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Theory and Methodology

Strategic financial management in a multinational financial conglomerate: A multiple goal stochastic programming approach [☆]

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Abstract

The paper discusses a multi-stage stochastic programming approach to the strategic financial management of a multi-company financial conglomerate. The planning system creates a comprehensive strategy which simultaneously covers a number of future scenarios within a multi-period planning horizon. Multiple conflicting goals may be specified for the group level, company level or individual business area level, and the decision maker's preferences are allowed to change over time to reflect changing operating conditions and trade-off relationships between the goals. Special features include, among other things, full market valuation throughout the model, integrated treatment of different types of risks, explicit modelling of various types of intra-group transactions and relationships, extensive structures to deal with distressed assets and the covering of losses within the group, as well as consideration of potential portfolio effects of a diversified group structure on the cost of funding. © 2001 Elsevier Science B.V. All rights reserved.

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1. Introduction

Recent years have witnessed a trend towards financial services conglomerates consisting of de-

posit-taking institutions, finance companies, other credit institutions, investment companies, securities firms, real estate firms as well as life insurance and property-liability insurance companies. The group may also include industrial and commercial firms, frequently organized under a holding company.

The management of this type of a conglomerate is a difficult task under the present day conditions in which future operating environments can not be forecasted with any degree of accuracy. From a strategic planning point of view the difference between a 'conglomerate' and a single financial institution is, on the other hand, in many cases smaller

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than what one might initially think. The ‘conglomerate’ may consist of, say, two domestic subsidiaries and one foreign subsidiary. As the decision about the number of individual firms in the group is often arbitrary you might equally well think of a single company. It is obvious that if the management board of the company does not take a stand on the composition of the firm’s business portfolios and the risks related to these portfolios, it may ruin the company. Unfortunately this has also been the case in numerous real-world situations as the banking crises and failed institutions and groups of institutions have demonstrated in a number of countries. Furthermore, the crises in the financial services industry appear to continue and the process of covering losses within the group, for instance, has therefore become an important management issue. The diversification effects on the funding side, in particular, also justify a group perspective. There has, however been a lack of appropriate tools for dealing with the complex issues involved.

The paper therefore discusses a dynamic multi-stage stochastic programming approach to the strategic financial management of a multi-company group. The system is used to create a comprehensive strategy which simultaneously covers a number of potential future scenarios within a multi-period planning horizon.

The general area of strategic asset and liability management or strategic financial risk management has received increased attention in financial institutions during the last few years. For extensive reviews of stochastic models, scenario generation procedures, recent advances in solution algorithms as well as practical applications in this area see Mulvey et al. (1997), Mulvey and Ziemba (1995), Carino et al. (1994), Bunn and Salo (1993), and Langen (1989). For a discussion of earlier applications see, for instance, Kusy and Ziemba (1986) and Korhonen (1984, 1987). Previous studies typically deal with strategic asset and liability allocation decisions at the level of individual institutions such as banks, insurance companies and pension funds. The present model extends the analysis to the management of a multi-company group with a multitude of intra-group relationships.

2. Outline of general features

The application described in this paper is a multi-stage stochastic linear program designed to deal with the strategic asset and liability management problem of a multi-company group consisting of predominantly financial institutions. Asset and liability management means by definition that assets, liabilities, capital and off-balance sheet items are being managed simultaneously.

The group structure and the number of firms in the group are generally quite free. Multinational and multi-level groups are allowed (Fig. 1), and the full model structure and the full set of variables are available for holding companies, subsidiaries and operative associated companies within the group. A reduced model structure is applied in the case of other group-related companies such as industrial and commercial firms. Intra-group funding, holdings and asset transactions are also explicitly modelled. The intra-group funding alternatives, in particular, include a wide range of different options as far as the instruments and type of funding are concerned.

The model allows a flexible choice of goals, risk measures and types of activities to be included in the analysis. Goals may be specified for the group level, company level or individual business area level, and they deal with both financial and non-financial aspects of the operations. The risk measures consider the effects of covariability or correlation, and they thus allow an integrated treatment of different types of risk. Furthermore, they permit a joint treatment of risks arising from both price changes and volume changes. The decision maker’s preferences are allowed to change over time to reflect changing operating conditions and trade-off relationships in the case of conflict-

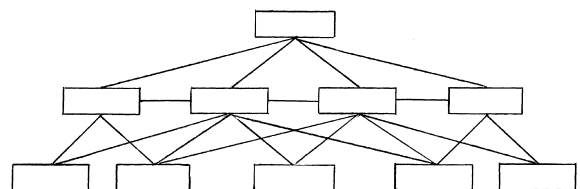


Fig. 1. Multinational and multi-level groups with varying structures and intra-group relationships.

ing goals. The degree of the decision maker's risk aversion is also considered, and it may differ between the goals.

The planning horizon in the model typically covers three or four years. Individual periods within the planning horizon usually have a length of one year. Future uncertainty is described by a set of alternative scenarios (Fig. 2), and the number of scenarios as well as the progression of the scenarios from one period to another is free. The scenarios deal with general economic conditions, the state of the domestic and foreign financial markets, and other aspects of the operating environment relevant to the group.

The model uses a set of standard modules to describe the existing or potential business portfolios

of the individual companies within the group. The number of variables in any particular module is generally free allowing the user to select the desired level of aggregation. All variables have explicit decision variables associated with them whenever applicable or conceivable. The currency denomination of all balance sheet and off-balance sheet variables is also free. Off-balance sheet variables include, among other things, interest rate, currency and stock index futures contracts. In addition to nominal or book values full market valuation is used throughout the model. A set of standard valuation formulas is being offered; in the case of real estate investments, stock investments and stock index futures contracts the user may also choose between alternatives and/or insert individual values.

