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An asset liability management model for housing associations

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Abstract *With asset liability management (ALM), all the relevant asset and liability classes are managed in an integrated fashion. We describe an ALM model for housing associations. This model uses simulation to show the development of a housing association, usually measured as solvency and profitability, dependent on both internal (strategy) and external (economy) factors. In order to assess the associations' risk and return profile, we generate a large number of economic scenarios. Furthermore, we will show the pitfalls of just using one or a few scenarios. Finally, we will show how this model can be used to obtain insight into the influence and effectiveness of specific instruments.*

Introduction

With asset liability management (ALM), all the relevant asset and liability classes are managed in an integrated fashion. The values of the assets and the liabilities are influenced by, amongst others, management strategy and economic circumstances. Management cannot influence the latter. ALM models can be used to show the expected development of an organisation, usually measured as solvency and profitability, dependent on both internal (strategy) and external (economy) factors. Traditional ALM models often only facilitate the use of one or a few possible economic scenarios[1]. These traditional models can be used to obtain a general picture of the expected development of solvency and profitability. However, these models do not take into account the uncertainty that is involved in predicting long-term economic developments. Therefore, it is impossible to get a reliable estimate of, for instance, the insolvency risk. In order to take this uncertainty into account a large number of economic scenarios have to be analysed. These scenarios should reflect both the uncertainty of the individual economic variables (i.e. variance) and the correlations between the separate variables. In this paper we describe a model which can be used to assess both the risk and the return characteristics of housing associations. Furthermore, we will show the pitfalls of just using one or a few scenarios. Finally, we will show how this model can be used to obtain insight into the influence and effectiveness of specific instruments.

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ALM for housing associations

In many West European countries, the government has retreated from the housing market. This has usually implied a reduction in financial support for the social rented sector. The operating risks are increasingly passed on to the social housing associations, which therefore have to adopt a more market-oriented approach. One example is The Netherlands, where social housing represents the largest share (40 per cent) of the housing market in Western Europe (Boelhouwer, 1997).

As the operating risks are now borne by the housing associations themselves, they are experiencing an increasing field of tension between guaranteeing the financial continuity of the organisation and its social objectives. For social managers it is important to what degree the housing of the target group can be combined with a greater financial risk. In order to be able to obtain insight into the financial risk connected to specific social and financing strategies, it is essential to analyse these factors together. This is called (integrated) ALM. With ALM it is possible to take into account all the cross-correlations between the instruments.

Table I shows a typical, simplified profit and loss account (part A) and balance sheet (part B) for a Dutch housing association. The asset side of the balance sheet of a housing association consists almost entirely of the dwellings owned. The liability side is dominated by long-term debt. Virtually the only incoming cash flow is rent income. The main outgoing cash flow is interest payments followed by maintenance.

Housing associations have a number of instruments that can be used to influence the value and the composition of the assets and the liabilities. One can think of the treasury strategy for debt, and the rental strategy, maintenance strategy, investment strategy (i.e. structural improvement, new construction, sale, acquisition, or demolition of dwellings) and target group strategy for the dwellings. The management can use these instruments in order to pursue a number of financial and social objectives. A financial objective could be to remain solvent; a social objective could be to keep a specific percentage of all the houses under a specific rent level.

How an association scores on its financial and social objectives is influenced by the strategies that have been implemented. However, the actual scores are also influenced by uncertain developments external to the association. Examples

Table I.
Key figures of Dutch housing associations

A. Typical profit and loss account (per cent)			
Rent income	78	-/- Interest payments	46
Other income	22	-/- Maintenance costs	20
		-/- Other costs	34
B. Typical balance sheet (per cent)			
Dwellings	85	Equity capital	9
Other assets	15	Debt	83
		Other liabilities	8

Source: Aedes (2000)

are interest rates, housing prices, wage and price inflation, and tenant mutation. The management cannot influence these so-called risk drivers. Management can, however, adjust its strategy dependent upon their expectations concerning the risk drivers. The treasury strategy can be made dependent upon an expected rise or fall of interest rates. Rent increases can be related to inflation. Furthermore, the different instruments are intertwined. With the treasury strategy, for instance, one has to take into account future financing needs caused by construction programs. Thus, housing association management is nowadays confronted with a complex dynamic strategic decision problem with several available interacting instruments, multiple objectives, and various risk-drivers which determine how the instruments affect the objectives. This asset-liability management problem is depicted in Figure 1. We will present a model that can support management in this decision problem.

