SIMULTANEOUS MODELS FOR ACCOUNTING POLICY OPTIMIZATION OF STOCK CORPORATIONS ACCORDING TO GERMAN COMMERCIAL LAW

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Abstract

The paper presents simultaneous models for accounting policy optimization of stock corporations according to German commercial law. In particular, we illustrate the integration into the optimization models of effective income tax, deferred taxes, remuneration principles for members of management boards and supervisory boards under stock corporation law, parameters for the distribution of profits, and key indicators of the annual financial statements. The models are useful to design optimal financial statements in line with the targets of the company**.

Keywords: Accounting Policy, Accounting Policy Optimization, Simultaneous Optimization Model

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1 Introduction

According to prevailing academic opinion, the accounting policy of a company is used to affect the behavior of its addressees (e.g., shareholders, investors, suppliers, creditors, employees, tax authorities, analysts, public opinion, etc.) in line with the targets of the company by means of conscientious, admissible design and planning of the accounting instruments (e.g., annual financial statements). Since the mid-1980s, intensive work has been carried out to design IT-based decision-making models for the purpose of simultaneous planning of the annual financial statement. In recent decades, a variety of new concepts and modifications to meet the changing basic legal and economic conditions has contributed to an extension of the optimization models (Freidank 1990; Freidank 2001, p. 1–24; Freidank and Buchholz 2008, p. 109–133; Freidank and Reibis 2007, p. 295–314; Freidank and Velte 2013, p. 883-930; Freidank, Bauer and Sassen 2014 p. 848–861; Hahn and Schneider 1998, p. 333–405; Johänngten-Holthoff 1985; Kloock 1989, p. 141–158; Krog 1998, p. 273–331; Lachnit and Freidank 1990, p. 29–39; Reibis 2005; Schäfer 1999; Seelbach and Fischer 1998, p. 231–271).

The purpose of this paper is to illustrate simultaneous models for accounting policy optimization of stock corporations according to German commercial law. Therefore, we will show how the above mentioned models have to be adapted to the provisions of the current German commercial and tax law (in particular the German Körperschaftsteuergesetz [KStG, Corporate Tax Act], Solidaritätszuschlagsgesetz [SolZG, Solidarity Surcharge Act], Gewerbesteuergesetz [GewStG, Trade Tax Act], and the Handelsgesetzbuch [HGB, Commercial Code]) and how they have to be modified from a decision-oriented perspective in regard to stock corporations. We will focus in particular on the integration into the optimization models of effective income tax; deferred taxes, which was comprehensively modified in 2009 by the German Accounting Modernization Act (Bilanzrechtsmodernisierungsgesetz [BilMoG]); remuneration principles for members of management boards and supervisory boards under stock corporation law; parameters for the distribution of profits; and key indicators of the annual financial statements.

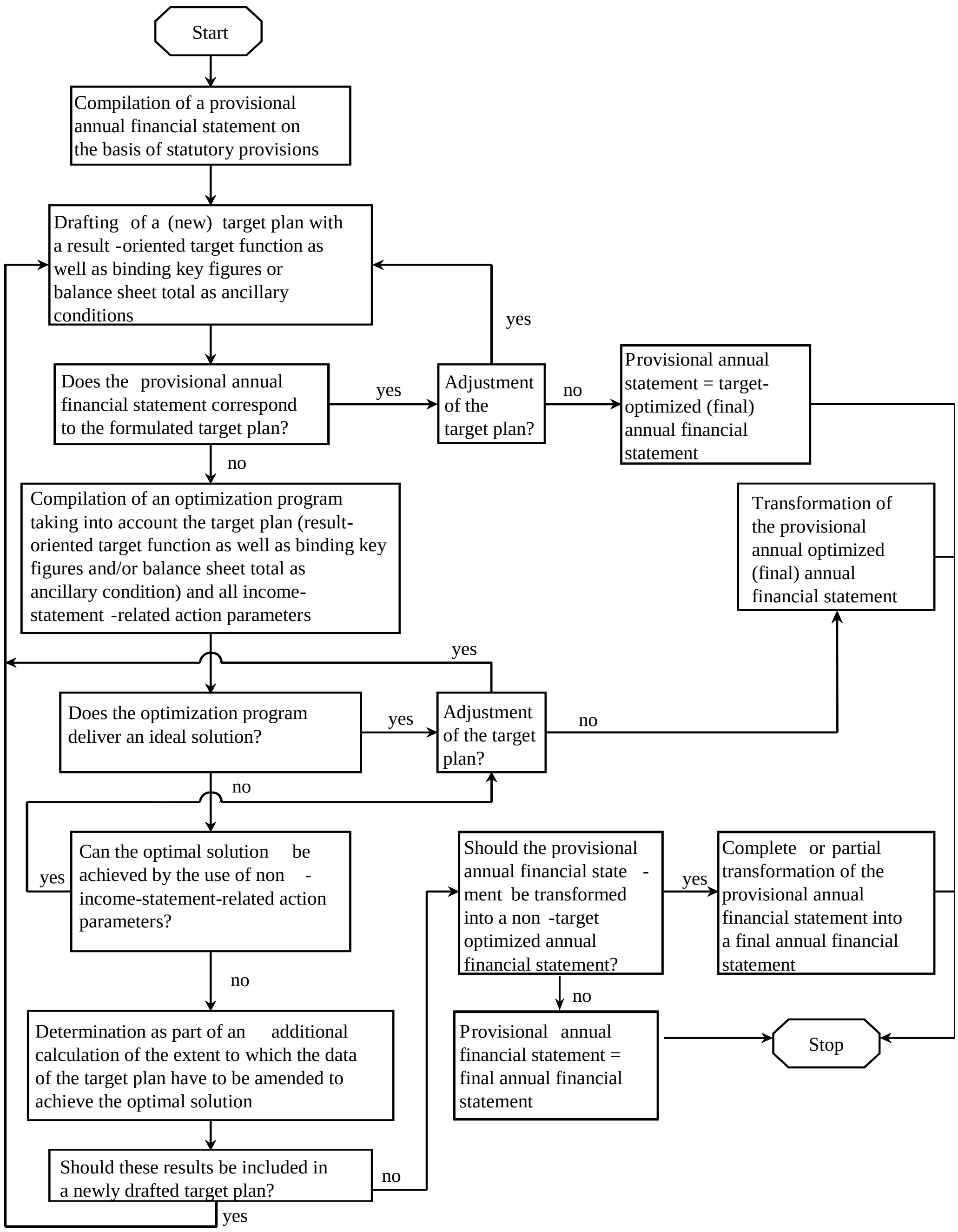
The remainder of this paper is organized as follows. Section 2 contains model extensions regarding the planning of annual financial statements. It starts with a general systematization, the determination of the target function, and the definition of the restrictions. This subsection analyzes the reporting of effective income tax effects, the inclusion of deferred tax effects, the recognition of bonuses for management board and supervisory board members, the restrictions relating action parameters to the impact on the result, the restrictions on noncompliant options regarding the German generally accepted accounting principles, the restrictions relating to the action parameters that draw on the results, and the restrictions relating to selected annual financial statement indicators. Section 3 contains examples that explain the models. Finally, results are presented in a summary in Section 4.

2 Model extensions regarding the planning of annual financial statements

2.1 General systematization

A provisional annual statement compiled on the basis of the commercial law provisions forms the starting point for the optimization approaches in the models for the result- or dividend-related accounting policy (Fig. 1). This provisional annual statement has to be transformed simultaneously in consideration of a target (i.e., target function and certain binding restrictions) through the use of the available result-effective action parameters into a target-optimal annual financial statement. If a target-adequate, optimal solution cannot be achieved after this process, it must be analyzed whether the solution can be achieved through the additional use of result-ineffective action parameters. If the program then still fails to devise an optimal solution, there is the option to use an additional calculation of how the target plan must be amended to ensure that the models nevertheless result in an optimal solution. Otherwise, the provisional annual financial statement is adopted as the final statement.

Figure 1. Flowchart to determine the target-optimized annual financial statement



Source: Freidank and Velte 2013, p. 900

Regarding these reactive effects, the models also have sequential features. Decision-makers can express the target function either by way of extremization (maximization or minimization) or by determining a fixed annual net profit. The following restrictions are taken into account as secondary targets in the form of binding ancillary conditions:

- statutory options and the scope of discretion regarding recognition and valuation in the balance sheet of each individual action parameter as well as certain profit allocation options with their upper and bottom limits (maneuvering funds);
- certain key figure levels that have to be considered from a corporate policy perspective;
- limits regarding the recording of effective and deferred income taxes;
- limits regarding the consideration of annual financial statement-related remuneration concepts for the management and supervisory boards;
- upper limits regarding the balance sheet total, because exceeding these limits might trigger certain publicity and audit obligations according to sec. 267 of the German Commercial Code.

For reasons of transparency, the following concepts only include selected key figures as well as the most important balance sheet and tax-law-related provisions. However, the models can generally be extended. The solution of the approaches can be achieved with the help of mathematical optimization programs, which are offered by various software vendors. In order to determine the input values required for the optimization calculations and the subsequent transformation of the provisional target-optimized annual financial statement, the use of spreadsheet calculation software is recommended.

2.2 Determination of the target function

If the provisional annual result before result-related revenues (e.g., corporate tax, trade tax, deferred taxes, and bonuses) and before use of maneuvering income is designated as vJvor, and if the positive and negative income statement-related action parameters (maneuvering funds) regarding the values of the individual preliminary balance sheet items of the fixed and current assets, of the accruals and deferrals, as well as long-term and short-term debts are designated as xA, XA, xAü, XAü, xa, Xa, xaü, Xaü, xU, XU, xUü, XUü, xu, Xu, xuü, Xuü, xFl, XFl, xFk, XFk, xfl, Xfl, xfk, Xfk, xRa, XRa, xra, Xra, then an intended target annual result of the commercial annual financial statement (sJnach) can be determined according to result-related income and according to maneuvering fund use as shown generally in Equation (1):

$$\text{sJnach} - \text{vJvor} = -\text{XKSt} - \text{XGewSt} - \text{XLS} - \text{xTAvor} - \text{xTAauf} + \text{xA} + \text{XA} + \text{xAü} + \text{XAü} - \text{xa} - \text{Xa} - \text{xaü} - \text{Xaü} + \text{xU} + \text{XU} + \text{xUü} + \text{XUü} - \text{xu} - \text{Xu} - \text{xuü} - \text{Xuü} + \text{xFl} + \text{XFl} + \text{xFk} + \text{XFk} - \text{xfl} - \text{Xfl} - \text{xfk} - \text{Xfk} + \text{xRa} + \text{XRa} - \text{xra} - \text{Xra}. \quad (1)$$

In this case, the subscriptions of the variables (X, x) mean:

A, a = fixed assets
Aü, aü = other fixed assets
Fk, fk = short-term debts
Fl, fl = long-term debts
GewSt = trade tax
KSt = corporate tax
LS = deferred income taxes
Ra, ra = accruals and deferrals
U, u = inventories
Uü, uü = other current assets
TAauf = supervisory board bonuses
TAvor = management board bonuses.

Receivables and other assets as well as current financial assets (sec. 266(2) HGB) are classified as other current assets. Asset items in uppercase signify an increase and those in lowercase signify a decrease. The reverse applies for debt items: positive parameters lead to an increase in the annual result and negative parameters to a decrease. This means, for example, that if variable Xu (the value of the action parameters that reduce the inventory assets) refers to the possibility of an additional set off of expenditure when using the "last-in, first-out" method relative to the average valuation undertaken in the provisional annual financial statement, the use of this option will have a negative impact on the target annual result (sJnach). By contrast, the write-up of investment securities held as fixed assets in the form of variable XAÜ (the value of those action parameters that increase the amount of the value of the other fixed assets) leads to an increase in the target annual result (sJnach).

Due to the amendment of the German authoritative principle that tax accounting should be based on commercial accounting by the German Accounting Modernization Act (Bilanzrechtsmodernisierungsgesetz [BilMoG]) in sec. 5(1) EStG (Freidank/Velte 2010, pp. 185–194), all action parameters that modify the annual result must be classified into the following groups.

Group I: These include only options permitted by commercial law, which may not be taken into consideration for the purposes of calculating income tax due to violating the aforementioned authoritative principle.

Group II: These include the commercial and tax law options that are compliant with the German generally accepted accounting principles and are taken into consideration for the purposes of the commercial annual financial statement as well as for the calculation of income tax. However, their tax-related impact is dependent on similar use in the commercial annual financial statements in accordance with the aforementioned authoritative principle. Some German scholars have pointed out that an autonomous use of options compliant with the German generally accepted accounting principles in the commercial annual financial statement as well as for income tax calculation purposes is admissible. This view is dismissed for the present purposes (for reasons, see Freidank and Velte 2010, p. 189–191).