Set of strategies

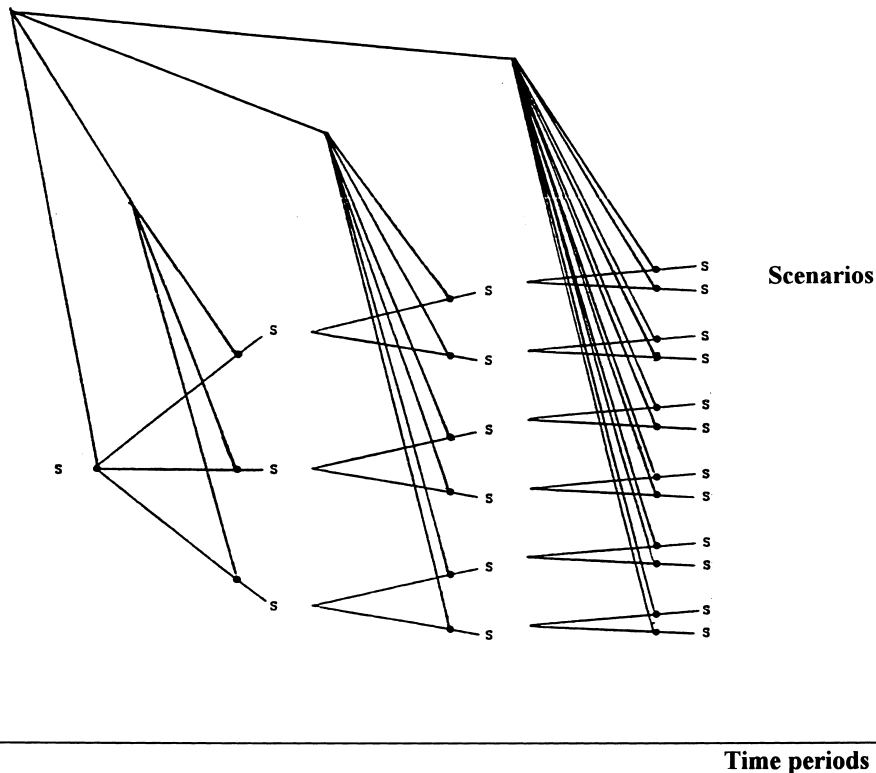


Fig. 2. Multi-period time horizon with different types of scenario trees, changing goal structures and priorities, a comprehensive set of optimal strategies for all periods and scenarios within the planning horizon.

In reflection of the crises in the financial sector in some countries, extensive structures have been developed to deal with distressed assets such as loans, real estate and stock holdings requiring restructuring investments, the covering of losses within the group and the treatment of bankruptcy conditions. Cumulative and non-cumulative instruments capable of covering losses on an on-going basis are therefore included throughout.

The cost of funding in the model depends on a modified capital ratio. The ratio is adjusted, among other things, for asset quality and the variability of accounting earnings, and it thus allows potential portfolio effects from the conglomerate structure as well as the effects of the management decision making to be reflected in the cost of funding. The effects of the liability structure, asymmetrical dividend information effects and other potential dividend related effects are also taken into consideration. A total of five different cost functions are available to reflect different maturity, collateral and subordination features. One of the functions allows for the possibility of a risk-based deposit insurance in the case of a deposit-taking institution within the conglomerate. Potential loan–deposit feedback relationships are included in the model, as well as transfers and securitisations of loans. Whenever applicable, scenario dependent take-downs, early prepayments and withdrawals either on the initiative of the companies themselves or their customers and fund providers are allowed. Institutional restrictions limiting early redemptions are also observed, as well as contractual arrangements concerning the redemption value.

The general structure of the model is as follows:

1. Asset modules
2. Liability modules
3. Capital modules
4. Taxation modules
5. Premium cost and aggregation modules
6. Futures modules
7. Accounting consolidation modules
8. Regulation modules
9. Objective functions

Section 3 presents an overview of the main features of the modules, and Section 4 discusses practical implementation issues. The paper ends with some concluding remarks.

3. Description of the modules

3.1. Asset modules

The current version of the model includes 15 general asset classes, each of which may contain several individual asset variables with different optional features. The optional features relate to decision variables used (general or intra-group), the type of nominal rate of return assumed, valuation methods, book values, prepayment options, collateral relationships and several other aspects of the operations. The full model structure and the full set of variables are available for companies of type A in the group (holding companies, subsidiaries and operative associated companies). A reduced set of variables is used to describe investments in other companies (type B) in the group, in which case the full model structure is not applied. The intra-group transactions available in these two cases are listed in the enclosed table. All variables are scenario dependent, and appropriate combinations of variables can be selected to describe current or potential future business portfolios of the companies in question. The level of disaggregation can be determined by the user of the model to reflect individual requirements. Multiple currencies are allowed in all cases, and currency exchange rates are scenario dependent. The general asset classes are presented in Table 1.

Cash and cash equivalents may, like all the other variables, be defined for multiple currencies and the model includes explicit decision variables for portfolio restructuring purposes. Technical or policy related upper and lower limits for the decision variables and the resulting total amounts of these variables are also available.

Short-term discount investments and *short-term interest bearing investments* have a maximum maturity of two years and they cover money market instruments and short-term lending. Four contract or maturity types per year are allowed as well as collateral relationships with one liability type. Like in most other cases, scenario dependent default rates and scenario and risk-class dependent required rates of return are applied in market valuations. Decision variables also include sales (if applicable). These asset types may con-

Table 1
Asset modules

Asset class	Name	Intra-group transactions with companies of types A and B	
1	Cash and cash equivalents	–	–
3	Short-term discount investments	–	B
6	Short-term interest bearing investments	–	B
11	Loans	A	B
20	Loans-group originated	A	–
26	<i>M</i> -variables	–	B
28	Bonds	–	B
30	Intra-group loans	A	–
35	Intra-group investments	A	–
37	Stocks-group transactions	A	–
38	Real estate-group transactions	A	–
40	Stocks	A	B
41	Real estate	A	–
43	Fixed assets	–	–
44	Other assets	–	–
	(Consolidated goodwill)		
	(Exchange differences)		

tain group-related lending not covered by intra-group loans.