Scenario analysis

A scenario can be defined as "a description of a possible state of an organisation's future environment, considering possible developments of relevant interdependent factors of the environment" (Brauers and Weber, 1988). The usefulness of working with scenarios is adequately described by Huss (1988) who states that "at their best scenarios reveal new strategic options and threats, and because they record explicit assumptions about the future and provide a common framework for discussion, they also contribute to a better understanding between managers". For a review paper on scenario analysis we refer to Bunn and Salo (1993).

The most-likely scenario

It is possible to analyse different strategies under the assumption of one given outcome for all the uncertain external variables. Normally, this would be the most-likely scenario as perceived by the management. Such an analysis usually provides helpful insight into the impact of a specific strategy, but not always. The most-likely scenario approach gives no information on the distribution of possible outcomes. Even the bandwidth of possible outcomes is not determined. One example is the choice of the term of new loans. The most plausible

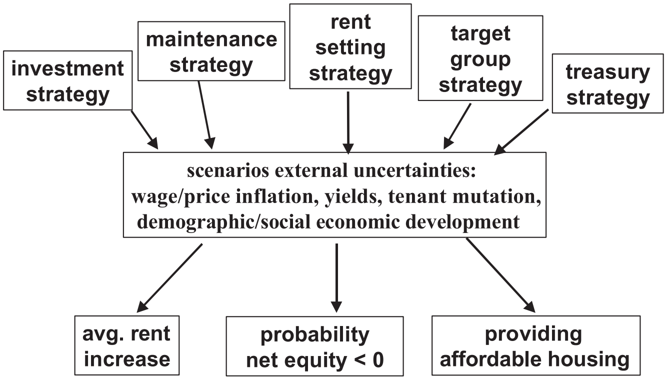

Figure 1.
ALM for housing association

assumption concerning interest rates is that the short rate is lower than the long rate. Given this assumption, the analysis would indicate that the association should only engage in short-term financing. However, this is not what most associations do since it is common knowledge that short rates are more volatile than long rates. Therefore, short-term financing is more risky than long-term financing.

Another example is large-scale investment programs, which combine newly built houses for rent and for sale. Under the most likely scenario, programs like this are almost always very profitable. Therefore, one would conclude that the associations should implement as many investment programs as possible. However, large-scale investment programs are also often quite risky. The conclusion could be very different if one were to take this risk into account.

Best case – worst case analysis

One method to incorporate risks is the so-called best case – worst case analysis. With this type of analysis, three scenarios are defined. Apart from the most likely scenario, one scenario is defined where everything goes wrong (the worst case), and one scenario is defined where all goes well (the best case). This approach also has its drawbacks, however. The most important drawback is that often several factors are important. Moreover, these factors are usually connected. With a limited number of scenarios, it is very difficult to take these connections into account. One example is the economic climate. High interest rates are unfavourable for housing associations. So are low inflation rates given that rent raises are linked to inflation. A worst case scenario could therefore combine high interest rates with low inflation. However, such a combination is very unlikely given the positive correlation between inflation and interest rates (0.6 during 1966-1998 in The Netherlands). The worst and best cases defined are therefore often very unrealistic. Sometimes, combinations of values are chosen which never have been observed before. It is questionable whether this is a good basis for the choice of the best strategy. This could result in unnecessary risk-averse courses of action if management bases its choice on a very unrealistic worst case scenario. This is just as undesirable as taking too much risk.

Monte Carlo simulation

We propagate the use of (Monte Carlo) simulation in order to be able to assess the risks involved in implementing a specific strategy. With simulation a large number of scenarios is generated. These scenarios are obtained by random drawing from a specific distribution. All scenarios are equally likely. With this method it is possible to take into account the interdependencies between the different variables. How this is done is described in the following section.