Group III: These include the options that are not compliant with the German generally accepted accounting principles and remain relevant only for the purpose of calculating income tax due to the scrapping of the reverse authoritative principle. These options have no impact on the target function of the commercial annual result. As we will show, however, the use of noncompliant options for the purposes of calculating income tax has, in consideration of deferred taxes in the commercial balance sheet, an indirect impact on the commercial annual financial statement.

Whereas the action parameters of group I are marked with a lowercase x, the action parameters marked with an uppercase X refer to the options of group II. As Equation (1) shows, the action parameter of the options of groups I and II may directly lead to a change in the target annual result. For the sake of simplicity, the options of group II are represented in the following through the symbol XM [all net-income-increasing action parameters in consideration of effective income-tax impact (XA, XAü, XU, XUü, XFL, XFK, XRA)] and through the symbol Xm [all net-income-lowering action parameters in consideration of effective income-tax impact (Xa, Xaü, Xu, Xuü, Xfl, Xfk, Xra)]. Furthermore, with respect to group III, all noncompliant (tax-related) options are expressed by the symbol XI (total value of those profit-/loss-effective action parameters that lead to an increase in the income-tax-related assessment bases without having a direct impact on the commercial net annual profit) or by the symbol Xi (total value of those profit-/loss-effective action parameters that lead to a reduction in the income tax-related assessment bases without having a direct impact on the commercial annual result).

If, however, the target balance sheet result (sBI) is to be expressed as a maximized, minimized, or fixed value, then Equation (1) must be modified as follows in consideration of a potential result carried forward and changes in reserves in the sense of sec. 158(1) AktG (see Section 2.3.7):

$$\begin{gathered} sBI - vJvor = - XKSt - XGewSt - XLS - xTAvor - xTAauf + xA + XA + xAü + XAü - xa - Xa - \\ xaü - Xaü + xU + XU + xUü + XUü - xu - Xu - xuü - Xuü + xFl + XFl + xFk + XFk - xfl - Xfl - \\ xfk - Xfk + xRa + XRa - xra - Xra + xGV - xvv + xRENTK + xRENTG + xRENTS + xRENTAG - \\ xreing - xreins - xreina - xreinü. \end{gathered} \tag{2}$$

2.3 Definition of the restrictions

2.3.1 Basic considerations

If the available maneuvering funds are adequately used for the purpose of realizing specific accounting policy objectives, the provisional annual result (vJvor) and the provisional balance sheet result are figures that can be inherently influenced by accounting policy. If an annual result or a balance sheet result shall be published at a determined amount, then the responsible persons must know to which extent the provisional annual result must be amended in consideration of the profit-/loss-related results in order to accurately reflect the target annual result (sJnach) or the target balance sheet result (sBI) and other desired annual financial statement figures. Owing to the quantitative recording of the linear correlations between the annual result, the balance sheet result, profit-/loss-dependent results, and the positive and/or negative use of maneuvering funds, it is possible to integrate the impact of structuring the accounting policy options in regard to profits and losses on the expenditure for corporation and trade taxes and bonuses, deferred income taxes, and other financial statement figures into a decision-making model.

2.3.2 Reporting of effective income tax effects

On the basis of the assumption that the tax base for corporation tax purposes (zvE) is subject to definitive taxation through corporation tax (sd) (sec. 23(1) KStG), the following applies:

$$XKSt = sd \cdot zvE. \tag{3}$$

If the solidarity surcharge rate (soli) (sec. 2, no. 3; sec. 3(1), nos. 1 and 2; sec. 4 SolZG) is included, the Equation above can be expressed as follows (with sk = (1 + soli) · sd):

$$XKSt = sk \cdot zvE. \tag{4}$$

Due to various violations of the aforementioned authoritative principle as well as the income and corporation tax-related modifications that have to be taken into consideration, the commercial target annual result (sJnach) and the tax base for corporation tax purposes (zvE) are not identical. These deviations have been identified in Table 1 with the symbol ka. It should be noted that ka may be a positive or a negative value. This depends both on the differences between the commercial balance sheet and income tax balance sheet as well as on the income and corporation tax-related modifications of the tax balance sheet result, and on the deduction of losses, subject to the latter being adjusted outside the tax balance sheet.

Table 1. Calculation of the tax base for corporation tax purposes

	Annual result under commercial law (Jnach)	
±	Deviations between the commercial and tax balance sheet	
=	Annual result under tax law	
±	Result correction due to income and corporate tax-law provisions (sec. 8, para. 1 KStG in conjunction with sec. 3; sec. 4, para. 5; sec. 4h EStG; e.g., deferred tax revenue)	
+	Non-deductible tax expenses (e.g., corporate tax [sec. 10, no. 2 KStG], trade tax [sec. 4, para. 5b EStG] or deferred tax expenses)	
+	Other non-deductible expenses (sec. 9 para. 1, no. 2; sec. 10, no. 1, 3, 4 KStG)	ka
+	Concealed profit distributions (sec. 8, para. 3 KStG)	
–	Concealed contributions	
–	Share in profits and manager compensation of the personally liable shareholder of a partnership limited by shares (sec. 9, para. 1, no. 1 KStG)	
=	Corrected annual result under tax law	
–	Loss deduction under corporate tax law (sec. 8, para. 1 KStG in conjunction with sec. 10d EStG) (Vk)	
=	Tax base for corporation tax purposes (zvE)	

With regard to the change factor ka, this then results in:

$$XKSt = sk \cdot (sJnach + ka). \tag{5}$$

Here, the condition (sJnach + ka) ≥ 0 must apply since otherwise KSt would take a negative value.

Table 1 shows that ka includes the expenditure for corporation tax, trade tax, the deferred tax result (XLS), and half of the supervisory board bonuses (sec. 10, no. 4 KStG) (xTAauf). These figures have a mutable character in the interdependent equation system. If these variables are deducted from the value ka, the following constant Equation results:

$$ka^* = ka - (XKSt + XGewSt - XLS + 0.5 \cdot xTAauf). \tag{6}$$

Equation (6) covers those deviations between the commercial annual result and the tax base for corporation tax purposes that do not relate to the effective corporation and trade tax expenditure, the deferred tax result, and half of the supervisory board bonuses. Due to these modifications, this means for Equation (5):

$$XKSt = sk \cdot (sJnach + ka^* + XKSt + XGewSt - XLS + 0.5 \cdot xTAauf) \tag{7}$$

Here, the condition ≥ 0 must apply to the term in brackets since otherwise XKSt would take a negative value.

In order to calculate the tax base for trade tax purposes (i.e., the trade income [GE] [sec. 7 GewSt]), the tax base for corporation tax purposes before loss deduction must still be adjusted by certain trade-tax-related modifications as well as by the deduction of trade losses carried forward (ga). This procedure is shown in Table 2 (Vk = loss deduction under corporate tax law [sec. 8, para. 1 KStG in conjunction with sec. 10d EStG]).

Table 2. Calculation of the tax base for trade tax purposes

	Tax base for corporation tax purposes before loss deduction (zvE + Vk)	ga
±	Modifications under trade tax law (sec. 8, sec. 9 GewStG)	
–	Loss deduction under trade tax law (Vg) (sec. 10a GewStG)	
=	Tax base for trade tax purposes (trade earnings) (GE)	

The following applies to trade tax (GewSt), which is assessed on the basis of the trade earnings (he = rate of assessment of the municipality in % : 100, me = trade tax index number in % : 100):

$$GewSt = me \cdot he \cdot GE. \tag{8}$$

and including the Equations developed above (with sg = me · he):

$$GewSt = sg \cdot (sJnach + ka^* + XKSt + XGewSt - XLS + 0.5 \cdot TAauf + ga + Vk). \tag{9}$$

Here, the condition ≥0 must apply for the term in brackets since otherwise GewSt would take a negative value.

The Equations developed above can now be transformed to make them usable for accounting policy optimization:

$$XKSt + sk \cdot xTAvor + sk \cdot 0.5 \cdot TAauf - sk \cdot XM + sk \cdot Xm - sk \cdot XI + sk \cdot Xi = sk \cdot (vJvor + ka^*) \tag{10}$$

$$- sg \cdot vJvor + XGewSt + sg \cdot xTAvor + sg \cdot 0.5 \cdot TAauf - sg \cdot XM + sg \cdot Xm - sg \cdot XI + sg \cdot Xi = sg \cdot (vJvor + ka^* + Vk + ga). \tag{11}$$

2.3.3 Inclusion of deferred tax effects

2.3.3.1 Commercial code requirements

The differences in recognition and measurement that have to be considered in accordance with sec. 274 HGB arise due to exceptions to the aforementioned authoritative principle, which states that certain commercial recognition and measurement provisions do not apply to the determination of the tax result (e.g., sec. 5(6) EStG). In addition to temporary and quasi-permanent differences between the commercial and tax balance sheet, tax-related losses carried forward pursuant to sec. 274(1), sent. 4 HGB may also lead to deferred tax assets, as these present a (future) economic benefit to the company (Herzig and Briesemeister 2012, p. 169–221).

However, the differences between the commercial and tax balance sheet items do not always have an impact on the result. These differences have to be recognized according to the temporary concept. They occur in connection with acquisition processes, whereby differences between the commercial value and the relevant taxation value arise. Examples of this include the acquisition of fixed assets subject to a fiscal subsidy that is reported differently in the commercial and tax balance sheets or a contribution in kind that is reported at different values in the commercial and tax balance sheets (Bertram 2014, note 126-130 on sec. 274). If the recognition of deferred taxes has an impact on the result (as is usually the case), the expenses or earnings from the change in reported deferred taxes must be indicated separately under the "taxes on income and earnings" item according to sec. 274(2), sent. 3 HGB. In the case of deviations without an impact on the results, the relevant changes to reported deferred taxes must be reflected in the equity (e.g., in other retained earnings). The following models are based on the standard case in which the deferred taxes have an impact on the result.

It should be noted that for corporations like the German stock corporation or the German limited liability corporation and companies assimilated within them by law, the balance between deferred income tax assets and liabilities can be reported in accordance with the overall difference approach (net method) or the gross method that reflects the deferred tax burden or relief separately in a liability or asset item (sec. 274(1), sent. 3 HGB) (Grottel and Larenz 2014, note 15 on sec. 274). The following company-specific income tax rates for the reporting of the deferred tax burden or relief at the time of the reversal of the differences in accordance with sec. 274(2), sent. 1 HGB are relevant to the calculation of the deferred tax assets and liabilities (Grottel and Larenz 2014, notes 60–63 on sec. 274 HGB):

- in the case of trade tax, a tax rate in consideration of the rate of assessment of the municipality, the trade tax index number, and the prohibition of the deduction of trade tax from its tax base (sg);
- in the case of corporation tax, the definitive tax burden rate in consideration of the solidarity surcharge, and the prohibition of the deduction of corporation tax from its tax base (sk).

The amount recognized as the deferred tax asset or liability per accounting period is the result of the multiplication of the consolidated company-specific income tax rate (s = sg + sk) with the identified asset or liability differences from temporary tax deferrals and benefits from losses carried forward that can be set off (Fuhrmann and Gellrich 2012, p. 121–122; Grottel and Larenz 2014, note 61 on sec. 274). The following model formulations are based on the assumption that in the case of tax deferrals or accruals a future constant income tax rate will be applied at the time of the reversal of the differences.

2.3.3.2 Model integration of deferred taxes

Taking into account the basic commercial conditions shown above, it is now possible to integrate the deferred income tax into the model in accordance with the individual difference approach. Due to the unbalanced reporting of deferred tax assets and liabilities, the addressees of the annual financial statement obtain a more transparent overview of the financial situation of the corporation in regard to the reported tax deferrals pursuant to sec. 274(1), sent. 3 HBG if they select the individual difference approach than if they opt for the net method. This corresponds in principle to the International Financial Reporting Standards (IFRS) rules contained in IAS 12.74 and DRS 18 (2014), 18.56 to 18.58. Furthermore, by using the gross method, the deferred asset and liability items as well as the deferred tax earnings and expenditures can be calculated separately and simultaneously in the following models. If the corporation maintains a corresponding register of differences (Freidank and Velte 2013, p. 809–811; Fuhrmann and Gellrich 2012, p. 119), the respective temporary and quasi-permanent differences that result from a comparison of the commercial and tax balance sheet values can be taken from this register. Finally, analogously to international provisions (IAS 12.24), we are assuming an obligation to recognize deferred tax assets.