Loan variables usually describe different customer or industry types. The model differentiates between loans originated by the institution and loans purchased by the institution. Sales treatment or financing (collateralized borrowing) treatment are allowed in the case of transfers and securitisations, and loans may also be transferred to other companies in the group, in which case they end up in loans-group originated in the counterparties. Nominal rates of interest include fixed rate, floating rate and variable rate alternatives. Market valuations are, like in the case of other variables, scenario dependent and they also consider non-interest revenues and costs. Differentiated valuation is allowed for originated loans and purchased loans, ordinary loans and classified loans, as well as transfers and securitisations. Scenario dependent prepayments on the initiative of the borrower are also permitted.

Other loan related features of interest include forward loan commitments with scenario dependent take-downs (FRA's are covered in the *interest rate futures modules*) and multi-period loan–deposit feedback relationships. In these relationships changes in the underlying originated loan volume before transfers and securitisations (sales treatment) are allowed to affect the forecasts for new

deposits in a number of deposit categories. Loans also contain group-related lending not covered by intra-group loans.

Loans-group originated describe loans acquired from another firm in the group. They therefore include the same fixed rate, floating rate and variable rate alternatives as the original loan variables. Market valuations and prepayments are also scenario dependent. Collateral relationships with two liability types are permitted, and these loans may be sold outside the group.

M-variables deal with special-purpose regulated funds and other items allowing a simplified model structure. Nominal rates of interest are assumed to be variable, and this item may also include group-related lending not covered by intra-group loans. Otherwise the treatment of this asset type resembles that of cash and cash equivalents.

Bonds contain a wide range of marketable instruments from ordinary bonds to fixed and floating rate preferred shares. Nominal rates of return include fixed rate, floating rate, variable rate, zero coupon, fixed rate perpetual and floating rate perpetual alternatives. Market valuations and prepayments are scenario dependent, and three types of collateral relationships within the balance sheet are allowed. Bonds may also contain group-related investments not covered by intra-group loans.

Intra-group loans consist of funding other than ordinary shares (which are dealt with in the next asset class) to parents, subsidiaries and operative associated companies within the group. Typical instruments range from simple credit lines to secured and unsecured bonds and notes, subordinated term instruments, ordinary perpetuals, as well as perpetual cumulative and non-cumulative instruments capable of covering losses on an ongoing basis. Decision variables relating to this asset type are technically defined as the decision variables of the counterparty (borrower). Nominal rates of return include the same alternatives as in the case of bonds. Scenario dependent prepayments on the initiative of the borrower are permitted, and scenario dependent market valuations also consider losses to be covered and reimbursements of covered losses in the case of cumulative and non-cumulative instruments. Collateral arrangements relevant for holding companies, for instance, are also allowed.

Intra-group investments include ordinary share capital invested in subsidiaries and operative associated companies (domestic or foreign) within the group. The amount of dividends to be received is determined as a decision variable of the counterparty (see *Ordinary shares* in Section 3.3). Revenues and costs relating to intra-group services are also considered in this section, and positive or negative market values of equity are computed internally from the valuations made in the counterparty. The amount of surplus relating to new issues of shares by the counterparty is determined by considering scenario dependent market expectations concerning dividend yields and growth rates as well as required rates of return that depend on a modified capital ratio. The ratio is adjusted for asset quality, variability of accounting earnings, asymmetrical dividend information effects and other dividend related effects (if any). Collateral arrangements similar to those in the case of intra-group loans are also available.

Stocks-group transactions consist of items acquired by the company from another firm in the group. Two alternative valuation formulas are available for scenario dependent pricing. Differentiated valuation is allowed for ordinary assets, distressed assets and sales of assets. Restructuring

investments required in the case of distressed assets are also taken into account, as well as certain collateral relationships. These assets may only be sold outside the group.

In a similar fashion, *real estate-group transactions* deals with real estate that has been acquired from another firm in the group. Perpetual pricing formulas based on either fixed rate or floating rate rental yields and growth rates are available, and differentiated valuation is allowed for investment assets, fixed assets, distressed assets and sales of assets. Operating costs and neglected maintenance investments affect valuations, and maintenance investments are constrained by replacement values adjusted for relevant index values. Collateral relationships and sales restrictions are similar to those in the case of stocks-group transactions.

Stocks include, in addition to ordinary purchases of stock, scenario dependent acquisitions of stock that originate from the loan portfolio (collaterals/take-overs relating to customer loans). Restructuring investments relating to distressed assets are therefore again taken into account, and regulatory or policy restrictions (if any) are observed concerning the time period allowed for the disposal of these types of assets. Stocks may also be sold to other firms in the group, in which case they end up in stocks-group transactions in the counterparties. Collateral relationships and principles of market valuation are similar in these two asset categories. Stocks also include group-related investments not covered by intra-group investments.

Real estate contains, in addition to ordinary real estate investments, scenario dependent acquisitions of real estate that originate from the loan portfolio (collaterals relating to customer loans) in a fashion similar to that in the case of stock investments. Regulatory and/or policy restrictions are therefore again observed concerning the time period permitted for the disposal of these types of assets. Intra-group sales of real estate are allowed, and they end up in real estate-group transactions in the counterparties concerned. Scenario dependent valuation alternatives, the treatment of maintenance investments as well as the allowed collateral relationships are similar to those in real estate-group transactions.

Fixed assets are generally described by a single variable, and they cover fixed assets other than those included in intra-group investments, stocks and real estate (general and group transactions). *Other assets* contain miscellaneous routine items, and their volume is determined indirectly by the decisions made in the other asset categories. *Consolidated goodwill* and *exchange differences* are dealt with in Section 3.7.