When a sufficient number of scenarios is generated, it is possible to estimate the likelihood of certain outcomes. We can actually calculate probabilities and quantify risks. With simulation it is possible to get an indication of both the expected return and the risk involved in a specific strategy. Thus, we can explicitly weigh return and risk, as for instance with the choice of the term of new loans.

Model description

We have developed a decision support system for the management of housing associations, which is based on the ideas presented above[2]. That is, we use scenario analysis sustained by Monte Carlo simulation. Thus, scenarios are used (rather than forecasts) to model the relevant macroeconomic uncertainties that affect housing associations. Furthermore, this system applies an integrated ALM approach. That is, it models both the assets and the liabilities of the association. Furthermore, it takes into account the interdependencies between the assets and the liabilities, and also how the assets and the liabilities are influenced by the external uncertainties. Both the assets (i.e. the dwellings) and the liabilities (i.e. the loans) are modelled at the lowest level. That is, we separately simulate each individual dwelling and each individual loan. This is called microsimulation.

The system consists of four modules, which will be described below. The first (economic) module generates ranges of scenarios of the future economic environment. The second (real estate) module simulates the future development of each individual dwelling, including new dwellings planned for the coming years. This development includes for each dwelling, amongst others, tenant mutation, maintenance prognoses, and the yearly rent increase. The third (treasury) module handles the debt portfolio. Here the financing strategy and the composition of the current portfolio are specified. The final ALM module integrates the outcomes from the other modules. Here we can evaluate strategies with respect to the resulting future developments of, for instance, the financial position and the number of affordable houses (i.e. the social objective).

Generating economic scenarios

We use econometric time-series modelling to obtain a (multivariate) distribution function for the relevant economic variables. The model is estimated on a dataset with historical time-series for the economic variables used. The main time-series we use are consumer price inflation, wage inflation, construction cost inflation, house price inflation, interest rate on cash (three-month treasury bills), and effective yield on long-term government bonds. The model we use guarantees that the statistical characteristics of the generated scenarios (i.e. expected values, volatility and dynamics) correspond with the statistical characteristics observed in the past (i.e. the historical time-series used to estimate the model). This makes interpretation of the results relatively easy. Management can evaluate studied strategies in view of the historical periods that underlie the applied scenarios. We want to stress that the scenarios generated by the model should not be seen as forecasts of the future economic environment. Instead, our main goal is to test a strategy against possible/plausible future developments. The main objective of the model is to perform risk- and sensitivity-analysis.

More specifically, we generate scenarios of the economic environment using a vector auto regressive time-series model of order one:

$$y_t = \mu + \Omega \cdot (y_t - 1 - \mu) + \varepsilon_1,$$
$$\varepsilon_t \sim N(0, \Theta),$$

where the notation $N(\mu, \Theta)$ denotes a Normal (Gaussian) distribution with average μ and covariance-matrix Θ, Ω is a matrix containing the autocorrelation coefficients between the different time-series, and y_t is the vector containing the applied (transformed) time-series in year t[3]. This approach, propagated by Sims (1980), has also been used in comparable fields like the ALM model for pension funds described by Boender *et al.* (1998).

Auto regressive of order one means that variable values in period $t + 1$ depend on (realised) variable values in period t. The underlying assumption of the model is that the realisation of *any* time-series in year t is an explanatory variable for the distribution of *any* time-series in year $t + 1$. Therefore, in this model all the time-series serve both as independent and as dependent variable in the regression.

The estimated values of the parameters μ, Ω and Θ, and the values y_0 of the time-series in the initial period, completely specify the probability distribution for period $t = 1$. Drawing a sample point from this distribution generates a value for the vector y_1, which in turn specifies the distribution of y_2. Iteratively repeating this process generates a time path of vectors $\{y_t \mid t = 0 \ldots T\}$, which is used as a scenario of the development of macroeconomic circumstances. After one scenario has been generated, the process described above can be started again at $t = 1$ to generate a second scenario, etc.

With a very large number of draws, the means and covariances will be similar to the (theoretical) means and covariances that are specified in the distribution. To reduce the number of draws needed, the draws are transformed in such a way that the moments of the distribution and the moments of the draws are exactly the same. In this way, the distributions of the economic variables can be described very well, using (much) less scenarios. As an example of the characteristics of the generated scenarios, Table II reports the results based on historical period 1966-2000. The correlation matrices of the historical period and of the generated scenarios are shown in Table III.