Table 3 shows the components of the assessment basis of deferred tax assets that will lead to the "total of the deferred taxes asset" item in the annual statement under commercial law when multiplying by the indicated tax factors. In the following, we assume that a positive result occurs in the reference period for the values zvE and GE (for all other constellations, see Freidank, Bauer and Sassen 2014).

Table 3. Determination of the deferred tax asset item

	Components of the assessment basis	**Tax factor**
	Temporary differences that lead to the recognition of deferred tax assets (ADt)	
+	Quasi-permanent differences that lead to the recognition of deferred tax assets (ADqp)	
=	Total of those differences that lead to deferred tax assets (AD)	s
+	Loss carried forward from the previous years under corporate tax law, which may be used within the next five years (ΣKVvor5)	sk
+	Loss of the period under corporate tax law that can be carried forward (KVvor) and that arises from a negative tax base for corporation tax purposes (– zvE)	sk
+	Loss carried forward from the previous years under trade tax law, which may be used within the next five years (ΣGVvor5)	sg
+	Loss of the period under trade tax law that can be carried forward (GVvor) and that arises from a negative tax base for trade tax purposes (trade earnings) (– GE)	sg
=	Amount of the deferred taxes asset item (XLESTA)	

The temporary and quasi-permanent balance sheet deviations (AD) as well as the losses carried forward from the previous year have to be valuated at the respective tax rates to determine the deferred asset item (XLESTA).

$$XLESTA = AD \cdot s + \sum KVvor5 \cdot sk + \sum GVvor5 \cdot sg \qquad (12)$$

The change in the amount of the deferred asset item compared to the previous year (ΔLESTA) must be calculated to determine the amount of deferred tax result. The amount of the deferred asset item of the previous period is expressed in the Equation below as LESTAvor.

$$\Delta LESTA = XLESTA - LESTAvor \qquad (13)$$

If $\Delta LESTA < 0$, the "deferred tax assets" item in the balance sheet decreases and leads to a deferred tax expense in the amount of ΔLESTA in the commercial income statement. If $\Delta LESTA > 0$, the "deferred tax assets" item in the balance sheet increases and leads to a deferred tax income to the extent of ΔLESTA.

Table 4 shows the components of the assessment basis for deferred tax liabilities that will lead to the "deferred tax liabilities" item in the annual statement under commercial law when multiplied by the indicated tax rate (s).

Table 4. Determination of the deferred tax liability item

Components of the assessment basis	Tax rate
Temporary differences that lead to the recognition of deferred tax liabilities (PDt)	s
+ Quasi-permanent differences that lead to the recognition of deferred tax liabilities (PDqp)	s
= Total of those differences that lead to deferred tax liabilities (PD)	s
= Amount of the deferred taxes liabilities item (LESTP)	

The sum of the temporary and quasi-permanent differences (PD) has to be multiplied by the tax rate (s) to receive the deferred tax liabilities.

$$XLESTP = PD \cdot s \tag{14}$$

The change in the deferred liability item relative to the previous year (ΔLESTP) has to be determined for the calculation of the deferred tax result. The deferred tax liabilities of the previous period is expressed in the Equation below as LESTPvor.

$$\Delta LESTP = XLESTP - LESTPvor \tag{15}$$

If ΔLESTP < 0, the "deferred tax liabilities" item in the balance sheet decreases and leads to deferred tax earnings in the amount of ΔLESTP. If ΔLESTP > 0, the "deferred tax liabilities" item increases and leads to deferred tax expenses in the amount of ΔLESTP.

The deferred tax result of the period (XLS) is calculated using the Equation below. The size of XLS arises from the change in deferred tax assets and liabilities in the balance sheet as a result of their formation and resolution. If XLS > 0, this leads to deferred tax expenses in the income statement, which reduces the net annual result. In the case of XLS < 0, this leads to deferred tax earnings, which increases the net annual result.

$$XLS + XLESTA - XLESTP = -LESTPvor + LESTAvor \tag{16}$$

The equations XLESTA and XLESTP have to be modified for simultaneous consideration of the effects of the use of options in groups I and III (see Sec. 2.2) on deferred taxes. The accounting options of group II (XM, Xm) have no relevance in this context since they alter the commercial and tax balance sheet amounts to the same extent. Thus, these accounting options have no impact on deferred taxes. The accounting options of groups I and II may affect the differences provisionally formed between the commercial and tax balance sheet items. This circumstance may lead to a change in deferred tax assets (AD) or deferred tax liabilities (PD). With regard to the "deferred tax assets" balance sheet item, this means that, for reasons of simplification, action parameters without an effective income tax impact that increase the net annual result (xA, xAü, xU, xUü, xFl, xFk, xRa) are reflected by the symbol xM, and all action parameters without an effective income tax impact that reduce the net annual profit (xa, xaü, xu, xuü, xfl, xfk, xra) are reflected by the symbol xm:

$$XLESTA + s \cdot xM\,(AD) - s \cdot xm\,(AD) + s \cdot XI\,(AD) - s \cdot Xi\,(AD) = s \cdot AD + \sum KVvor5 \cdot sk + \sum GVvor5 \cdot sg. \tag{17}$$

The Equation for the "deferred tax liabilities" balance sheet item is expressed as follows:

$$XLESTP - s \cdot xM\,(PD) + s \cdot xm\,(PD) + s \cdot XI\,(PD) + s \cdot Xi\,(PD) = s \cdot PD. \tag{18}$$

Thus, the relevant action parameters of the accounting options of groups I and III must be inserted in each case in Equations (17) or (18). Their allocation depends on the potential changes of the provisionally formed differences between commercial and tax balance sheet items. If the company decides, for example, to form tax-free reserves (group Xi [PD]), the exercise of this accounting option will lead to an increase in the variable XLESTP. If the company decides, for instance, to recognize self-created immaterial assets as part of the fixed assets pursuant to sec. 248(2), sent. 2 HG (group xM [PD]), this will lead to an increase in the variable XLESTP. Had the decision-makers opted for the exercise of one of these two options for the purpose of compiling the provisional annual financial statement, their impact on the deferred tax liabilities would already be included in the value of PD. Provided that the options are to be counted towards the available maneuvering funds, they would have to be assigned to the variables Xi (PD) and xm (PD) in Equation (18).

2.3.4 Recognition of bonuses for management board and supervisory board members

Companies can use specific variable assessment bases for bonuses for management and supervisory board members pursuant to sec. 87(1) AktG in conjunction with sec. 113(3) AktG (Drygala 2010, note 25–27 on sec. 113 AktG; Seibt 2010, note 12 on sec. 87 AktG.), which have to be taken into consideration for the purposes of planning the annual financial statement. In this case the extensions described below must be included in the optimization models. If a profit participation for the management board consists of a portion of the net result, the bonus (xTAvor) will be calculated as shown in Equation (19). The annual result is reduced beforehand by specific mandatory components [avor = rate of the management board according to the corrected annual result; xreings = total value of legal or statutory reserves setting (this does not include any setting of the equity reserve in accordance with sec. 58(2a) AktG since these settings are always made on a voluntary basis); xvv = total value of the commercial loss carried forward from the previous year].

$$xTAvor = avor \cdot (sJnach - xvv - xreings) \text{ with } 0 \leq avor \leq 1 \tag{19}$$

The reserve setting xreings can be split into a legal part (xreing) and a statutory part (xreins). Accordingly, Equation (20) applies:

$$xreings = xreing + xreins. \tag{20}$$

Sec. 150(2) AktG requires that 5% of the net annual profit reduced by the loss carried forward from the previous year must be transferred to the statutory reserve unless the funding level required by law or articles of association can also be achieved by a lower transfer to the reserve. Based on the standard case of an adoption of the annual financial statement by the management board and the supervisory board (see sec. 58(1), sent. 1 AktG for an exceptional case), the transfer to reserves can be described as shown in Equation (21) (reinn = lower reserve transfer pursuant to sec. 150(2) AktG; r = rate for the setting of the legal reserve):

$$xreings = r \cdot 0.05 \cdot (sJnach - xvv) + (1 - r) \cdot reinn + reins \text{ with } r = 1 \text{ in the case of } 0.05 \cdot (sJnach - xvv) < reinn \text{ and } r = 0 \text{ in the case of } 0.05 \cdot (sJnach - xvv) \geq reinn. \tag{21}$$

If Equation (21) is inserted into Equation (19), then the following term results after some modifications for the calculation of management board bonuses:

$$-(1 - 0.05 \cdot r) \cdot avor \cdot (XKSt - XGewSt - XLS - xTAauf + xM - xm + XM - Xm) + [1 + (1 - 0.05 \cdot r) \cdot avor] \cdot xTAvor - (0.05 \cdot r - 1) \cdot avor \cdot xvv + avor \cdot xreins = (1 - 0.05 \cdot r) \cdot avor \cdot vJvor + (r - 1) \cdot avor \cdot reinn. \tag{22}$$

In contrast to the calculation of the bonuses for the management board, the bonuses for supervisory board members pursuant to sec. 113(3), sent. 1 AktG are calculated by applying a constant rate (aauf) of the balance sheet result, which has to be reduced beforehand by an amount of at least 4% of the contributions paid on the lowest issue price of the shares (Aus) (aauf = rate of the supervisory board according to the adjusted balance sheet result; xGV = profit carried forward from the previous year; xRENTK = withdrawal from capital reserve; xRENTG = withdrawal from the legal reserve; xRENTS = withdrawal from the statutory reserve; xRENTAG = withdrawal from other retained earnings; xreina = transfer to other retained earnings pursuant to sec. 58(2) AktG; xreinü = other transfers to other retained earnings pursuant to sec. 58(2a) AktG).

$$TAauf = aauf \cdot (sJnach + xGV - xvv + xRENTK + xRENTG + xRENTS + XRENTAG - xreing - xreins - xreina - xrein\ddot{u} - 0.04 \cdot Aus) \tag{23}$$

Here, the condition ≥ 0 must apply for the term in brackets since otherwise TAauf would take a negative value.

The variable xreina can be specified by sec. 58(2) AktG in the case that the management and supervisory board adopt the annual financial statements. Since, on the one hand, a maximum of 50% of the difference between the annual result and the loss carried forward, and, on the other hand, the write-ups to the legal reserve may be transferred to the other retained earnings in this case, Equation (24) applies (dm = rate available for disposal by the management). As only parts of the net annual profit that is available to fund the reserve according to sec. 58(2) AktG, the transfers to the legal reserves as well as the reversal of a loss carried forward must first be deducted from the net annual profit (sec. 58(2), sent. 4 AktG). This does not apply to a transfer to the capital reserve because this reserve is neither funded by the net annual profit nor serves to fund the latter (ADS 1997, note 16 on sec. 58, p. 296).

$$\text{xreina} = \text{dm} \cdot [\text{sJnach} - \text{r} \cdot 0.05 \cdot (\text{sJnach} - \text{xvv}) + (1 - \text{r}) \cdot \text{reinn} - \text{xvv}] \text{ with } 0 \leq \text{dm} \leq 0.5 \tag{24}$$

If Equation (24) is integrated into Equation (23), after some modifications the following results:

$$-(1 - \text{dm}) \cdot (1 - 0.05 \cdot \text{r}) \cdot \text{aauf} \cdot (-\text{XKSt} - \text{GewSt} - \text{XLS} - \text{xTAvor} + \text{xM} - \text{xm} + \text{XM} - \text{Xm}) + [1 + (1 - 0.05 \cdot \text{r}) \cdot \text{aauf}] \cdot \text{xTAauf} - \text{aauf} \cdot [(1 - \text{dm}) \cdot (0.05 \cdot \text{r} - 1) \cdot \text{xvv} + \text{xGV} + \text{xRENTK} + \text{xRENG} + \text{xRENTS} + \text{xRENTG} - \text{xreins} - \text{xreinü}] = (1 - \text{dm}) \cdot (1 - 0.05 \cdot \text{r}) \cdot \text{aauf} \cdot \text{vJvor} + [(\text{dm} - 1) \cdot (1 - \text{r}) \cdot \text{reinn} - 0.04 \cdot \text{Aus}] \cdot \text{aauf}. \tag{25}$$

2.3.5 Restrictions on action parameters with an impact on the result

With regard to the determination of action parameters that have an impact on the result and their upper and lower limits as ≤ conditions, there is the problem that the values of the existing accounting option cannot be divided infinitely. Hence, a determined optimal solution of the optimization model cannot be realized because the calculated value does not correlate with the commercial and tax provisions. For this reason, the optimization of the target function must be based on a mixed-integer approach (Corsten, Corsten and Sartor 2005, p. 125–178; Müller-Merbach 1973, p. 366–414), which ensures that the action parameters can be included in the optimal solution with every possible intermediate value or only with their upper and lower limits. For example, certain overhead cost components as part of the production costs can only be recognized in the amount of 0 or to the maximum amount.