All balance sheet variables and decision variables are constrained by appropriate market determined, policy determined or technical upper and lower limits.

3.2. Liability modules

The number of non-insurance related liability classes is currently 10, each of which may contain several individual liability variables with different optional features. Like in the case of the asset classes, the full model structure and the full set of variables are available for companies of type A (holding companies, subsidiaries and operative associated companies), whereas a reduced set of variables is used to describe funding obtained from other companies (type B) in the group. The intra-group transactions relating to these two cases are listed in Table 2. All variables are again scenario dependent, multiple currencies are allowed, and the level of aggregation is determined by the model user to reflect individual requirements. The general liability classes are presented in Table 2.

It has already been noted that the cost of funding in the model depends on a modified capital ratio adjusted, among other things, for asset quality and the variability or accounting earnings. This is an important feature since it allows potential portfolio effects from the conglomerate structure as well as the effects of the management decision making to be reflected in the cost of funding. The effects of the liability structure, asymmetrical dividend information effects and other potential dividend related effects are also taken into consideration. Five different cost functions are available to reflect different maturity, collateral and subordination features. One of the functions allows for the possibility of a risk-based deposit insurance in the case of a deposit-taking institution within the conglomerate (for details see Section 3.5). A brief summary of the other characteristics of the liability classes is presented here.

Short-term discount borrowing (collateralized) typically covers central bank funding and other repos. A maximum maturity of one year and four contract or maturity types per year are allowed, and collateral types include short-term money market instruments and bonds. These liability items are in the cost function for short-term debt and uninsured deposits.

Short-term discount borrowing and *short-term interest bearing borrowing* contain unsecured money market instruments with a maximum maturity of two years, and four contract or maturity types per year are again considered. Scenario dependent early redemptions on the initiative of the

Table 2
Liability modules

Liability class	Name	Intra-group transactions with companies of types A and B	
47	Short-term discount borrowing (collat.)	–	–
50	Short-term discount borrowing	–	–
53	Short-term interest bearing borrowing	–	–
55	Deposits	–	–
57	M-variables (borrowing)	A	B
60	Borrowing (loan-related)	–	–
65	Borrowing	A	B
68	Borrowing	A	B
70	Borrowing	–	–
71	Other liabilities (Negative consolidation differences) (Exchange differences)	–	–

borrower are allowed (if applicable). The effects of the liability structure are taken into account by including these items in the cost function for short-term debt and uninsured deposits.

Deposits consist of ordinary retail deposits (insured or uninsured). The volume of deposits is indirectly affected by decisions made in the loan portfolio (multi-period loan-deposit feedback relationships), since changes in the underlying originated loan volumes before transfers and securitisations (sales treatment) are allowed to affect the forecasts for new deposits. Nominal rates of interest include fixed rate, floating rate and variable rate alternatives. Insured deposits are in the cost function for deposits (risk-based deposit insurance) and uninsured deposits are in the cost function for short-term debt and uninsured deposits. Non-interest costs are also generally considered in market valuations. Scenario dependent early withdrawals on the initiative of customers or fund providers are permitted.

M-variables (borrowing) resemble their counterparts on the asset side. They deal with special-purpose regulated liabilities, credit lines and other items allowing a simplified model structure. Nominal rates of interest are assumed to be variable, and scenario dependent redemptions on the initiative of the borrower are allowed. These variables also include intra-group borrowing relating to intra-group loans in the counterparty, and they may contain other group-related borrowing.

Borrowing (60) covers mortgage-backed bonds or notes and other loan-related collateralized borrowing that originates from transfers and securitisations (financing treatment) in the loan portfolio (loans and loans-group transactions). Multiple collaterals are allowed, and nominal rates of interest include fixed rate, floating rate and variable rate alternatives. This liability type is in the cost function for long-term debt. Non-interest costs are also usually considered in market valuations.

Borrowing (65) deals with collateral trust bonds and unsecured bonds or notes. In case of a collateral two alternatives are available, and scenario dependent early redemptions on the initiative of the borrower are allowed. Nominal rates of return

cover the zero coupon version in addition to those included in the previous liability type, and market valuations are similar to the previous case. These variables may also contain intra-group borrowing relating to intra-group loans in the counterparty as well as other group-related borrowing.

Borrowing (68) is a major liability class in the model in that it covers a multitude of instruments such as mortgage bonds, collateral trust bonds (including those backed by investments in subsidiaries), unsecured bonds and notes, subordinated term debt and term preferred shares, ordinary perpetuals, as well as perpetual cumulative and non-cumulative instruments capable of covering losses on an on-going basis. Furthermore, the variables in this liability class also include intra-group borrowing or funding relating to intra-group loans in the counterparty, and they may contain other group-related funding. Additional decision variables are specified in the case of cumulative and non-cumulative instruments to describe the amount of losses to be covered, the reimbursement of covered losses as well as the amount of cumulative and non-cumulative interest or dividend payments to be made in any given period and scenario. Extensive structures are needed to deal with legal and contractual restrictions concerning the order and limits in covering losses from reserves, ordinary share capital, non-cumulative or cumulative instruments, respectively, the reimbursement of covered losses and the payment of interest or dividends on these instruments.

Nominal rates of return in this liability class include fixed rate, floating rate, variable rate, zero coupon, fixed rate perpetual and floating rate perpetual alternatives. Scenario specific required rates of return depend, like in the case of other funding, on a modified capital ratio and the effects of the liability structure are considered by including unsubordinated liability items in the cost function for long-term debt and other items in the cost function for subordinated debt. Non-interest costs, the covering of losses and the reimbursement of covered losses are also taken into account in valuations. Scenario dependent early redemptions on the initiative of the borrower are allowed (if applicable or permitted by institutional

restrictions), and they may be limited by the availability of distributable funds and/or proceeds from fresh new issues. Potential collaterals in this liability class are intra-group loans and investments, stocks and real estate.