Housing associations finance their investments with long-term bonds. The terms of these bonds can vary quite significantly. (See the Appendix for a description of how interest rates on new loans are modelled.)

Simulating dwellings

Over 80 per cent of the associations' income and of the associations' assets are usually related to the dwellings offered for rent. It is therefore of the utmost importance to adequately model the development of (the characteristics of) these dwellings. In our opinion, microsimulation is the best way to do this. That is, we propagate the use of simulation to generate a future scenario for each individual dwelling. Such a scenario includes, amongst others, tenant mutations, maintenance expenses, (dis)investments, and the development of

Table II. Statistics of the historical period 1966-2000 and the generated scenarios

	Historical average (%)	Standard deviation (%)	Auto-correlation	Scenarios average (%)	Standard deviation (%)	Auto-correlation
Prices	4.21	2.82	0.86	4.21	2.85	0.86
Wages	5.30	3.94	0.88	5.29	3.87	0.89
Long interest rate	7.54	1.50	0.75	7.54	1.51	0.82
House prices	6.32	8.62	0.71	6.32	8.63	0.70
Construction costs	5.28	4.36	0.71	5.28	4.27	0.70
Short interest rate	6.85	2.77	0.52	6.86	2.82	0.54

Notes: Historical statistics are based on yearly data from 1966-2000. Scenario statistics are from 500 scenarios generated by the VAR model. These are long-run yearly averages. In the first few years, the averages slowly coverage from the 2000 starting values to the long-term historical average

Table III. Correlation matrices

	Prices	Wages	Long interest rate	House prices	Construction costs
A. Historical					
Wages	0.89				
Long interest rate	0.61	0.37			
House prices	0.33	0.47	–0.22		
Construction costs	0.67	0.70	0.28	0.32	
Short interest rate	0.38	0.26	0.75	–0.30	0.35
B. Scenarios					
Wages	0.90				
Long interest rate	0.90	0.40			
House prices	0.34	0.42	0.00		
Construction costs	0.67	0.70	0.36	0.30	
Short interest rate	0.41	0.31	0.75	–0.15	0.41

actual and desired rent levels. Tenant mutations and, dependent on the type of (dis)investment program, sale and renovation will be allocated to individual dwellings based on random drawings from a probability distribution.

Using microsimulation has a number of advantages compared to simulation on a higher level, such as a block of dwellings or even all the associations' dwellings together. It is, for instance, easier to estimate the risks involved in investment and disinvestment programs. The renovation or sale of a dwelling is often performed when a dwelling becomes unoccupied, i.e. when the old tenant leaves. Therefore, the number of yearly sales and renovations will be uncertain, and will depend, amongst others, upon the tenant mutation level. There are a number of potential errors when microsimulation is not used. First of all, an example we often observe in practice. A block of 100 dwellings will be offered for sale. The average mutation level for this block is 10 per cent. Therefore, the association assumes that ten dwellings will be sold yearly. In fact, only the expected number of sales in the first year is equal to ten. In the second year, the number of mutations, and therefore the number of sales will depend upon the number of sales in the first year, etc. Furthermore, the mutation level might differ between the dwellings within the block. Therefore, the actual mutation level might decrease during the years as the dwellings with the highest mutation probability will be sold first. Thus, the number of sales will decline, and it will take much more than ten years to sell the whole block. With microsimulation, this problem is easily solved as each dwelling is assigned its own mutation probability and, consequently, mutations.

Without microsimulation, a second problem occurs when the block of dwellings is not uniform in the characteristics of the individual dwellings. That is, when the dwellings differ in things like the current and/or the desired rent level, size and quality of the building, the expected sales price, maintenance prognoses, etc. In that case, reducing income and costs by 10 per cent when 10 per cent of a block is sold in one specific year might not be correct. With microsimulation you know exactly what the income and costs are from each individual dwelling. Thus, when a dwelling is sold, you know exactly the income and costs you lose because of this sale.