If the action parameters are initially formulated as ≤ restrictions, then the following Equations (26) to (53) result. Here, all result-increasing action parameters (xA, Xa, xAü, XAü, xU, XU, xUü, XUü, XFL, XFL, XFK, XFK, XRA, XRA) and all result-decreasing action parameters (xa, Xa, xaü, Xaü, xu, Xu, xuü, Xuü, xfl, Xfl, XFK, XFK, xra, XRA) are listed individually. Certain accounting options apply in the following optimization models for cumulative groups of assets or liabilities. Nevertheless, for each accounting option it is possible to define a separate variable and formulate a separate restriction. However, the complexity of the optimization model would significantly increase. For example, the assessment scope in Equation (35), XU ≤ oUv (XU) – vUv, contains the value of all action parameters that increase the amount of inventories when considering effective income tax effects. The condition oUv (XU) ≥ vUv describes the range of the value of the inventories between the value in the interim financial statements (vUv) and the upper limit of the value of the inventories. The maximum can be exercised by using all the action parameters of the options group XU.

$$\text{xA} \leq \text{oAs (xA)} - \text{vAs} \qquad \text{with oAs (xA)} \geq \text{vAs} \tag{26}$$

$$\text{XA} \leq \text{oAs (XA)} - \text{vAs} \qquad \text{with oAs (XA)} \geq \text{vAs} \tag{27}$$

$$\text{xAü} \leq \text{oAü (xAü)} - \text{vAü} \qquad \text{with oAü (xAü)} \geq \text{vAü} \tag{28}$$

$$\text{XAü} \leq \text{oAü (XAü)} - \text{vAü} \qquad \text{with oAü (XAü)} \geq \text{vAü} \tag{29}$$

$$\text{xa} \leq \text{vAs} - \text{uAs (xa)} \qquad \text{with vAs} \geq \text{uAs (xa)} \tag{30}$$

$$\text{Xa} \leq \text{vAs} - \text{uAs (Xa)} \qquad \text{with vAs} \geq \text{uAs (Xa)} \tag{31}$$

$$\text{xaü} \leq \text{vAü} - \text{uAü (xaü)} \qquad \text{with vAü} \geq \text{uAü (xaü)} \tag{32}$$

$$Xaü \leq vAü - uAü\ (Xaü) \quad \text{with } vAü \geq uAü\ (Xaü) \tag{33}$$

$$xU \leq oUv\ (xU) - vUv \quad \text{with } oUv\ (xU) \geq vUv \tag{34}$$

$$XU \leq oUv\ (XU) - vUv \quad \text{with } oUv\ (XU) \geq vUv \tag{35}$$

$$xUü \leq oUü\ (xUü) - vUü \quad \text{with } oUü\ (xUü) \geq vUü \tag{36}$$

$$XUü \leq oUü\ (XUü) - vUü \quad \text{with } oUü\ (XUü) \geq vUü \tag{37}$$

$$xu \leq vUv - uUv\ (xu) \quad \text{with } vUv \geq uUv\ (xu) \tag{38}$$

$$Xu \leq vUv - uUv\ (Xu) \quad \text{with } vUv \geq uUv\ (Xu) \tag{39}$$

$$xuü \leq vUü - uUü\ (xuü) \quad \text{with } vUü \geq uUü\ (xuü) \tag{40}$$

$$Xuü \leq vUü - Uuü\ (Xuü) \quad \text{with } vUü \geq uUü\ (Xuü) \tag{41}$$

$$xFl \leq vFl - uFl\ (xFl) \quad \text{with } vFl \geq uFl\ (xFl) \tag{42}$$

$$XFl \leq vFl - uFl\ (XFl) \quad \text{with } vFl \geq uFl\ (XFl) \tag{43}$$

$$xFk \leq vFk - uFk\ (xFk) \quad \text{with } vFk \geq uFk\ (xFk) \tag{44}$$

$$XFk \leq vFk - uFk\ (XFk) \quad \text{with } vFk \geq uFk\ (XFk) \tag{45}$$

$$xfl \leq oFl\ (xfl) - vFl \quad \text{with } oFl\ (xfl) \geq vFl \tag{46}$$

$$Xfl \leq oFl\ (Xfl) - vFl \quad \text{with } oFl\ (Xfl) \geq vFl \tag{47}$$

$$xfk \leq oFk\ (xfk) - vFk \quad \text{with } oFk\ (xfk) \geq vFk \tag{48}$$

$$Xfk \leq oFk\ (Xfk) - vFk \quad \text{with } oFk\ (Xfk) \geq vFk \tag{49}$$

$$xRa \leq oRa\ (xRa) - vRa \quad \text{with } oRa\ (xRA) \geq vRa \tag{50}$$

$$XRa \leq oRa\ (XRa) - vRa \quad \text{with } oRa\ (XRa) \geq vRa \tag{51}$$

$$xra \leq vRa - uRa\ (xra) \quad \text{with } vRa \geq uRa\ (xra) \tag{52}$$

$$Xra \leq vRa - uRa\ (Xra) \quad \text{with } vRa \geq uRa\ (Xra) \tag{53}$$

If the commercial and tax accounting rules permit the recognition of any number of intermediate values, the above restrictions can be included in their present form in the optimization model. However, some accounting option groups are relevant only to the extent of their maximum value or in the amount of 0. This circumstance requires a modification of the restriction. This issue is particularly relevant to those accounting options that include the "recognition" or "no recognition" option. The solution of this problem is exemplified in the following by reference to the option group xAü in Equation (28):

$$[oAü\ (xAü) - vAü] \cdot xAü \leq oAü\ (xAü) - vAü \text{ with} \tag{54}$$

$$xAü \leq 1 \text{ (integer).} \tag{55}$$

The variable xAü is subject to the condition of being integer. The variable xAü is also assigned to the coefficients of oAü (xAü) – vAü in the target function line and the other restriction lines of the simplex table. Therefore, there is only the option to allocate the values of 0 or 1. This procedure ensures that the optimal solution under xAü can only take the values of 0 or 1. In the case of xAü = 1, the amount of oAü (xAü) is fully result-effective. If there are also other option groups with similar restrictions, the restriction approaches have to be modified analogously.

Now the decision-makers can use the available result-altering accounting options on the basis of the preliminary balance sheet values by using the formulated action parameter restrictions for the purpose of target-appropriate transformation of the financial statements. It is irrelevant in this context whether the decision-makers have already used accounting options to prepare the preliminary balance sheet because the impact of these decisions in the optimization models will either be retained or (partly) undone. However, the decision-makers need to know the legally permissible upper and lower commercial and tax limits to integrate them precisely into the optimization approaches. This approach could be supported by the integration of optimization models in accounting policy expert systems, which then assist the users in their databases with commercial and tax legal commentaries (Freidank 1993, p. 312–323).

For example, there is the option to write off certain fixed assets on the basis of the straight-line method or on the basis of the depreciation method according to the expected use of the assets. In this case, the amount of the difference between the value already calculated in the preliminary financial statements with respect to the straight-line method and the higher expenses for using the depreciation method according to expected use of the assets is to include an option (Xa, Equation [31]) in the optimization models. If for the option group Xa there is only the option to choose between these two methods, then the relevant restrictions have to be formulated as indicated below. Here, vAs – uAs (Xa) represents the higher possible volume of depreciation. This value must be determined by the decision-makers and recognized in the optimization calculations:

$$[\text{vAs} - \text{uAs (Xa)}] \cdot \text{Xa} \leq \text{vAs} - \text{uAs (Xa) with} \quad (56)$$

$$\text{Xa} \leq 1 \text{ (integer).} \quad (57)$$

However, if for the option group Xa (Equation [31]) there is a further assessment alternative by which the lower limit of the fixed assets can be further reduced (e.g., even by a depreciation that is permissible under commercial law), which allows for any number of intermediate values, then Xa is to divide into two subgroups (GA = integer values; ZW = intermediate values):

$$[\text{vAs} - \text{uAs (XaGA)}] \cdot \text{Xa (GA)} \leq \text{vAs (XaGA) with} \quad (58)$$

$$\text{Xa (GA)} \leq 1 \text{ (integer)} \quad (59)$$

$$[\text{vAs} - \text{uAs (XaZW)}] \leq \text{vAs} - \text{uAs (XaZW) with} \quad (60)$$

$$\text{Xa} = \text{Xa (GA)} + \text{Xa (ZW).} \quad (61)$$

In this case, the decision-makers have to recognize the maximum possible amount for the write-off (XaZW) as the input size in the optimization model. If there are also further individual options in this group or if there are other option groups with similar restrictions, the restriction approaches have to be modified analogously.

The determined accounting options regarding recognition, valuation, and discretion were allocated clearly to the variables of the target function. This procedure prevents interdependencies between the action parameters and allows one to separate the potential accounting option value into separate option groups. The structural variables of the optimization model show the necessary value of the maneuvering fund to reach the target-optimal financial statement. The slack variables of the optimal solution show the non-required value of the maneuvering fund regarding the action parameters employed as well as the latent reserves of the other restrictions included in the planning approach (e.g., key figures and balance sheet total).

Table 5 shows the complete formulated model approach with the balance sheet result as a target value. Here, the indices of the individual option groups are substituted by sequential numbering with xA = x8, XA = x9, ..., xreinü = x47 to adjust the structural variables to the data of the computational model. A similar approach is used for the restrictions, which were also provided from Y1 to Y64 with serial numbers. Conditions Y1 to Y7 contain restrictions required to recognize effective and deferred tax effects as well as management and supervisory board bonuses. Conditions Y8 to Y43 characterize the maneuvering fund, which is based on the individual accounting option groups. Conditions Y44 to Y64 contain the options regarding the appropriation of the result as well as the restriction on key figures or the balance sheet total (see below). The individual accounting option groups differ only in terms of the alternatives for which any number of intermediate values exist. If there are also option groups that find their optimal solution only in the maximum value or in the amount of 0, then the planning approaches have to be modified as shown above. In this case, an option group includes at least two structural variables. Whereas the second variable is to be used for alternatives that may become part of the optimal solution at any intermediate value, the first variable of each group applies to the options that require an integer solution. The complete mixed-integer formulation is shown in its general form in Table 6 on the basis of the option groups xA (Equation [26]) and XA (Equation [27]), each of which involves two structural variables per group.

2.3.6 Restrictions on noncompliant options regarding the German generally accepted accounting principles

For the action parameters of group III (noncompliant options regarding the German generally accepted accounting principles), a cumulative determination of the available discretion margins is sufficient since they have no direct impact on the annual result and the structure of the annual financial statement. If tax-accounting options are only relevant to decision-making at their maximum value or at the value of 0, a modification of the restriction approach (IM [XI], im [Xi] = maximum increasing or decreasing opportunity for taxation purposes) is also required for these noncompliant options regarding the German generally accepted accounting principles.

$$XI \cdot IM\ (XI) \leq IM\ (XI) \text{ with} \tag{62}$$

$$XI \leq 1 \text{ (integer) and} \tag{63}$$

$$Xi \cdot im\ (Xi) \leq im\ (Xi) \text{ with} \tag{64}$$

$$Xi \leq 1 \text{ (integer)} \tag{65}$$

However, if there are additional alternatives for the two action parameters XI and Xi that permit any number of intermediate values, then the parameters XI and Xi or the maximum possible use of the tax maneuvering funds must be split into two subgroups analogously to the commercial procedures described above in Sec. 2.3.5 (GA = integer values, ZW = intermediate values):

$$XI\ (GA) \cdot IM\ (XIGA) \leq IM\ (XIGA) \text{ with} \tag{66}$$

$$XI\ (GA) \leq 1 \text{ (integer) and} \tag{67}$$

$$XI\ (ZW) \leq IM\ (XIZW) \text{ in which case} \tag{68}$$

$$XI = XI\ (GA) + XI\ (ZW) \text{ applies and} \tag{69}$$

$$Xi\ (GA) \cdot im\ (XiGA) \leq im\ (XiGA) \text{ with} \tag{70}$$

$$Xi\ (GA) \leq 1 \text{ (integer) and} \tag{71}$$

$$Xi\ (ZW) \leq im\ (XiZW) \text{ in which case} \tag{72}$$

$$Xi = Xi\ (GA) + Xi\ (ZW) \text{ applies} \tag{73}$$

Table 5 shows the summarized optimization model. Here, we assume for restrictions Y36 and Y37 that there are many intermediate values for the variables XI and Xi.

