amadeus	Mean	9,599	9,634	278,630
	Median	2,056	2,050	21,102
	Standard deviation	131,605	122,712	1,007,174
Comparison	Correlation	0.966	0.953	0.902
	P-value of two-tailed t-test	0.078	0.000	0.714
Liabilities	Number of observations	72,304	67,375	292
ASSERT	Mean	6,491	7,288	204,682
	Median	1,194	1,327	13,572
	Standard deviation	94,913	105,589	920,559
Amadeus	Mean	6,145	5,948	172,350
	Median	1,078	1,020	11,367
	Standard deviation	100,033	86,091	661,951
Comparison	Correlation	0.954	0.907	0.826
	P-value of two-tailed t-test	0.002	0.000	0.296
Depreciation	Number of observations	71,109	65,848	291
ASSERT	Mean	385	450	18,832
	Median	55	70	646
	Standard deviation	13,402	15,336	132,390
Amadeus	Mean	295	303	11,929
	Median	44	44	287
	Standard deviation	8,358	8,326	71,217
Comparison	Correlation	0.951	0.959	0.953
	P-value of two-tailed t-test	0.000	0.000	0.085
Operating profit/loss	Number of observations	72,295	67,366	292
ASSERT	Mean	565	452	8,790
	Median	85	72	506
	Standard deviation	15,586	11,469	120,919
Amadeus	Mean	550	439	25,557
	Median	85	59	438
	Standard deviation	22,318	21,847	170,277
Comparison	Correlation	0.848	0.509	0.470
	P-value of two-tailed t-test	0.745	0.858	0.067

Table 16: Forecasting quality of ASSERT - Sweden

Year		2008	2009	2010
Total assets	Number of observations	32,099	31,998	21,182
ASSERT	Mean	10,511	11,343	10,622
	Median	972	1,054	1,087
	Standard deviation	216,180	230,652	253,658
AMADEUS	Mean	11,754	12,606	13,115
	Median	1,176	1,167	1,222
	Standard deviation	243,303	290,896	383,280
Comparison	Correlation	0.987	0.953	0.918
	P-value of two-tailed t-test	0.000	0.024	0.045
Liabilities	Number of observations	32,099	31,998	21,182
ASSERT	Mean	6,945	7,620	6,582
	Median	602	687	711
	Standard deviation	125,724	147,338	131,461
AMADEUS	Mean	6,864	7,312	7,869
	Median	640	617	615
	Standard deviation	125,842	167,072	247,847
Comparison	Correlation	0.841	0.684	0.855
	P-value of two-tailed t-test	0.837	0.662	0.216
Depreciation	Number of observations	31,886	31,742	20,933
ASSERT	Mean	281	333	304
	Median	28	32	42
	Standard deviation	3,984	4,686	3,835
AMADEUS	Mean	262	281	243
	Median	30	30	30
	Standard deviation	2,892	3,078	2,701
Comparison	Correlation	0.914	0.812	0.894
	P-value of two-tailed t-test	0.059	0.001	0.000
Operating profit/loss	Number of observations	32,090	31,986	21,174
ASSERT	Mean	594	301	575
	Median	86	80	86
	Standard deviation	9,697	25,392	8,732
AMADEUS	Mean	802	553	748
	Median	102	80	108
	Standard deviation	18,453	20,346	18,209
Comparison	Correlation	0.586	-0.395	0.767
	P-value of two-tailed t-test	0.013	0.240	0.049

Table 17: Forecasting quality of ASSERT - United Kingdom

Year		2008	2009	2010
Total assets	Number of observations	8,206	8,046	3,957
ASSERT	Mean	68,877	77,753	63,112
	Median	5,313	5,830	5,568
	Standard deviation	598,885	664,769	347,711
AMADEUS	Mean	75,565	77,415	70,043
	Median	6,380	6,419	6,208
	Standard deviation	563,319	540,419	467,344
Comparison	Correlation	0.855	0.830	0.896
	P-value of two-tailed t-test	0.055	0.935	0.047
Liabilities	Number of observations	8,206	8,046	3,957
ASSERT	Mean	49,108	58,095	47,525
	Median	3,145	3,796	3,662
	Standard deviation	501,649	573,274	285,924
AMADEUS	Mean	51,103	51,231	45,815
	Median	3,380	3,253	3,188
	Standard deviation	406,986	386,232	275,580
Comparison	Correlation	0.743	0.772	0.929
	P-value of two-tailed t-test	0.592	0.095	0.313
Depreciation	Number of observations	8,145	7,945	3,877
ASSERT	Mean	2,111	2,485	1,941
	Median	117	134	154
	Standard deviation	22,105	25,287	10,793
AMADEUS	Mean	2,196	2,386	1,707
	Median	131	133	121
	Standard deviation	21,885	22,152	9,721
Comparison	Correlation	0.968	0.958	0.915
	P-value of two-tailed t-test	0.170	0.246	0.001
Operating profit/loss	Number of observations	8,181	8,020	3,954
ASSERT	Mean	4,213	4,146	5,306
	Median	376	285	352
	Standard deviation	42,596	86,602	44,439
AMADEUS	Mean	4,245	4,362	4,570
	Median	409	356	440
	Standard deviation	43,650	40,666	23,495
Comparison	Correlation	0.481	0.126	0.418
	P-value of two-tailed t-test	0.947	0.831	0.255