A second example where microsimulation has a clear advantage is in estimating rent income. Dutch housing associations usually distinguish the actual current rent level and the desired rent level. Often, the yearly rent increases are a function of the size of the gap between the current and the desired rent. Rent increases are higher when the gap is larger. Furthermore, associations often harmonise the rents with a tenant mutation. That is, when the old tenant leaves, the new tenant immediately has to pay the desired rent level. Such a harmonisation will lead to a higher rent increase for this dwelling in the year of the mutation, but to lower rent increases in later years. The yearly harmonisation incomes will both depend on the mutation level and on the gap between the current and the desired rent level of the dwelling. Finally, the associations often have agreements with the municipalities to keep a specific number of dwellings below a specific rent level. Therefore, rent increases sometimes have to be more moderate than initially planned in order to meet the agreements. All this makes it very difficult to adequately estimate rent increases and thus rent income when you do not use microsimulation. With microsimulation we know the current and the desired rent levels of all the dwellings in each year. We are, therefore, able to accurately determine the actual rent increase for each individual dwelling. Furthermore, we are able to calculate and report the number of dwellings below specific rent levels.

Description of the real estate module

In the real estate module of the ALM model, all the information in relation to the dwellings is collected. All relevant information that is recorded at the level of the individual dwelling is collected in the so-called dwellings-file. This file contains information like the current rent level, location of the dwelling, area, block number, target group, current quality, dwelling-type, and current market value. Information that is usually recorded at a higher level than the individual dwelling (per dwelling-type, area or block number, for instance) is collected in several tables. Examples are prognoses for maintenance costs, insurance payments, wages and salaries, and mutation levels. All cost prognoses should be specified in current prices. The relevant index (consumption prices, wages, construction costs, or house prices) can be specified separately for each table.

The real estate module also contains the specification of strategies in relation to the dwellings. Examples are disinvestment strategies (demolition or sale of individual dwellings or blocks), renovation plans (investment necessary to obtain the desired quality of a block of dwellings, and the effect on rent levels and the remaining lifespan), rent strategy, and plans for acquiring or building new dwellings. Sales and renovations can be performed in a specific year or they can be linked to tenant mutation. As with the cost prognoses, all amounts should be specified in current prices. The relevant index can be specified separately.

After all relevant information and strategies are provided, a prognosis of the real estate portfolio can be established. As we are using microsimulation, the prognosis of the real estate portfolio is nothing more than the sum of the prognoses of the individual dwellings. For each individual dwelling, the model first gets the basic information out of the dwellings-file. Then it simulates a future for each dwelling. It is assumed that all tenant mutations, investments and disinvestments take place at 1 January. Only the regular rent increases take place at 1 July. For each year during the remaining lifespan of the dwelling the model performs the following actions:

(1) Determine whether the dwelling is sold or renovated in the current year (irrespective of a tenant mutation). If the dwelling is renovated, determine the costs of this renovation and the benefits (such as a rent increase, or additional lifespan). If the dwelling is sold, determine the price for which it will be sold. The renovation costs and the sales price depend on the realised values of the relevant indices in the current economic scenario.

(2) If the dwelling is not sold, is the dwelling demolished or at the end of its lifespan?

(3) If not, determine whether a tenant mutation takes place. The mutation probability is obtained from the table with mutation levels. Mutation levels can vary depending on the type of building, but also depending on the block number, the location, etc. Tenant mutation is assigned to a dwelling by comparing the specified probability with a random draw from a Uniform(0,1) distribution.

(4) If a tenant mutation takes place, check whether a renovation is planned and/or whether the dwelling should be sold. If the dwelling is renovated, determine the costs of this renovation. If the dwelling is sold, determine the price for which it will be sold. If the dwelling is not sold, determine the initial rent for the new tenant, taking into account the rent strategy with mutation and taking into account the effects of a possible renovation.

(5) Assign maintenance and other costs to the dwelling. The actual costs assigned to a dwelling will depend on the realised values of the relevant indices in the current economic scenario and on the number of dwellings in the portfolio.

(6) Determine the increase of the current and the desired rent per 1 July. The rent increase can be linked to an economic index (usually price inflation) and to the gap between the current and the desired rent level. It is also possible to link the rent increase to the number of dwellings with a rent below a specific rent level.