Table 5. Optimization model

	XKSt	XGewSt	XLS	XLESTA	XLESTP	xTAvor	xTAauf
	x1	**x2**	**x3**	**x4**	**x5**	**x6**	**x7**
Z	-x1	-x2	-x3			-x6	-x7
Y1	x1					+sk·x6	+0.5·sk·x7
Y2		+x2				+sg·x6	+0.5·sg·x7
Y3			+x3	+x4	-x5		
Y4				+x4			
Y5					x5		
Y6	(1-0.05·r)·avor·x1	+(1-0.05·r)·avor·x2	+(1-0.05·r)·avor·x3			+[1+(1-0.05·r)·avor]·x6	+(1-0.05·r)·avor·x7
Y7	(1-dm)·(1-0.05·r)·aauf·x1	+(1-dm)·(1-0.05·r)·aauf·x2	±(1-dm)·(1-0.05·r)·aauf·x3			+(1-dm)·(1-0.05·r)·aauf·x6	+[1+(1-dm)·(1-0.05·r)·aauf]·x7
Y8							
Y9							
Y10							
Y11							
Y12							
Y13							
Y14							
Y15							
Y16							
Y17							
Y18							
Y19							
Y20							
Y21							
Y22							
Y23							
Y24							
Y25							
Y26							
Y27							
Y28							
Y29							
Y30							
Y31							
Y32							
Y33							
Y34							
Y35							
Y36							
Y37							
Y38							
Y39							
Y40							
Y41							
Y42							
Y43							
Y44	r·0.05·x1	+r·0.05·x2	+r·0.05·x3			+r·0.05·x6	+r·0.05·x7
Y45							
Y46	-dm·(1+r·0.05)·x1	-dm·(1+r·0.05)·x2	-dm·(1+r·0.05)·x3			-dm·(1+r·0.05)·x6	-dm·(1+r·0.05)·x7
Y47							
Y48							
Y49				-b·x4			
Y50	c·x1	+c·x2		+(1-c)·x4	+c·x5	+c·x6	+c·x7
Y51				-d·x4			
Y52	x1	+x2		-e·x4	+x5	+x6	+x7
Y53							
Y54	g·x1	+g·x2		-g·x4	+g·x5	+g·x6	+g·x7
Y55	h·x1	+h·x2		-h·x4	+h·x5	+h·x6	+h·x7
Y56	x1	+x2			+x5	+x6	+x7
Y57	-(1-j)·x1	-(1-j)·x2	+j·x3	+x4	-x5	-(1-j)·x6	-(1-j)·x7
Y58						-(1-k)·x6	-(1-k)·x7
Y59	l·x1	+l·x2	+l·x3	+x4		+l·x6	+l·x7
Y60						+m·x6	+m·x7
Y61	(1+n)·x1	+(1+n)·x2	+(1+n)·x3			+n·x6	+n·x7
Y62	o·x1	+o·x2		-o·x4	+o·x5	+o·x6	+o·x7
Y63	(p-1)·x1	+(p-1)·x2	-p·x3	-p·x4	+p·x5	+(p-1)·x6	+(p-1)·x7
Y64	-x1	-x2	-x3			-x6	-x7

Table 5. Optimization model (continued)

	xA	XA	xAü	XAü	xa	Xa
	x8	**x9**	**x10**	**x11**	**x12**	**x13**
Z	+x8	+x9	+x10	+x11	-x12	-x13
Y1		-sk·x9		-sk·x11		+sk·x13
Y2		-sg·x9		-sg·x11		+sg·x13
Y3						
Y4	+s·x8		+s·x10		-s·x12	
Y5	-s·x8		-s·x10		+s·x12	
Y6	-(1-0.05·r)·avor·x8	-(1-0.05·r)·avor·x9	-(1-0.05·r)·avor·x10	-(1-0.05·r)·avor·x11	+(1-0.05·r)·avor·x12	+(1-0.05·r)·avor·x13
Y7	-(1-dm)·(1-0.05·r)·aauf·x8	-(1-dm)·(1-0.05·r)·aauf·x9	-(1-dm)·(1-0.05·r)·aauf·x10	-(1-dm)·(1-0.05·r)·aauf·x11	+(1-dm)·(1-0.05·r)·aauf·x12	+(1-dm)·(1-0.05·r)·aauf·x13
Y8	x8					
Y9		x9				
Y10			x10			
Y11				x11		
Y12					x12	
Y13						x13
Y14						
Y15						
Y16						
Y17						
Y18						
Y19						
Y20						
Y21						
Y22						
Y23						
Y24						
Y25						
Y26						
Y27						
Y28						
Y29						
Y30						
Y31						
Y32						
Y33						
Y34						
Y35						
Y36						
Y37						
Y38						
Y39						
Y40						
Y41						
Y42						
Y43						
Y44	-r·0.05·x8	-r·0.05·x9	-r·0.05·x10	-r·0.05·x11	+r·0.05·x12	+r·0.05·x13
Y45						
Y46	+dm·(1-r·0.05)·x8	+dm·(1-r·0.05)·x9	+dm·(1-r·0.05)·x10	+dm·(1-r·0.05)·x11	-dm·(1+r·0.05)·x12	-dm·(1+r·0.05)·x13
Y47		-(1-s)·x9		-(1-s)·x11		+(1-s)·x13
Y48	x8	+x9	+x10	+x11	-x12	-x13
Y49	+(1-b)·x8	+(1-b)·x9	+(1-b)·x10	+(1-b)·x11	-(1-b)·x12	-(1-b)·x13
Y50	+(1-c)·x8	+(1-c)·x9	+(1-c)·x10	+(1-c)·x11	-(1-c)·x12	-(1-c)·x13
Y51	-d·x8	-d·x9	-d·x10	-d·x11	+d·x12	+d·x13
Y52	-e·x8	-e·x9	-e·x10	-e·x11	+e·x12	+e·x13
Y53	x8	+x9	+x10	+x11	-x12	-x13
Y54	+(1-g)·x8	+(1-g)·x9	+(1-g)·x10	+(1-g)·x11	-(1-g)·x12	-(1-g)·x13
Y55	+(1-h)·x8	+(1-h)·x9	+(1-h)·x10	+(1-h)·x11	-(1-h)·x12	-(1-h)·x13
Y56						
Y57	+(1-j)·x8	+(1-j)·x9	+(1-j)·x10	+(1-j)·x11	-(1-j)·x12	-(1-j)·x13
Y58	+(1-k)·x8	+(1-k)·x9	+(1-k)·x10	+(1-k)·x11	-(1-k)·x12	-(1-k)·x13
Y59	+(1-l)·x8	+(1-l)·x9	+(1-l)·x10	+(1-l)·x11	-(1-l)·x12	-(1-l)·x13
Y60	+(1-m)·x8	+(1-m)·x9	+(1-m)·x10	+(1-m)·x11	-(1-m)·x12	-(1-m)·x13
Y61	-n·x8	-n·x9	-n·x10	-n·x11	+n·x12	+n·x13
Y62	-o·x8	-o·x9	-o·x10	-o·x11	+o·x12	+o·x13
Y63	+(1-p)·x8	+(1-p)·x9	+(1-p)·x10	+(1-p)·x11	+(p-1)·x12	+(p-1)·x13
Y64	+x8	+x9	+x10	+x11	-x12	-x13

Table 5. Optimization model (continued)

	xaü	Xaü	xU	XU	xUü	Xuü
	x14	**x15**	**x16**	**x17**	**x18**	**x19**
Z	-x14	-x15	+x16	+x17	+x18	+x19
Y1		sk·x15		-sk·x17		-sk·x19
Y2		sg·x15		-sg·x17		-sg·x19
Y3						
Y4	-s·x14		+s·x16		+s·x18	
Y5	+s·x14		-s·x16		-s·x18	
Y6	+(1-0.05·r)·avor·x14	+(1-0.05·r)·avor·x15	-(1-0.05·r)·avor·x16	-(1-0.05·r)·avor·x17	-(1-0.05·r)·avor·x18	-(1-0.05·r)·avor·x19
Y7	+(1-dm)·(1-0.05·r)·aauf·x14	+(1-dm)·(1-0.05·r)·aauf·x15	-(1-dm)·(1-0.05·r)·aauf·x16	-(1-dm)·(1-0.05·r)·aauf·x17	-(1-dm)·(1-0.05·r)·aauf·x18	-(1-dm)·(1-0.05·r)·aauf·x19
Y8						
Y9						
Y10						
Y11						
Y12						
Y13						
Y14	x14					
Y15		x15				
Y16			x16			
Y17				x17		
Y18					x18	
Y19						x19
Y20						
Y21						
Y22						
Y23						
Y24						
Y25						
Y26						
Y27						
Y28						
Y29						
Y30						
Y31						
Y32						
Y33						
Y34						
Y35						
Y36						
Y37						
Y38						
Y39						
Y40						
Y41						
Y42						
Y43						
Y44	+r·0.05·x14	+r·0.05·x15	-r·0.05·x16	-r·0.05·x17	-r·0.05·x18	-r·0.05·x19
Y45						
Y46	-dm·(1+r·0.05)·x14	-dm·(1+r·0.05)·x15	+dm·(1-r·0.05)·x16	+dm·(1-r·0.05)·x17	+dm·(1-r·0.05)·x18	+dm·(1-r·0.05)·x19
Y47		+(1-s)·x15		-(1-s)·x17		-(1-s)·x19
Y48	-x14	-x15	-a·x16	-a·x17	-a·x18	-a·x19
Y49	-(1-b)·x14	-(1-b)·x15	-b·x16	-b·x17	-b·x18	-b·x19
Y50	-(1-c)·x14	-(1-c)·x15	+(1-c)·x16	+(1-c)·x17	+(1-c)·x18	+(1-c)·x19
Y51	+d·x14	+d·x15	-d·x16	-d·x17	-d·x18	-d·x19
Y52	+e·x14	+e·x15	-e·x16	-e·x17	-e·x18	-e·x19
Y53	-x14	-x15				
Y54	-(1-g)·x14	-(1-g)·x15	-g·x16	-g·x17	-g·x18	-g·x19
Y55	-(1-h)·x14	-(1-h)·x15	+(1-h)·x16	+(1-h)·x17	-h·x18	-h·x19
Y56			-i·x16	-i·x17	-i·x18	-i·x19
Y57	-(1-j)·x14	-(1-j)·x15	+(1-j)·x16	+(1-j)·x17	+(1-j)·x18	+(1-j)·x19
Y58	-(1-k)·x14	-(1-k)·x15	+(1-k)·x16	+(1-k)·x17	+(1-k)·x18	+(1-k)·x19
Y59	-(1-l)·x14	-(1-l)·x15	+(1-l)·x16	+(1-l)·x17	+(1-l)·x18	+(1-l)·x19
Y60	-(1-m)·x14	-(1-m)·x15	+(1-m)·x16	+(1-m)·x17	+(1-m)·x18	+(1-m)·x19
Y61	+n·x14	+n·x15	-n·x16	-n·x17	-n·x18	-n·x19
Y62	+o·x14	+o·x15	-o·x16	-o·x17	-o·x18	-o·x19
Y63	+(p-1)·x14	+(p-1)·x15	+(1-p)·x16	+(1-p)·x17	+(1-p)·x18	+(1-p)·x19
Y64	-x14	-x15	+x16	+x17	+x18	+x19