References

[Bach et al., 2008] Bach, S., Buslei, H., Dwenger, N., Fossen, F. Dokumentation des Mikrosimulationsmodells BizTax zur Unternehmensbesteuerung in Deutschland. Data Documentation 29, DIW Berlin 2008

[Blouin et al., 2010] Blouin, J., Core, J.E., Guay, W.R. Have the tax benefits of debt been overestimated? In: Journal of Financial Economics 98 (2010), pp. 195–213

[Castellucci et al., 2003] Castellucci, L., Coromaldi, M., Parisi, V., Perlini, L., Zoli, M. Report Describing Results and Country IT Tax Schedule Model. Technical Report, University of Rome Tor Vergata 2003

[Collins & Shackelford, 1995] Collins, J.H., Shackelford, D.A. Corporate Domicile and Average Effective Tax Rates: The Cases of Canada, Japan, the United Kingdom, and the United States. In: International Tax and Public Finance 2 (1995), pp. 55–83

[Creedy & Gemmell, 2007] Creedy, J., Gemmell, N. Corporation Tax Revenue Growth in the UK: A Microsimulation Analysis. Research Paper Number 984, The University of Melbourne - Department of Economics 2007

[Destatis, 2011] Destatis. Statistisches Bundesamt. Jährliche Körperschaftsteuerstatistik 2007. Wiesbaden 2011

[Devereux & Griffith, 1999] Devereux, M.P., Griffith, R. The taxation of discrete investment choices. Working Paper Series No. W98/16, The Institute for Fiscal Studies 1999

[Fairfield et al., 2009] Fairfield, P.M., Ramnath, S., Yohn, T.L. Do Industry-Level Analyses Improve Forecasts of Financial Performance? In: Journal of Accounting Research 47 (2009), pp. 147–178

[Fama & French, 2000] Fama, E., French, K. Forecasting Profitability and Earnings. In: Journal of Business 73 (2000), pp. 161–175

[Graham, 1996a] Graham, J. Debt and the marginal tax rate. In: Journal of Financial Economics 41 (1996a), pp. 41–73

[Graham, 1996b] Graham, J. Proxies for the corporate marginal tax rate. In: Journal of Financial Economics 42 (1996b), pp. 187–221

[Graham & Kim, 2009] Graham, J., Kim, H. Simulating Corporate Marginal Income Tax Rates and Implications for Corporate Debt Policy. Working Paper, Duke University 2009

[Koch, 2010] Koch, R. Die Aufkommens- und Belastungswirkungen alternativer Vorschläge zur Reform der Konzernbesteuerung in Europa. Dissertation, Georg-August-Universität Göttingen 2010

[Nicodème, 2001] Nicodème, G. Computing effective corporate tax rates: comparisons and results. MPRA Paper No. 3808, European Commission, DG Economics and Financial Affairs 2001

[Oestreicher & Koch, 2011] Oestreicher, A., Koch, R. The Revenue Consequences of Using a Common Consolidated Corporate Tax Base to Determine Taxable Income in the EU Member States. In: FinanzArchiv 67 (2011), pp. 64–102

[Oestreicher et al., 2012] Oestreicher, A., Koch, R., Vorndamme, D., Hohls, S. Aufkommenswirkungen einer Abschaffung des Ergebnisabführungsvertrags bei der ertragsteuerlichen Organschaft. IFSt-Schrift Nr. 482, Berlin 2012

[Oropallo & Parisi, 2005] Oropallo, F., Parisi, V. Will Italy's Tax Reform Reduce the Corporate Tax Burden? A Microsimulation Analysis. Working Paper No. 403, ISTAT, University of Cassino 2005

[Plesko, 2003] Plesko, G. An evaluation of alternative measures of corporate tax rates. In: Journal of Accounting and Economics 35 (2003), pp. 201–226

[Poppe, 2007] Poppe, A. Auswirkungen der Einführung einer konsolidierten Körperschaftsteuer-Bemessungsgrundlage in der Europäischen Union. Dissertation, Georg-August-Universität Göttingen 2007

[Reister et al., 2008] Reister, T., Spengel, C., Heckemeyer, J., Finke, K. ZEW Corporate Taxation Microsimulation Model (ZEW TaxCoMM). Discussion Paper No. 08-117, ZEW Zentrum für Europäische Wirtschaftsforschung 2008

[Schratzenstaller, 2004] Schratzenstaller, M. Zur Ermittlung der faktischen effektiven Unternehmenssteuerlast. In: Perspektiven der Unternehmensbesteuerung. Schratzenstaller, M. and Truger, A. 2004, pp. 43–76

[Shevlin, 1990] Shevlin, T. Estimating Corporate Marginal Tax Rates with Asymmetric Tax Treatment of Gains and Losses. In: Journal of the American Taxation Association 11 (1990), pp. 51–67

[Zimmerman, 1983] Zimmerman, J. Taxes and firm size. In: Journal of Accounting and Economics 5 (1983), pp. 119–149

FAT

Georg-August-Universität Göttingen
Faculty of Economic Sciences
Finance · Accounting · Taxes

Platz der Göttinger Sieben 3
D-37073 Göttingen
Phone +49 / 5 51 / 39 73 08
Fax +49 / 5 51 / 39 78 74
www.fat.business.uni-goettingen.de