(7) Go to the next year.

In the current version of the model of the real estate module the economic scenarios are only used to obtain the relevant indices for rent levels, costs, and prices. Tenant mutation and the decision to invest or disinvest are independent of the economic climate in a specific year. In reality, tenant mutation levels might vary depending on the economic climate. Furthermore, management might decide to skip an investment program in unfavourable economic conditions. It should not be difficult to extend the model to incorporate these dependencies. This is, however, a topic for future research.

Simulating loans

Like the dwellings on the assets side, loans are by far the most important liability. On average, over 80 per cent of the liability-side of the balance sheet is debt. Furthermore, over 50 per cent of the associations' costs are interest payments. Therefore, adequate assessment of the risks related to the debt portfolio and the treasury strategy is important. As with the dwellings, we also use microsimulation to generate future debt portfolios. The most important risks and uncertainties related to a loan that is already in the portfolio are interest rate revisions and options enclosed (like early redemption).

Strategic treasury decisions are usually related to the term of new loans and to early redemption (yes or no). Options for early redemption can have a large impact on the risk and return characteristics of an association. It is, therefore, important to include these options in your risk analysis. The analysis of these options is, however, virtually impossible when you do not use microsimulation. When early redemption is allowed, usually a penalty has to be paid when exercising such an option. Whether exercising an option is profitable depends on the interest rate of the loan, the current market rate, and on the penalty. It therefore depends on the economic climate in the year the option can be exercised. Consequently, this choice is scenario-dependent. In some economic scenarios, you will exercise the option. In others, you will not. These options can reduce the risk profile of the association. The model will exercise an option when the Net Present Value of the loan exceeds the sum of the amount outstanding and the penalty payment.

Description of the treasury module

Each loan (or bond) can be described as a series of deposits, interest payments and redemptions. In the treasury module, deposits, interest payments and redemptions are called cash-flow events. In our model, all loans are explicitly modelled as a succession of events. For instance, obtaining a loan from a bank and actually receiving the amount lent can be seen as two separate events. Each event can generate additional events. For instance, obtaining a loan leads to the obligation to pay a fixed amount of interest each year. Each interest payment can again be seen as a separate event. All the events taken together simulate the development of a loan. By using this so-called event method, we can take into account all possible types of loans.

The event method uses three types of event: cash-flow events, type events, and option events. Cash-flow events are all events that generate a cash flow, like redemptions, deposits, and interest payments. Type events specify the type of loan, and generate a series of cash-flow events following from the specific type of loan. These cash-flow events do not have to be specified by the user. Thus, a type event specifies the interest payments and redemptions. Possible type events are fixed (i.e. the principal amount remains constant over the term of the loan), linear (i.e. the yearly redemption equal the principal amount divided by the term of the loan), and annuity. Most loans are completely specified by entering one cash-flow event, the deposit of the principal amount, and one type event which specifies the interest payments and the redemptions. An option event, finally, describes an event where the housing association has a choice (an option), like early redemption. Whether the early redemption option will in fact be exercised is uncertain. This will depend on the interest rate levels at that specific time.

The choice of the term of new loans can be made in several ways. The most common approach is to specify one type of loan and one term. All future loans will then have these characteristics. For instance, many associations always finance their investments with ten-year fixed loans. An alternative approach is to choose the term of the loan such that the future interest rate exposure is spread out as equally as possible. An association that has to refinance its complete debt portfolio within one year is very vulnerable to interest rate levels in that specific year. A strategy that leads to a refinancing need of 10 per cent of the portfolio in each year is therefore less risky. Finally, the association can decide upon the term of new loans dependent on the term structure of interest rates and on its own expectations concerning future interest rate developments. For instance, if the short rates are relatively low and the long rates are relatively high, one could decide to shorten the terms of the loans. This strategy is the most difficult one, as management has to have a vision on future interest rates. Our model supports all three strategies presented above, and can therefore be used to analyse the consequences of different strategies.

To obtain prognoses for the development of the debt portfolio, the treasury module is linked to the economic module and the real estate module. The economic module is needed to obtain interest rate scenarios for new loans and for interest rate conversions on existing loans. The real estate module is needed to obtain information on the amount of capital needed to finance (future) investments. The economic, real estate and treasury modules are linked in the ALM module.