Table 5. Optimization model (continued)

	xu	Xu	xuü	Xuü	xFl	XFl
	x20	**x21**	**x22**	**x23**	**x24**	**x25**
Z	-x20	-x21	-x22	-x23	+x24	+x25
Y1		+sk·x21		+sk·x23		-sk·x25
Y2		+sg·x21		+sg·x23		-sg·x25
Y3						
Y4	-s·x20		-s·x22		+s·x24	
Y5	+s·x20		+s·x22		-s·x24	
Y6	+(1-0.05·r)·avor·x20	+(1-0.05·r)·avor·x21	+(1-0.05·r)·avor·x22	+(1-0.05·r)·avor·x23	-(1-0.05·r)·avor·x24	-(1-0.05·r)·avor·x25
Y7	+(1-dm)·(1-0.05·r)·aauf·x20	+(1-dm)·(1-0.05·r)·aauf·x21	+(1-dm)·(1-0.05·r)·aauf·x22	+(1-dm)·(1-0.05·r)·aauf·x23	-(1-dm)·(1-0.05·r)·aauf·x24	-(1-dm)·(1-0.05·r)·aauf·x25
Y8						
Y9						
Y10						
Y11						
Y12						
Y13						
Y14						
Y15						
Y16						
Y17						
Y18						
Y19						
Y20	x20					
Y21		x21				
Y22			x22			
Y23				x23		
Y24					x24	
Y25						x25
Y26						
Y27						
Y28						
Y29						
Y30						
Y31						
Y32						
Y33						
Y34						
Y35						
Y36						
Y37						
Y38						
Y39						
Y40						
Y41						
Y42						
Y43						
Y44	+r·0.05·x20	+r·0.05·x21	+r·0.05·x22	+r·0.05·x23	-r·0.05·x24	-r·0.05·x25
Y45						
Y46	-dm·(1+r·0.05)·x20	-dm·(1+r·0.05)·x21	-dm·(1+r·0.05)·x22	-dm·(1+r·0.05)·x23	+dm·(1-r·0.05)·x24	+dm·(1-r·0.05)·x25
Y47		+(1-s)·x21		+(1-s)·x23		+(1-s)·x25
Y48	+a·x20	+a·x21	+a·x22	+a·x23		
Y49	+b·x20	+b·x21	+b·x22	+b·x23		
Y50	-(1-c)·x20	-(1-c)·x21	-(1-c)·x22	-(1-c)·x23	-c·x24	-c·x25
Y51	+d·x20	+d·x21	+d·x22	+d·x23	-x24	-x25
Y52	+e·x20	+e·x21	+e·x22	+e·x23		
Y53					+f·x24	+f·x25
Y54	+g·x20	+g·x21	+g·x22	+g·x23	-g·x24	-g·x25
Y55	-(1-h)·x20	-(1-h)·x21	+h·x22	+h·x23		
Y56	+i·x20	+i·x21	+i·x22	+i·x23		
Y57	-(1-j)·x20	-(1-j)·x21	-(1-j)·x22	-(1-j)·x23	+(1-j)·x24	+(1-j)·x25
Y58	-(1-k)·x20	-(1-k)·x21	-(1-k)·x22	-(1-k)·x23	+(1-k)·x24	+(1-k)·x25
Y59	-(1-l)·x20	-(1-l)·x21	-(1-l)·x22	-(1-l)·x23	-l·x24	-l·x25
Y60	-(1-m)·x20	-(1-m)·x21	-(1-m)·x22	-(1-m)·x23	-m·x24	-m·x25
Y61	+n·x20	+n·x21	+n·x22	+n·x23	-n·x24	-n·x25
Y62	+o·x20	+o·x21	+o·x22	+o·x23	-o·x24	-o·x25
Y63	+(p-1)·x20	+(p-1)·x21	+(p-1)·x22	+(p-1)·x23	+(1-p)·x24	+(1-p)·x25
Y64	-x20	-x21	-x22	-x23	+x24	+x25

Table 5. Optimization model (continued)

	xFk	XFk	xfl	Xfl	xfk	Xfk
	x26	**x27**	**x28**	**x29**	**x30**	**x31**
Z	+x26	+x27	-x28	-x29	-x30	-x31
Y1		-sk·x27		+sk·x29		+sk·x31
Y2		-sg·x27		+sg·x29		+sg·x31
Y3						
Y4	+s·x26		-s·x28		-s·x30	
Y5	-s·x26		+s·x28		+s·x30	
Y6	-(1-0.05·r)·avor·x26	-(1-0.05·r)·avor·x27	+(1-0.05·r)·avor·x28	+(1-0.05·r)·avor·x29	+(1-0.05·r)·avor·x30	+(1-0.05·r)·avor·x31
Y7	-(1-dm)·(1-0.05·r)·aauf·x26	-(1-dm)·(1-0.05·r)·aauf·x27	+(1-dm)·(1-0.05·r)·aauf·x28	+(1-dm)·(1-0.05·r)·aauf·x29	+(1-dm)·(1-0.05·r)·aauf·x30	+(1-dm)·(1-0.05·r)·aauf·x31
Y8						
Y9						
Y10						
Y11						
Y12						
Y13						
Y14						
Y15						
Y16						
Y17						
Y18						
Y19						
Y20						
Y21						
Y22						
Y23						
Y24						
Y25						
Y26	x26					
Y27		x27				
Y28			x28			
Y29				x29		
Y30					x30	
Y31						x31
Y32						
Y33						
Y34						
Y35						
Y36						
Y37						
Y38						
Y39						
Y40						
Y41						
Y42						
Y43						
Y44	-r·0.05·x26	-r·0.05·x27	+r·0.05·x28	+r·0.05·x29	+r·0.05·x30	+r·0.05·x31
Y45						
Y46	+dm·(1-r·0.05)·x26	+dm·(1-r·0.05)·x27	-dm·(1+r·0.05)·x28	-dm·(1+r·0.05)·x29	-dm·(1+r·0.05)·x30	-dm·(1+r·0.05)·x31
Y47		+(1-s)·x27		-(1-s)·x29		-(1-s)·x31
Y48						
Y49						
Y50	-c·x26	-c·x27	+c·x28	+c·x29	+c·x30	+c·x31
Y51			+x28	+x29		
Y52	-x26	-x27			+x30	+x31
Y53			-f·x28	-f·x29		
Y54	-g·x26	-g·x27	+g·x28	+g·x29	+g·x30	+g·x31
Y55	-h·x26	-h·x27			+h·x30	+h·x31
Y56	-x26	-x27			+x30	+x31
Y57	+(1-j)·x26	+(1-j)·x27	-(1-j)·x28	-(1-j)·x29	-(1-j)·x30	-(1-j)·x31
Y58	+(1-k)·x26	-(1-k)·x27	-(1-k)·x28	-(1-k)·x29	-(1-k)·x30	-(1-k)·x31
Y59	-l·x26	-l·x27	+l·x28	+l·x29	+l·x30	+l·x31
Y60	-m·x26	-m·x27	+m·x28	+m·x29	+m·x30	+m·x31
Y61	-n·x26	-n·x27	+n·x28	+n·x29	+n·x30	+n·x31
Y62	-o·x26	-o·x27	+o·x28	+o·x29	+o·x30	+o·x31
Y63	+(1-p)·x26	+(1-p)·x27	+(p-1)·x28	+(p-1)·x29	+(p-1)·x30	+(p-1)·x31
Y64	+x26	+x27	-x28	-x29	-x30	-x31

Table 5. Optimization model (continued)

	xRa	XRa	xra	Xra	XI	Xi	xGV
	x32	**x33**	**x34**	**x35**	**x36**	**x37**	**x38**
Z	+x32	+x33	-x34	-x35			x38
Y1		-sk·x33		+sk·x35	-sk·x36	+sk·x37	
Y2		-sg·x33		+sg·x35	-sg·x36	+sg·x37	
Y3							
Y4	+s·x32		-s·x34		+s·x36	-s·x37	
Y5	-s·x32		+s·x34		-s·x36	+s·x37	
Y6	-(1-0.05·r)·avor·x32	-(1-0.05·r)·avor·x33	+(1-0.05·r)·avor·x34	+(1-0.05·r)·avor·x35			
Y7	-(1-dm)·(1-0.05·r)·aauf·x32	-(1-dm)·(1-0.05·r)·aauf·x33	+(1-dm)·(1-0.05·r)·aauf·x34	+(1-dm)·(1-0.05·r)·aauf·x35			-aauf·x38
Y8							
Y9							
Y10							
Y11							
Y12							
Y13							
Y14							
Y15							
Y16							
Y17							
Y18							
Y19							
Y20							
Y21							
Y22							
Y23							
Y24							
Y25							
Y26							
Y27							
Y28							
Y29							
Y30							
Y31							
Y32	x32						
Y33		x33					
Y34			x34				
Y35				x35			
Y36					x36		
Y37						x37	
Y38							x38
Y39							
Y40							
Y41							
Y42							
Y43							
Y44	-r·0.05·x32	-r·0.05·x33	+r·0.05·x34	+r·0.05·x35			
Y45							
Y46	+dm·(1-r·0.05)·x32	+dm·(1-r·0.05)·x33	-dm·(1+r·0.05)·x34	-dm·(1+r·0.05)·x35			
Y47					+(1-s)·x36	-(1-s)·x37	
Y48							
Y49	-b·x32	-b·x33	+b·x34	+b·x35			
Y50	+(1-c)·x32	+(1-c)·x33	-(1-c)·x34	-(1-c)·x35			
Y51	-d·x32	-d·x33	+d·x34	+d·x35			
Y52							
Y53							
Y54	-g·x32	-g·x33	+g·x34	+g·x35			
Y55	-h·x32	-h·x33	+h·x34	+h·x35			
Y56							
Y57	+(1-j)·x32	+(1-j)·x33	-(1-j)·x34	-(1-j)·x35			
Y58	+(1-k)·x32	+(1-k)·x33	-(1-k)·x34	-(1-k)·x35			
Y59	+(1-l)·x32	+(1-l)·x33	-(1-l)·x34	-(1-l)·x35			
Y60	+(1-m)·x32	+(1-m)·x33	-(1-m)·x34	-(1-m)·x35			
Y61	-n·x32	-n·x33	+n·x34	+n·x35			
Y62	-o·x32	-o·x33	+o·x34	+o·x35			
Y63	+(1-p)·x32	+(1-p)·x33	+(p-1)·x34	+(p-1)·x35			+x38
Y64	+x32	+x33	-x34	-x35			+x38

Table 5. Optimization model (continued)

	xvv	xRENTK	xRENTG	xRENTS	xRENTA	xreing	xreins	xreina	xreinü
	x39	**x40**	**x41**	**x42**	**x43**	**x44**	**x45**	**x46**	**x47**
Z	-x39	+x40	+x41	+x42	+x43	-x44	-x45	-x46	-x47
Y1									
Y2									
Y3									
Y4									
Y5									
Y6	-(0.05·r-1)·avor·x39						+avor·x45		
Y7	-(1-dm)·(0.05·r-1)·aauf·x39	-aauf·x40	-aauf·x41	-aauf·x42	-aauf·x43		+aauf·x45		+aauf·x47
Y8									
Y9									
Y10									
Y11									
Y12									
Y13									
Y14									
Y15									
Y16									
Y17									
Y18									
Y19									
Y20									
Y21									
Y22									
Y23									
Y24									
Y25									
Y26									
Y27									
Y28									
Y29									
Y30									
Y31									
Y32									
Y33									
Y34									
Y35									
Y36									
Y37									
Y38									
Y39	x39								
Y40		x40							
Y41			x41						
Y42				x42					
Y43					x43				
Y44	+r·0.05·x39					x44			
Y45							x45		
Y46	-dm·(1+r·0.05)·x39							-x46	
Y47									x47
Y48									
Y49									
Y50									
Y51									
Y52									
Y53									
Y54									
Y55									
Y56									
Y57									
Y58									
Y59									
Y60									
Y61									
Y62			-x41	-x42	-x43	+x44	+x45	+x46	+x47
Y63	-x39	+x40	+x41	+x42	+x43	-x44	-x45	-x46	-x47
Y64	-x39	+x40	+x41	+x42	+x43	-x44	-x45	-x46	-x47

Table 5. Optimization model (continued)