Borrowing (70) may cover, among other things, consolidated mortgage bonds. Multiple collaterals involving real estate and stocks (including group transactions) are therefore allowed. Otherwise the treatment of these liabilities resembles that of loan-related borrowing (60).

Other liabilities contain miscellaneous routine items, and their volume is determined indirectly by the decisions made in the other liability categories. *Negative consolidation differences* and *exchange differences* are dealt with in Section 3.7.

3.3. Capital modules

This section includes four variable types, which are denominated in the base currencies of the companies concerned (domestic or foreign). All variables are scenario dependent. The variable types are the presented in Table 3.

Distributable funds may be positive or negative (90/94), and the decision variables relating to this item deal with

- losses to be covered from reserve funds, ordinary shares, non-cumulative or cumulative instruments, respectively;
- reimbursements of losses covered from cumulative and non-cumulative instruments;
- ordinary dividends and cumulative or non-cumulative interest/dividend payments to be made;
- transfers of positive accounting earnings to reserve funds.

The decision variables are constrained by appropriate legal and contractual restrictions, in-

cluding those relating to bankruptcy conditions. *Revaluation reserves* have passive role in the model, and the amount of this variable is therefore simply given by an initial value at the beginning of the planning horizon.

The decision variables defined for *reserve funds* deal with transfers of positive accounting earnings to reserve funds and losses to be covered from these funds. The amount of surplus to be transferred to reserve funds is determined in the pricing process of the scenario dependent new issues of shares (see *Ordinary shares* and Section 3.5). Legal and contractual restrictions are observed concerning the required or allowed transfers of earnings and the process of covering losses.

Ordinary shares also contain intra-group funding relating to intra-group investments (asset class 35) in the counterparty. Other group-related funding may also be involved. The decision variables defined for this capital item include new issues of shares, losses to be covered from ordinary share capital, and dividends to be paid. Dividends to be paid are determined by considering target dividends, scenario dependent speeds of adjustment of dividends towards target dividends, as well as debt and equity related pricing effects arising from potential expropriation effects, dividend tax effects and asymmetrical information effects in the case of unexpected changes in dividends (if any). Target dividends are in turn computed as a function of mean (positive) accounting earnings (adjusted for variability) and target ratios of dividends to earnings.

The amount of surplus associated with new issues of shares is determined by considering scenario dependent market expectations concerning dividend yields and growth rates as well as required rates of return that depend on a modified capital ratio adjusted for asset quality, variability of accounting earnings, dividend information effects and other dividend related effects (if any).

The model also allows for the formulation of various types of institutional restrictions regarding the order and limits in covering losses from reserves, ordinary share capital, non-cumulative and cumulative instruments, respectively, the availability of distributable funds, the payment of div-

Table 3
Capital modules

Variable type	Name
90/94	Distributable funds
96	Revaluation reserves
97	Reserve funds
98	Ordinary shares

idents in the case of covered losses, as well as bankruptcy conditions.

Note that perpetual non-cumulative instruments were covered in liability class 68. General loan loss provisions are included in Section 3.4, which also contains a separate variable for loan loss reserves (taxation). Regulatory capital definitions are dealt with in Sections 3.5 and 3.8.

3.4. Taxation modules

The items covered in this section consist of seven variable types, which are (like the capital items) denominated in the base currencies of the companies in question. All variables are also scenario dependent. The variable types are listed in Table 4.

Explicit decision variables have been defined for both increases and decreases in *loan loss reserves* to be applied in taxation. Legal restrictions are therefore included concerning upper limits for increases as well as the resulting total amount of these reserves. Similarly, restrictions are observed regarding the order and limits in using changes in loan loss reserves and tax loss carry-forwards to change pre-taxation profits. *General loan loss provisions (accounting)* are determined as a fraction of classified loans in any given period and scenario, and they are not used for taxation purposes.

Total net benefits (market valued) summarize all items in the model relating to operating income and capital gains or losses valued at market. *Book value adjustments* transform market values to book values in any given period and scenario. *Pre-tax-*

ation profits deal with profits before changes in tax loss carry-forwards and loan loss reserves (taxation) in any given scenario. *Tax loss carry-forwards* have a decision variable associated with them (decrease in the amount in any scenario), and as noted restrictions are included concerning the way in which tax loss carry-forwards and loan loss reserves (taxation) are used to manipulate pre-taxation profits and thus *taxes* to be paid in any given scenario.

3.5. Premium cost and aggregation modules

In the discussion of liability classes and capital items it was noted that the cost of funding in the model depends on a modified capital ratio adjusted, among other things, for asset quality and the variability of accounting earnings. This is a notable feature since one of the few benefits from the conglomerate structure might arise from potential portfolio effects relating to a diversified group structure and its effect on the cost of funding. The modified capital ratio is only remotely related to regulatory requirements and can therefore also be applied in the case of non-regulated entities. It employs adjusted liabilities (effectively represented by risk-weighted assets with regulatory or non-regulatory weights) and adjusted capital where regulatory capital items are modified in the case of general loan loss provisions and the regulator's risk measures as expressed by the capital requirements for various types of risks are replaced by the variability of earnings which, contrary to the regulatory approach, also considers the effects of correlations. To reflect an outside observer's point of view the variability of accounting earnings (as opposed to the market valued profits also available in the model) is employed, and the variability of earnings is measured by the semiabsolute deviation of earnings.