Risk analysis

After the economic, real estate and treasury modules have been filled in, they can be combined in the ALM module. Given the strategies specified in the real estate and treasury modules and the simulated scenarios for the economy, for the dwellings, and for debt, we can generate scenarios for the housing association as a whole. That is, we can simulate future profit and loss accounts, balance sheets, and cash flow statements. More specifically, for each economic scenario from the economic module a prognosis is established for the real estate portfolio and for the debt portfolio. By combining these two prognoses, we can establish a prognosis for the cash flows, the balance sheet, and profit and loss accounts of the association.

The ALM module can be used to perform asset liability management studies or risk analyses. However, before a risk analysis can be performed management has to decide upon a number of issues. First, the association has to define its objectives or goals. Generally, an association has several, sometimes conflicting, objectives. For instance, a financial objective of increasing the solvency level up to 15 per cent might conflict with the social objective of keeping 80 per cent of the dwellings below a specific rent level. Second, the risk measures have to be defined. That is, how do we measure whether or not an objective has been realised? For instance, an association with a 15 per cent solvency objective can decide that each scenario with an outcome below 15 per cent is unacceptable. As a risk measure, we can then use the probability of not realising a 15 per cent solvency level. This probability can be defined as the number of scenarios with a solvency level below 15 per cent divided by the total number of scenarios. Finally, management has to decide upon the relevant time span for the analysis. In the risk analyses we perform for housing associations, we usually work with 10 to 20 year time spans.

In the ALM module, there are a number of ways to perform scenario- and risk analysis. First of all, the model can generate a large number of numerical overviews. These overviews vary from prognoses for balance sheets and profit and loss accounts to detailed cash flow prognoses per block of dwellings and to overviews of the distribution of rent levels per type of dwelling or per area. Furthermore, the model can generate two different types of graphical overviews. These overviews can be used to analyse the risk measures, to explicitly weigh risk and return, and to explicitly weigh social and financial objectives. These two overviews are called the scenario cloud, and the risk-return field. These two will be described below.

Scenario clouds

Scenario clouds present the development over time of one specific variable for each individual scenario. With 100 scenarios, this would lead to a “cloud” of 100 lines showing the development of the variable over, for instance, the coming ten years. Figure 2 gives an example for equity capital (in this case in millions of guilders). The dark (black) line represents the average over all 100 scenarios. Each grey line represents one individual scenario.

This picture also immediately shows the pitfalls of using just one scenario. The dark line could be seen as the outcome of the most likely scenario. It remains positive over the entire time span. However, there are 11 scenarios with negative equity capital in 2008. So, under the current assumptions the probability of insolvency is 11 per cent in 2008. Furthermore, the objective of this specific association is to have at least 30 million equity capital in 2008. On average, equity capital is almost 50 million. However, 35 per cent of the scenarios remain below 30 million. With one or a few scenarios, it is impossible to quantify this risk.

A representation like the above can also be used to split up equity in a risk buffer and "free" equity. The risk buffer is needed to cover operating risks, given a specific probability of default. Free equity is not needed to guarantee the continuity of the association. It can be used for other purposes, like developing new strategies (new, partly uneconomic, construction or renovation) or supporting other, less fortunate associations by means of lending money with interest rates below market level. If we assume that a 5 per cent probability of insolvency in ten years is still acceptable, the association in the example above has negative free equity. Given the current probability of 7 per cent, the scenario cloud has to be shifted upwards in order to obtain a 5 per cent probability of insolvency in 2008. (Negative) free equity is the extra capital needed to realise this shift upwards.

For an association, it is useful to know the external variables to which it is sensitive. This knowledge can be used to look for possible ways to reduce (extreme) sensitivity. An association that has to pay off a large amount of debt in one specific year is especially sensitive to the interest rates in that year. Rearranging the debt portfolio might help to reduce this risk.