	RS
Z	=sBI-vJvor
Y1	=sk·(vJvor+ka*)
Y2	=sg·(vJvor+ka*+Vk+ga)
Y3	=-LESTPvor+LESTAvor
Y4	=s·AD+∑KVvor5·sk+∑GVvor5·sg
Y5	=s·PD
Y6	=(1-0.05·r)·avor·vJvor+(r-1)·avor·reinn
Y7	=(1-dm)·(1-0.05·r)·aauf·vJvor+[(dm-1)·(1-r)·reinn-0.04·Aus]·aauf
Y8	≤oAs(x8)-vAs
Y9	≤oAs(x9)-vAs
Y10	≤oAü(x10)-vAü
Y11	≤oAü(x11)-vAü
Y12	≤vAs-uAs(x12)
Y13	≤vAs-uAs(x13)
Y14	≤vAü-uAü(x14)
Y15	≤vAü-uAü(x15)
Y16	≤oUv(x16)-vUv
Y17	≤oUv(x17)-vUv
Y18	≤oUü(x18)-vUü
Y19	≤oUü(x19)-vUü
Y20	≤vUv-uUv(x20)
Y21	≤vUv-uUv(x21)
Y22	≤vUü-uUü(x22)
Y23	≤vUü-uUü(x23)
Y24	≤vFl-uFl(x24)
Y25	≤vFl-uFl(x25)
Y26	≤vFk-uFk(x26)
Y27	≤vFk-uFk(x27)
Y28	≤oFl(x28)-vFl
Y29	≤oFl(x29)-vFl
Y30	≤oFk(x30)-vFk
Y31	≤oFk(x31)-vFk
Y32	≤oRa(x32)-vRa
Y33	≤oRa(x33)-vRa
Y34	≤vRa-uRa(x34)
Y35	≤vRa-uRa(x35)
Y36	≤I(x36)
Y37	≤i(x37)
Y38	≤vGV-uGV(x38)
Y39	≤vVV-uVV(x39)
Y40	≤vK-uK(x40)
Y41	≤vG-uG(x41)
Y42	≤vS-uS(x42)
Y43	≤vAG-uAG(x43)
Y44	=r·0.05·vJvor+ (1-r)·reinn
Y45	=reins
Y46	=dm·[(1-r)·reinn-(1-r·0.05)·vJvor]
Y47	≤(1-s)·(vZ+vP)
Y48	≤a·vU-vA
Y49	≤b·(vA+vU+vRa)-vA
Y50	≤(c-1)·(vA+vU+vRa)-c·(vFl+vFk-vKSt-vGewSt-vLESTP-vTAvor-vTAauf)
Y51	≤d·(vA+vU+vRa)-vFl
Y52	≤e·(vA+vU+vRa)-(vFk-vKSt-vGewSt-vLESTP-vTAvor-vTAauf)
Y53	≤f·vFl-vA
Y54	≤g·(vU+vRa-vFl-vFk+vKSt+vGewSt+vLESTP+vTAvor+vTAauf)-(1-g)·vA
Y55	≤h·(vA+vU+vRa-vFk+vKSt+vGewSt+vLESTP+vTAvor+vTAauf)-(vA+vUv)
Y56	≤i·vU-(vFk-vKSt-vGewSt-vLESTP-vTAvor-vTAauf)
Y57	≤j·vJvor-(vA+vU+vRa-vFl-vFk+vKSt+vGewSt+vLESTP+vTAvor+vTAauf)
Y58	≤k·vJvor-(vA+vU+vRa-vFl-vFk+vKSt+vGewSt+vLESTP+vTAvor+vTAauf)
Y59	≤l·vJvor-(vA+vU+vRa)
Y60	≤m·vJvor-(vA+vU+vRa)
Y61	≤n·vJvor
Y62	≤-o·(vA+vU+vRa-vFl-vFk+vKSt+vGewSt+vLESTP+vTAvor+vTAauf)-(vS+vG+vAG)
Y63	≤vJvor+p·(vA+vU+vRa-vFl-vFk+vKSt+vGewSt+vLESTP+vTAvor+vTAauf)
Y64	≤sBI-vJvor

Table 6. Structure of the mixed-integer optimization approach

		xA (GA)	xA (ZW)	XA (GA)	XA (ZW)		RS
Z	· · ·	[oAs (xAGA) - vAs] · xA (GA)	+ xA (ZW)	+ [oAs (XAGA) - vAs] · XA (GA)	+ XA (ZW)	· · ·	= SBI - vJvor
· · ·	· · ·	· · ·	· · ·	· · ·	· · ·	· · ·	· · ·
Y(xAGA)	· · ·	[oAs (xAGA) - vAs] · xA (GA)				· · ·	≤ oAs (xAGA) - vAs
Y (xAZW)	· · ·		xA (ZW)			· · ·	≤ oAs (xAZW) - vAs
Y (XAGA)	· · ·			[oAS (XAGA) - vAs] · XA (GA)		· · ·	≤ oAs (XAGA) - vAs
Y(XAZW)	· · ·				XA (ZW)	· · ·	≤ oAs (XAZW) -vAs
· · ·	· · ·	· · ·	· · ·	· · ·	· · ·	· · ·	· · ·
Y(a)	·	[oAS (xAGA) - vAs] · xA (GA)	+ xA (ZW)	+ [oAs (XAGA) - vAs] · XA (GA)	+ XA (ZW)	·	≤ a · vU - vA
Y (b)	·	(1 - b) · [oAs (xAGA) - vAs] · xA (GA)	+ (1 - b) · x (ZW)	+ (1 - b) · [oAs (XAGA) - vAs] · XA (GA)	+ (1 - b) · XA (ZW)	·	≤ b · (vA + vU + vRa) - vA
· · ·	· · ·	· · ·	· · ·	· · ·	· · ·	· · ·	· · ·

2.3.7 Restrictions on the action parameters that draw on results

The following action parameters for the disposition of the result are included in the optimization models that are based on the commercial balance sheet for stock corporations after partial allocation of the annual result (sec. 268[1] HBG in conjunction with sec. 270[2] HGB) and transfer of the annual result to the balance sheet result (sec. 158[1] AktG).

Table 7. Action parameters for the disposition of the result

1.	Target annual result	sJnach
2.	+ Profit carried forward from the preceding year	xGV
3.	– Loss carried forward from the preceding year	xvv
4.	+ Withdrawals from capital reserves	xRENTK
5.	+ Withdrawals from legal reserves	xRENTG
6.	+ Withdrawals from statutory reserves	xRENTS
7.	+ Withdrawals from other retained earnings	xRENTAG
8.	– Transfers to the legal reserves pursuant to sec. 150(2) AktG	xreing
9.	– Transfers to the statutory reserves pursuant to the articles of association	xreins
10.	– Transfers to other retained earnings pursuant to sec. 58(2) AktG	xreina
11.	– Other transfers to other retained earnings pursuant to sec. 58(2a) AktG	xreinü
12.	= Target balance sheet result	sBI

The decision-makers can decide in accordance with legal and statutory rules if and to what extent profits or losses carried forward from preceding years and withdrawals from or transfers to reserves are required and admissible. In the case of options, they can be used in the context of accounting policy to reach the target balance sheet result. Accordingly, the following applies:

$$xGV \leq vGV - uGV\ (xGV) \quad \text{with } vGV \geq uGV\ (xGV) \tag{74}$$

$$xvv \leq vVV - uVV\ (xvv) \quad \text{with } vVV \geq uVV\ (xvv) \tag{75}$$

$$xRENTK \leq vK - uK\ (xRENTK) \quad \text{with } vK \geq uK\ (xRENTK) \tag{76}$$

$$xRENTG \leq vG - uG\ (xRENTG) \quad \text{with } vG \geq uG\ (xRENTG) \tag{77}$$

$$xRENTS \leq vS - uS\ (xRENTS) \quad \text{with } vS \geq uS\ (xRENTS) \tag{78}$$

$$xRENTAG \leq vAG - uAG\ (xRENTAG) \quad \text{with } vAG \geq uAG\ (xRENTAG). \tag{79}$$

If the legal or statutory provisions (Freidank and Velte 2013, p. 770–786) allow the use of any number of intermediate values, there are no objections to including the six restrictions in the above form in the optimization models (see restrictions Y38 to Y43 in Table 5). In these cases, the possible or required minimum values have to be entered into the model. If action parameters should not have an impact on the target balance sheet result due to legal or statutory provisions or because of accounting policy decisions, the minimum values have to be entered in the optimization models for the provisional balance sheet values of the profits or losses carried forward and reserves. For example, one is not allowed to make withdrawals from the legal reserves in the event of a net annual loss if profit has been carried forward from the previous year or if other retained earnings are available for reversal. However, if only certain amounts of these components have to or should be included in the target balance sheet result, the corresponding restrictions must be expressed as = conditions. For example, there is a legal obligation to loss repayment if there is a sufficient profit for the year. In this case, the bottom limit of the commercial loss carried forward from the previous year [uVV (xvv)] must be 0, which means that the total loss carried forward is set off at the expense of the balance sheet result. If the company is planning to distribute the other retained earnings (or a specific part), it is to proceed analogously.

In regard to those action parameters that affect the transfers to the retained earnings, there is a dependency of these accounting options to the annual result, which must be taken into consideration for formulating the respective restrictions. The provisions of sec. 150(2) AktG must be observed regarding the limits for transfers to the legal reserve (see Sec. 2.3.4 and restriction Y44 in Table 5)

$$- r \cdot 0.05 \cdot (- XKSt - XGewSt - XLS - xTAvor - xTAauf + xM - xm + XM - Xm - xvv) + xreing = r \cdot 0.05 \cdot vJvor + (1 - r) \cdot reinn. \tag{80}$$

Statutory reserves pursuant to the articles of association must be formed from the net annual profit in accordance with the agreement defined in the articles of association by the management board at the expense of the balance sheet profit. Based on the assumption that the envisaged transfer value of the reserves required in terms of the articles of association is defined in the articles of association (reins), then the following restriction applies (see restriction Y45 in Table 5):

$$xreins = reins. \tag{81}$$

With regard to the transfer to the other retained earnings (sec. 58[2] AktG), the following restriction applies in the case of the adoption of the annual financial statement by the management board and the supervisory board and provided that the special case of a deviating authorization in the articles of association regarding the disposal of the management board pursuant to sec. 58(2), sent. 2 and 3 AktG is not taken into consideration:

$$- dm \cdot [(1 + r \cdot 0.05) \cdot XKSt - (1 + r \cdot 0.05) \cdot XGewSt - (1 + r \cdot 0.05) \cdot XLS - (1 + r \cdot 0.05) \cdot TAvor - (1 + r \cdot 0.05) \cdot TAauf + (1 - r \cdot 0.05) \cdot xM - (1 + r \cdot 0.05) \cdot xm + (1 - r) \cdot XM - (1 + r \cdot 0.05) \cdot Xm - (1 + r \cdot 0.05) \cdot xvv] + xreina = dm \cdot [(1 - r) \cdot reinn - (1 - r \cdot 0.05) \cdot vJvor]. \tag{82}$$

The transfer to other retained earnings (xreinü) is based on the provisions of sec. 58(2a) AktG. According to this section, the management board and the supervisory board may enter the equity share of tax-related appreciation in value in the case of fixed and current assets as well as liabilities that have been formed as part of the tax income determination in the other retained earnings (Cahn and Spannenberg 2010, note 52a on sec. 58, p. 557; Förschle and Hoffmann (2014), note 258 on sec. 272, p. 1077.). Whereas the reversals amount to attributions to asset items that must be recognized according to sec. 253(5) HGB with the consequence of income tax-related impacts, the factual circumstances of the liability items include all tax-related provisions that lead to a reduction in the tax-assessment basis in the reference period (e.g., the formation of tax-free reserves). When determining the equity share (EKA) of the tax-effective attribution (vZ) or the increase in the liability items in the tax balance sheet (vP), the prospective income tax burden (s) that must be deducted from the amount must be calculated in principle specifically for each company.

$$EKA = (1 - s) \cdot (vZ + vP) \tag{83}$$

The company can transfer the equity share at a maximum value or in an intermediate amount in the other retained earnings. The underused amount cannot be rescheduled later. The company may transfer the equity share without credit per the restriction of sec. 58(1) AktG and sec. 58(2) AktG in the other retained earnings. Sec. 58(2a) AktG does not contain any provisions on when the retained earnings formed have to be resolved. Since this item does not have the character of an adjustment factor for the amounts of the value-appreciated assets and does not present a substitute for implementing tax-related privileges but is clearly designed to make the resulting equity shares available for the tax-related allocations and formations of liability items of the distribution of profits, the dissolution of the amounts in question can only be carried out as part of the disposition powers of the competent corporate bodies (Hüffer 2012, note 20 on sec. 58, p. 293). Accordingly, the general provisions that apply to the dissolution of the balance sheet item for other retained earnings must be applied here as well. To direct the retained earnings, and thus to direct the balance sheet result and their distribution, the following options are at the disposal of the decision-makers for the accounting policy:

- to transfer (or not) the equity share to the other retained earnings,
- to determine the amount of equity share as part of the latitude of discretion, or
- to resolve (or not) the other retained earnings formed in regard to the equity share. Reversals of retained earnings formed in accordance with sec. 58(2a) AktG are recognized in the form of the variable xRENTAG or the restriction $\leq$ vAG – uAG (xRENTAG) (see restriction Y43 in Table 5).

When integrating the xreinü variable into the optimization models, it must be taken into account that the value of the tax-related effective attributions and the formed liability items that define the equity share pursuant to sec. 58(2a) AktG is composed of three elements:

- attributions that necessarily result from tax reversals of fixed or current assets that have already been taken into account as part of the preparation of the provisional annual financial statement (vZ),
- the formation of tax liabilities that have already been recognized as part of the preparation of the provisional annual financial statement (vP), and
- changes in the preliminary write-ups (vZ) and the provisionally formed liabilities (vP) that are triggered by the action parameters of the option group II (commercial and tax-related options)

and the option group III (noncompliant options).