The effects of the liability structure, asymmetrical dividend information effects and (implicitly) other potential dividend related effects are also taken into consideration. A total of five different cost functions are available to reflect different maturity, collateral and subordination features. Separate functions are defined for deposits (allow-

Table 4
Taxation modules

Variable type	Name
74	Loan loss reserves (taxation)
75	General loan loss provisions (accounting)
76/1	Total net benefits (market valued)
76/2	Book value adjustments
77	Pre-taxation profits
78	Tax loss carry-forwards
79	Taxes

ing for the possibility of a risk-based deposit insurance in the case of a deposit-taking institution), short-term debt and uninsured deposits, long-term debt, subordinated debt and equity.

The variable types included in this section are presented in Table 5. All variables are scenario dependent.

Tier 1 capital definitions include potential restrictions concerning upper limits for non-cumulative instruments. *Tiers 2 and 3 capital* equations contain regulatory and technical restrictions regarding the relationship to Tier 1 capital, as well as the amount of general loan loss provisions, upper Tier 2 cumulative instruments and lower Tiers 2 and 3 conventional subordinated debt instruments allowed to be counted as capital. *Risk weighted assets* may be computed using regulatory or non-regulatory weights. Scenario dependent market expectations concerning dividend yields and growth rates are observed in defining *unexpected changes in dividends*. *Surplus in adjusted capital deficit in adjusted capital* includes multiple definitions for different levels of the adjusted capital ratio. The amounts of *insured deposits to be priced* are defined only for the current period cost function due to the nature of the deposit insurance. In other cases the amounts to be priced are differentiated by the applicable cost functions (premium fixation periods in the case of fixed rate, floating rate, variable rate and zero coupon items).

3.6. Futures modules

Four general futures contract classes are currently available, each of which may contain several individual variables. All variables are again scenario dependent, and multiple currencies are allowed. The futures contracts are used to transform the overall risk position on a macrohedging basis. The contract classes are presented in Table 6.

Short-term interest rate futures contracts generally have a maximum maturity of two years. Typical instruments include treasury bill futures, commercial paper futures and certificate of deposit futures. Four contract types per year are allowed and the pricing method is based on the cost of carry. This item also covers customer related for-

Table 5
Premium cost and aggregation modules

Variable type	Name
<i>General items and unsubordinated debt</i>	
101	Tier 1 capital
106	Tiers 2 and 3 capital
116	Risk weighted assets
117	Unexpected changes in dividends
118	Adjusted capital
120	Surplus in adjusted capital/deficit in adjusted capital
121–123	Definitions of junior debt classes
<i>Insured deposits</i>	
124	Definition of junior debt
125	Definition of insured deposits to be priced
126–128	Definition of risk-based deposit insurance premiums
<i>Short-term debt and uninsured deposits</i>	
129	Definition of junior debt
130–133	Definition of short-term debt and uninsured deposits to be priced
135–146	Definition of premium costs for short-term debt and uninsured deposits
<i>Long-term debt</i>	
150–153	Definition of long-term debt to be priced
155–166	Definition of premium costs for long-term debt
<i>Subordinated debt including non-cumulative instruments</i>	
168	Adjusted capital
169	Surplus in adjusted capital/deficit in adjusted capital
170–173	Definition of subordinated debt to be priced
175–186	Definition of premium costs for subordinated debt
<i>Equity</i>	
188	Adjusted capital
189	Surplus in adjusted capital/deficit in adjusted capital
190–191	Definition of surplus relating to new issues of ordinary shares
<i>Other aggregated variables</i>	
194	Total assets (book value)
195	Total liabilities (book value)
196	Total assets (market value)
197	Total liabilities (market value)
198	Market value of equity

ward rate agreements (FRA). Decision variables are, like in the case of the other contract classes, defined for purchases and sales of futures contracts in any given scenario by contract type.

Table 6
Futures modules

Contract class	Name
250	Short-term interest rate futures
260	Long-term interest rate futures
270	Stock index futures
280	Currency futures

Long-term interest rate futures contracts include instruments like treasury bond futures and mortgage bond futures. Their maximum maturity is three years, and four contract types per year are allowed. The pricing method is again based on the cost of carry.

Stock index futures contracts are assumed to have a maximum maturity of one year. The cost of carry-based pricing is adjusted for a scenario dependent premium or discount relative to the theoretical stock index futures price to reflect bullish vs. bearish market conditions. Two alternative pricing formulas and four contract types per year are available.

Currency futures have a maximum maturity of one year, and four contract types per year are again considered. The futures rate is based on the spot exchange rate adjusted for the interest rate differential between the two currencies. This item also includes customer related forward contracts.

3.7. Accounting consolidation modules

The process of accounting consolidation is quite technical by nature, and its main function is to determine the distributable funds of the group. It also has a role in the formulation of institutional restrictions in the case of regulated entities. The acquisition method, equity method and cost method are applied in the case of subsidiaries, operative associated companies and other group-related companies, respectively. The group-related companies include, among other things, investments in the industrial and commercial firms in the group. The current rate method is used in the case of foreign entities.

A general overview of the consolidation procedures can be obtained from the consolidation

related variable definitions listed in Appendix A. All variables are scenario dependent.

3.8. Regulation modules and objective functions

A number of institutional or *regulatory* issues have already been covered in the previous sections. These have included, among other things, restrictions regarding early redemptions and the disposal of certain types of assets, the process of covering losses, bankruptcy conditions, capital definitions, taxation, and the process of accounting consolidation. The present section deals with capital adequacy related regulations (defined broadly as those concerning capital ratios supplemented with restrictions on large exposures and limits on investments in stocks and real estate), liquidity and cash reserve requirements, as well as restrictions on foreign currency positions. Not all firms in the group are subject to these restrictions. Furthermore, the group of companies involved may differ from the group as defined for accounting consolidation purposes. The management may wish to apply standards higher than those given by the regulator's minimum levels, and as a result some of the restrictions are also allowed to appear in the *objective functions*.