Accruals and deferrals are not included in the recording of changes since they are set-off items that are not valuated separately and are, moreover, excluded according to the wording of the law. Accordingly, the following applies (see restriction Y47 in Table 5):

$$-(1-s)\cdot(XA + XAü - Xa - Xaü + XU + XUü - Xu - Xuü - XFl - XFk + Xfl + Xfk - XI + Xi) + xreinü \leq (1-s)\cdot(vZ + vP). \tag{84}$$

It is necessary that the optimization model makes only positive values available for the forty-seven structural variables. Therefore, the following non-negativity requirements apply:

$$XKSt, XGewSt, XLS, XLESTA, XLESTP, xTAvor, xTAauf, xA, XA, xAü, XAü, xa, Xa, xaü, Xaü, xU, XU, xUü, XUü, xu, Xu, xuü, Xuü, xFl, XFl, xFk, XFk, xfl, Xfl, xfk, Xfk, xRa, XRa, xra, Xra, XI, Xi, xGV, xvv, xRENTK, xRENTG, xRENTS, xRENTAG, xeing, xreins, xreina, xeinü \geq 0. \tag{85}$$

2.3.8 Restrictions on selected annual financial statement indicators

The planning of annual financial statement indicators is part of the target-oriented planning of annual financial statements. Therefore it is necessary to formulate restrictions. The annual financial statement indicators that are usually considered relevant to an analysis of the annual financial statement or as part of a balance sheet rating are included in the optimization approaches (Conenenberg, Haller, and Schultze 2014, p. 1017–1175; Gibson 1983, p. 23–27; Küting and Weber 2012, p. 281–322; Lachnit 2004, p. 39–60). The following indicators have been taken into consideration for the purposes of the model (see restrictions Y48 to Y63 in Table 5). In principle, it is possible to include further restrictions in the form of indicators.

$$\text{Fixed assets : current assets} \leq a \text{ is equivalent to} \tag{86}$$

$$xA + XA + xAü + XAü - xa - Xa - xaü - Xaü - a\cdot xu - a\cdot XU - a\cdot xUü - a\cdot XUü + a\cdot xu + a\cdot Xu + a\cdot xuü + a\cdot Xuü \leq a\cdot vU - vA \tag{87}$$

$$\text{Fixed assets : balance sheet total} \leq b \text{ (investment ratio) is equivalent to} \tag{88}$$

$$(1-b)\cdot xA + (1-b)\cdot XA + (1-b)\cdot xAü + (1-b)\cdot XAü - (1-b)\cdot xa - (1-b)\cdot Xa - (1-b)\cdot xaü - (1-b)\cdot Xaü - b\cdot xU - b\cdot XU - b\cdot xUü - b\cdot XUü + b\cdot xu + b\cdot Xu + b\cdot xuü + b\cdot Xuü - b\cdot Xuü - b\cdot xRa - b\cdot xra + b\cdot xra + b\cdot Xra - b\cdot XLESTA \leq b\cdot(vA + vU + vRa) - vA \tag{89}$$

$$\text{Balance sheet total : equity} \leq c \text{ (1 : c = equity ratio)} \tag{90}$$

The equity ratio must be formulated as a reciprocal value because it arrives as a ≤ condition in the planning approach. The same applies for the following indicators of coverage as well as the values of profitability of equity and total capital. A corresponding transformation of the equity ratio specified in Inequality (90) is more complicated because in this case, owing to income tax and bonus effects, there are interdependencies between the desired ratio level, equity, and liabilities and the use of result-altering action parameters. The tax bonuses result will be made in Inequality (90.2) below through the following variables while a corresponding change in the income tax provisions and other liabilities (i.e., of short-term borrowed capital) is assumed:

$$XKSt + XGewSt + XLESTP + xTAvor + xTAauf \tag{90.1}$$

$$c\cdot XKSt + c\cdot GewSt + (1-c) + (1-c)\cdot XLESTA + c\cdot XLESTP + c\cdot xTAvor + c\cdot xTAauf + (1-c)\cdot xA + (1-c)\cdot XA + (1-c)\cdot xAü + (1-c)\cdot XAü - (1-c)\cdot xa - (1-c)\cdot Xa - (1-c)\cdot xaü - (1-c)\cdot Xaü + (1-c)\cdot xU + (1-c)\cdot XU + (1-c)\cdot xUü + (1-c)\cdot XUü - (1-c)\cdot xu - (1-c)\cdot Xu - (1-c)\cdot xuü - (1-c)\cdot Xuü - c\cdot xFl - c\cdot XFl - c\cdot xFk - c\cdot XFk + c\cdot xfl + c\cdot Xfl + c\cdot xfk + c\cdot Xfk + (1-c)\cdot xRa + (1-c)\cdot xra - (1-c)\cdot Xra \leq (c-1)\cdot(vA + vU + vRa) - c\cdot(vFl + vFk - vKSt - vGewSt - vLESTP - vTAvor - vTAauf). \tag{90.2}$$

Similarly, the remaining indicator restrictions are taken into consideration in the planning model. The integrated indicators are listed below. We refrain from presenting the detailed structure of the accounting policy Equations at this point (Freidank 1990, p. 118–123).

$$\text{Non-current liabilities : balance sheet total} \leq d \text{ (ratio of long-term debts)} \tag{91}$$

Current liabilities : balance sheet total ≤ e (ratio of short-term debts) (92)
Fixed assets : non-current liabilities ≤ f (1: f = asset coverage rate I) (93)

Fixed assets : equity ≤ g (1: g = asset coverage rate II) (94)

(Fixed assets + inventories) : (Equity + non-current liabilities) ≤ h (long-term asset coverage) (95)

Current liabilities : current assets ≤ i (1 : i = liquidity ratio) (96)

Equity : net annual result (earnings after taxes) ≤ j (= 1: j return on equity after taxes) (97)

Equity : net annual result before taxes (earnings before taxes) ≤ k (= 1: k = return on equity before taxes) (98)

(Equity + liabilities) : net annual result (earnings after taxes) ≤ l (1: l = total return on capital after taxes) (99)

(Equity + liabilities) : net annual profit before taxes (earnings before taxes) ≤ m (1 : m = total return on capital before taxes) (100)

(Effective + deferred income taxes) : net annual result before taxes (earnings before taxes) ≤ n (tax rate) (101)

Equity : retained earnings ≤ o (1 : o = rate of own financing) (102)

Equity : balance sheet result ≤ p (1 : p = distribution rate) (103)

By including the following restriction in the model, the accounting policy-makers are able to ensure that the balance sheet total does not exceed the critical thresholds stipulated in sec. 267(1), no. 1 or (2) no. 1 HGB to avoid mandatory audits pursuant to sec. 316(1) HGB and/or to benefit publicity privileges (cf., e.g., sec. 274a, 276, 326, 327 HGB) (BS = upper limit of the balance sheet total, see restriction Y64 in Table 5) if, for example, the limits on revenue or number of employees are exceeded.

$$vA + xA + XA + xAü + XAü – xa – Xa – xaü – Xaü + vU + xU + XU + xUü + XUü – xu – Xu – xuü – Xuü + vRa + xRa + XRa – xra – Xra + XLESTA) \leq BS – (vA + vU + vRa + vLESTA) \quad (104)$$

If the company strives for a certain balance sheet result (sBI) (e.g., for the purpose of income smoothing), this fixation approach must be taken into account in the case of a maximum target function by including the following restriction:

$$– XKSt – XGewSt – XLS – xTAvor – xTAauf + xA + XA + xAü + XAü – xa – Xa – xaü – Xaü + xU + XU + xUü + XUü – xu – Xu – xuü – Xuü + xFl + XFl + xFk + XFk – xfl – Xfl – xfk – Xfk + xRa + XRa – xra – Xra + xGv – xvv + xRENTK + xRENTG + xRENTS + xRENTAG – xeing – xreins – xreina – xeinü \leq sBI – vJvor \quad (105)$$

3 Summary

We have shown that, even after the reforms of German balance sheet law, mathematical procedures of optimal planning can be used to prepare annual financial statements of corporations that consider complex target structures and action parameters simultaneously. However, this requires a significant conceptual adjustment of the existing models, owing to the extensive amendments of the German balance sheet and tax-related accounting principles in 2009 and modifications, triggered by international developments, of the goals of the balance sheet information provided to the recipients of annual financial statements.

The IT-based optimization programs presented here, which can be combined with other accounting and auditing tools such as ACL or IDEA, provide those in charge of accounting with a means to quickly and clearly identify the appropriate values to base their decisions on in preparing the annual profit and loss account and/or balance sheet in spite of the many interdependencies rooted in accounting law. In those cases in which an optimal solution cannot be determined, the programs identify the conflicting structural and slack variables. This information puts decision-makers in a position to identify the data in the target plan (such as profit targets, planned balance sheet totals, and/or certain analytical indicators of the annual profit and loss account) that prevent an optimal

solution and, if necessary, to reformulate the targets on the basis of revised data so as to arrive at an optimal financial statement that is both in line with the accounting policy goals of the company and viable under the given conditions. Against this backdrop, the simultaneous models presented here are to some degree also of a sequential nature. In assessing the performance and usefulness of the IT-supported accounting policy optimization models, we must take into account that, because of the complexity and interdependence of the relationships in question, optimal accounting policy choices will rarely be achieved under realistic conditions if done by hand; yet at the same time these decisions will have a significant impact on key issues such as perceived company performance, the ability to pay dividends, as well as the burden on the corporation from income taxes and profit sharing.

The optimization models presented here have been adapted to the recent accounting reforms in Germany (e.g., BilMoG) and can be further expanded in various directions, which makes them highly flexible in terms of adaptability. The models can easily be refined to include additional measures (e.g., value indicators) or take particular optional choices into account (also those that do not affect profit and loss). Moreover, a characteristic feature of our models is that they are able to incorporate all significant accounting policy targets in mathematical optimization equations in the form of a target function (primary targets) and/or secondary conditions (secondary targets), provided that they can be sufficiently operationalized. This makes it possible to incorporate multiple, potentially competing objectives of the decision-maker (e.g., maximizing balance sheet profits versus achieving some debt equity ratio) and to determine an optimal overall solution. If we furthermore consider that, when expanding the models, an equation defined to express formally correct secondary conditions (e.g., indicators or balance sheet totals that must be met) can easily be adopted as the target function, then primary and secondary targets basically become completely interchangeable with regard to integrating the intentions of accounting policy.

Finally, the optimization models presented here can also be applied in the case of preparing a so-called "*Einheitsbilanz*", i.e., an integrated balance sheet that fulfills the requirements of commercial as well as tax law. [36] For this purpose, we must exclude from the optimization iterations deferred taxes as well as those action parameters that may be used in preparing commercial financial statements only. Against this background, the approaches can also be used in decision-making in matters of multi-period accounting policy. Calculating a series of optimal earnings and dividends per period with sufficient precision both for companies and stakeholders from the perspective of tax law poses no difficulties in principle. The formal objectives identified in this way can be entered into the model as set items, which – by utilizing the effectively available discretionary funds for the respective accounting period and by taking additional secondary targets into consideration (key indicators, balance sheet total) – makes it possible to transform the realized earnings according to the respective ends to be achieved. Moreover, our optimization models can be expected to have additional significance for businesses if we bear in mind, particularly, that the main task of tax-balance-sheet planning is not to determine the optimal reduction – or increase – in profits per annum, but to find the most suitable action parameters for the purpose of success for the period in question (Heinhold 1985, p. 56).

German commercial law does not directly prohibit auditors from providing consultation services to companies in matters of accounting policy provided that such consultation is limited to informing about alternative accounting options and does not result in self-auditing (sec. 319, 319a HGB in conjunction with sec. 23a of the Professional Code of Conduct for Auditors/Certified Accountants.The presented approaches can thus be expected to be successfully applicable also in the area of business consulting by accounting firms. Moreover, the optimization models, and the possibilities of expansion that they offer, represent a set of tools to assist auditing concerned with corporations' performance-related expenses (such as taxes on earnings and shares in profits), equity and earnings statements, and appropriation of net income, and are therefore a significant contribution to rationalizing the auditing of annual financial statements under commercial law. The auditor who adopts or (further) develops the models corresponding to his or her audit task only needs to enter the necessary variables into the models (e.g., income tax rates and/or profit-sharing rates, options, margins of discretion, performance indicators, balance sheet totals, accounting policy targets of the client) in addition to the provisional annual financial statement. The respective optimization program then delivers the solutions permissible under commercial and/or tax law.

[36] Pursuant to sec. 274a, no. 5 of the German Commercial Code, small stock corporations within the meaning of sec. 267(1) of the German Commercial Code do not have to take the provisions of sec. 274 of the German Commercial Code on the limitations on deferred taxes into account.

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