The objectives or goals of the model may be defined for the group level, company level or individual business area level, and they deal with both financial and non-financial aspects of the operations. The goals of individual firms may in some cases be partly independent of those of the group to reflect the degree of control or other special circumstances in the companies concerned. Risk measures are applied in the case of general financial goals. The degree of the decision maker's risk aversion is also considered, and it may differ between the goals. The goal levels and the decision maker's priorities are allowed to change over time or from one scenario to another to reflect changing operating conditions and trade-off relationships between conflicting goals. The general types of goals are presented in Table 7.

As the list indicates, the three financial dimensions of profitability, capital adequacy and liquidity are covered by market oriented as well as

Table 7
Types of goals

(1)	<i>Market valued profits</i> (1a) expected profits (1b) risk
(2)	<i>Accounting earnings</i> (2a) expected earnings (2b) risk
(3)	<i>Adjusted capital ratios</i> (3a) expected value (3b) risk
(4)	<i>Regulatory capital ratios</i> (4a) expected value (4b) risk
(5)	<i>Liquidity</i>
(6)	<i>Cash reserve requirements</i>
(7)	<i>Currency positions</i>
(8)	<i>Growth/market share</i>
(9)	<i>Upper limits for customer related business activities</i> (satisfaction of customer demand)
(10)	<i>Lower limits for customer related business activities</i> (minimum supply)
(11)	<i>Other upper and lower limits</i> (cases allowing flexible limits)
(12)	<i>Technical goals</i>

regulatory (or institutional) measures. Needless to say, market-based measures are to be preferred from a decision making point of view, but special circumstances may require the consideration of other measures, too.

In the case of *market valued profits* the model minimizes negative deviations of expected profits from the *expected profits* goal. In addition, it may maximize positive deviations from the expected profits goal. Profits include all items relating to operating income and capital gains or losses valued at market. The market valuation thus covers all assets, liabilities and off-balance sheet items such as futures contracts. *Risk* is measured by the variability of profits, which in turn is measured by the semiabsolute deviation, i.e., the weighted average of negative deviations of profits from the expected profits goal, the weights being the subjective probabilities of the scenarios in question. A notable feature of the semiabsolute deviation is that contrary to the more traditional variance measure it allows the use of efficient linear programming solvers in practical applications.

The risk measure considers the effects of co-variability or correlation, and it thus allows an integrated treatment of credit risk, interest rate risk, currency risk, equity risk and real estate risk. Furthermore, it allows a joint treatment of risks arising from both price changes and volume changes. The volume changes may be caused by exogenous events like take-downs, early prepayments and withdrawals or by endogenous events relating to the management's own decision making. Futures contracts, for instance, can also be used to transform the overall risk position on a macrohedging basis. The model minimizes positive deviations of risk from the risk goal. In addition, it may maximize negative deviations from the risk goal. The grade of the decision maker's risk aversion is considered by specifying intermediate goal levels and by applying appropriate priorities during the optimization process.

The other goals involving risk measures are treated in a similar fashion. The remaining goals may be defined separately for individual scenarios, and they thus allow scenario dependent changes in the assumed goal levels and in the priorities attached to these goals. The model minimizes violations of the relevant upper or lower limits according to the relative importance of these goals. *Liquidity* is measured by the difference between liquid assets and volatile liabilities. *Cash reserve requirements* deal with the regulatory definition of liquidity. *Upper and lower limits for customer related business activities* refer to cases like the satisfaction of customer loan demand (upper limit), and policy related priorities might be specified for different customer groups. Similarly, a lower limit would try secure a minimum loan supply. In the presence of conflicting goals neither type of goal may be achieved, of course. In order to facilitate the finding of reasonable solutions *other upper and lower limits* allow for flexible limits in cases (especially on the investment side) in which a fixed limit is not absolutely necessary. *Technical goals* are used to describe various types of institutional requirements (typical examples can be found in the area of taxation and the process of covering losses), where the subject matter may be expressed as a system involving a sequence of minimizations in a predetermined order.

4. Implementation of the model

The number of optional features available in the model is quite large. The user of the model would in practice only select those alternatives that appear relevant in any particular case. The level of aggregation, in particular, would depend on the planning situation at hand. Initial applications would usually make use of fewer and more aggregated variables, and applications at the group level might be less detailed than special investigations involving individual companies in the group. Efficient solution algorithms are nevertheless needed, and work is currently under way to employ interior-point methods in the optimization process. The discussion of the typical implementation process in this section is based on the experiences gained in the previous application mentioned in Section 1 of this paper.

Both applications are general purpose stochastic programs and this might result in a very large number of second and subsequent stage decisions. This was not a problem in the previous application, and in the present case one should note that out of the rather extensive list of instruments and optional features one would only select those that are relevant in describing the current or potential future business portfolios of the various companies within the group. An effort has been made to provide basic modules that could be used in a number of different applications and organizations, and not all of them are therefore necessarily meant to be used in one particular application. Discussions with company executives have also indicated that they would in most cases be happy with fairly aggregated descriptions of their investment portfolios, which certainly helps to control the size of the problem. One should also note that the computing time required to solve a large model is not a critical issue in strategic planning.

The size of the problem also depends on the length of the planning horizon as well as the number of scenarios used. A group with main emphasis on credit institutions would typically use a medium-term planning horizon of three to four years. Insurance companies might find a planning

horizon of four to five years appropriate. The typical number of scenarios used in the previous application is shown in Fig. 2 of the present paper. In the current version the number of scenarios as well as the progression of the scenarios from one period to another is free.

The planning process itself starts with an initial phase, in which a scenario team first develops general descriptions of the future scenarios to be included in the analysis. The scenarios typically deal with general economic conditions, the state of the domestic and foreign financial markets, and other aspects of the operating environment relevant to the group. The scenario approach implies that it is no longer necessary to come up with a single 'forecast' for developments which cannot really be forecasted with any degree of accuracy. Instead the members of the scenario team are encouraged to exploit any divergent views that they or any outside experts might have. These scenarios are then discussed in a financial planning team consisting of representatives of the various business areas in the group. Each area then produces its estimates of the implications of the general scenarios as far as its operating parameters are concerned. At this stage they are also asked to list any additional assumptions that they have made in arriving at their assessments. It is important to ensure that the assumptions of the different business areas are internally consistent, and in case of conflicts some sectors may be asked to reconsider their estimates.

The first runs of the model are made with a preliminary goal structure that is partly derived from the views expressed by the financial planning team. The trade-offs between different goals are then analysed by solving the model with several alternative goal structures. As is generally the case, overemphasis on one goal area in terms of either goal levels or priorities tends to lead to unacceptable solutions as far as the other goals are concerned. The final decision on an acceptable combination of goal levels and priorities as well as on the overall strategy to be adopted is made by the group management.

This type of planning process is repeated periodically or whenever the planning situation and/or data relating to the planning situation change.

In other words, the scenario team first updates its views on general economic conditions and other aspects of the operating environment relevant to the group. The financial planning team then revises (if necessary) its estimates of the implications of these conditions on the operating parameters of the individual business areas, alternative goal structures and strategies are analysed, and potential adjustments to the overall strategy are made.

The group management therefore always has a full set of alternative strategies available for all periods and scenarios within the planning horizon. Only the guidelines for the present actions are of immediate interest. The future strategies are mainly computed in order to prevent the management at the present time from making decisions that might turn out to be fatal in the sense that if one of the extreme scenarios should materialize, the management would not be able to take appropriate action any more, i.e., action that would enable it to attain the set of goals relevant at that time. The future strategies are therefore never actually implemented; as time goes on and more information about the future becomes available, all strategies are gradually adjusted. It should also be noted that this kind of an approach to strategic planning does not necessarily require any major changes in the way organizations otherwise operate because tactical or operational decisions would remain at lower levels, i.e., at levels they are typically made even today.

It is also worth noting that even though the companies in the group are taking precautionary measures when they prepare themselves for an uncertain future, this does not necessarily mean that the adopted strategies are *defensive* or *passive*. If the group management does want to pursue a defensive strategy, this is reflected in the structure of goals in terms of the goal levels and the priorities attached to them, and the model computes the most efficient way to carry out such a strategy. Conversely, an *offensive* strategy implies a different set of goals, and the model again determines the appropriate way to act in this kind of a situation. Various combinations of defensive and offensive strategies can also be analysed in the same way.

5. Conclusion

The traditional way of managing financial institutions is often based on a single and rather vague view of the future. Even assuming that the management might by some miraculous intuitive process have transformed this view into a set of optimal decisions (and this is a rather bold assumption), the mere fact that these decisions are based on one single scenario means that the resulting strategy will differ from a strategy that prepares the institutions for a wide range of eventualities. Multiple scenarios require precautionary measures which would not be necessary if the future were assumed to be deterministic or reasonably predictable. The consequences of the failure to take notice of this trivial fact have been dramatic in the financial sector of a number of countries.

Forthcoming versions of the present model will include, among other things, modules covering insurance liabilities.

Appendix A. Accounting consolidation modules

Variable type	Name
201	Definition of accounting net benefits to be eliminated in a subsidiary relating to intra-group loans (asset type 30) in the parent
202	Definition of intra-group services/transactions to be eliminated in a subsidiary that are defined in terms of items relating to intra-group investments (asset type 35) in the parent
203	Definition of distributable funds in a subsidiary after the elimination of intra-group transactions
204	Definition of distributable funds in the parent/holding company after the elimination of intra-group transactions

205	Definition of distributable funds in a group consisting of a subsidiary and sub-subsidiaries	35/12/12a	Definition of consolidated distributable funds in the group (cumulated from sub-subsidiaries and subsidiaries and adjusted for cumulative write-offs of goodwill and negative consolidation differences as well as for items originating from operative associated companies (see 35/7))
210	Definitions of company level sums of asset and liability categories for consolidation purposes		
35/1	Definition of own funds to be eliminated in a subsidiary or operative associated company	35/13/13a	Definition of consolidated reserve funds in the group
35/2	Exchange differences in the case of foreign subsidiaries or operative associated companies	35/14/14a	Definition of consolidated ordinary share capital in the group
35/3	Definition of the original value of goodwill or negative consolidation difference relating to intra-group investments (asset type 35)	35/15/15a	Definition of consolidated goodwill or negative consolidation differences (net amount) in the group
35/4/5	Definition of the remaining value of goodwill or negative consolidation difference relating to intra-group investments (asset type 35)	35/16/16a	Definition of consolidated exchange differences (net amount) in the group
35/6	Definition of value adjustments to the book value of intra-group investments (asset type 35) in operative associated companies	35/17	Currency transformations relating to revaluation reserves in subsidiaries and sub-subsidiaries
35/7	Definition of value adjustments relating to distributable funds in the case of operative associated companies	35/18/18a	Definition of consolidated revaluation reserves in the group
35/8	Definition of the adjusted book value of intra-group investments (asset type 35) in operative associated companies	35/19	Currency transformations relating to general loan loss provisions in subsidiaries and sub-subsidiaries
35/9	Definition of the remaining amount of ordinary share capital in a subsidiary after eliminations (see 35/1)	35/20/20a	Definition of consolidated general loan loss provisions in the group
35/10	Definition of the remaining amount of reserve funds in a subsidiary after eliminations (see 35/1)	35/21	Currency transformations relating to asset and liability categories in subsidiaries and sub-subsidiaries
35/11	Definition of the remaining amount of distributable funds (adjusted in 203 for intra-group transactions) in a subsidiary after eliminations (see 35/1)	35/22/22a	Definitions of consolidated asset and liability categories in the group (see 210)

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