Analysing risk factors is especially important for financial variables like solvency and profitability. In our model, it is possible to mark those scenarios that show the worst development. The same scenarios are also marked automatically in other scenario clouds you have generated. By jointly looking

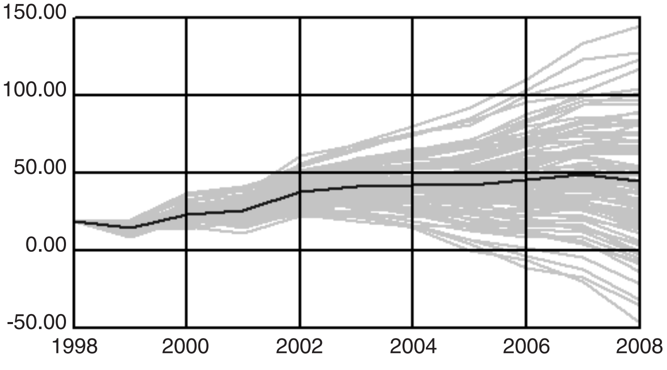

Figure 2.
Scenario cloud of equity capital for 100 scenarios

at the scenario cloud of the relevant variable and at scenario clouds for the external risk factors (e.g. inflation and interest rates), it is often possible to find the cause of the unfavourable development of the goal variable. Figures 3 and 4 give a simple example of this idea. Figure 3 gives the average interest rate paid by the association and Figure 4 the market interest rate for new long-term loans. The scenario with the highest interest rate paid is marked in Figure 3. In Figure 4 the same scenario is marked. As could be expected, high interest rates paid correspond with a high interest scenario. This kind of analysis is easily extended to more complex cases. For instance, we could analyse four scenario clouds together: equity, average interest rate paid, price inflation, and market interest rate. We often find that scenarios with low equity levels are characterised by a combination of high market interest rates and low levels of price inflation. Marking the scenarios with the lowest equity levels can test this.

When a scenario cloud suddenly diverges in one specific year, this can also indicate extreme sensitivity. A large construction program for new houses could for instance cause such a divergence. Such a conclusion might induce the association to reduce the risks involved in the specific program. In Figure 3, we

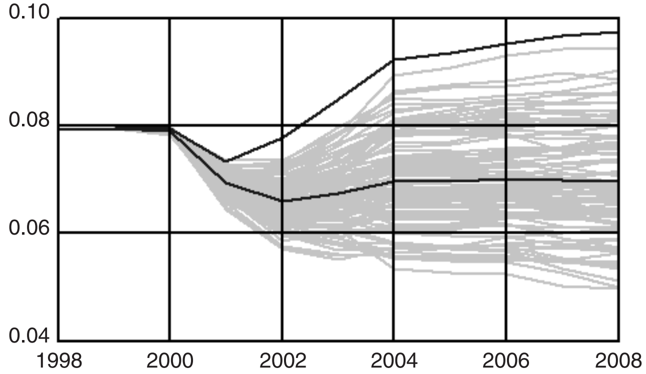

Figure 3.
Scenario cloud for the average interest rate paid for 100 scenarios

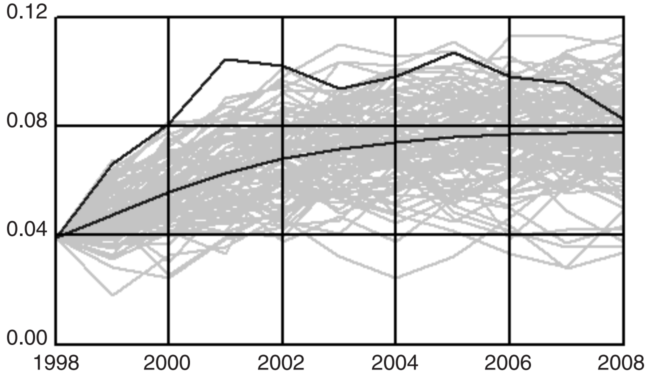

Figure 4.
Scenario cloud for the market interest rate for 100 scenarios

see an example for the average interest rate paid by a housing association. In the period 2002-2004 a significant part of the debt portfolio has to be paid off. Therefore, the association is very sensitive to interest rate levels in this period. While on average the interest charges will go down, it is still not unlikely that they will actually go up. That is, the number of high interest scenarios is still relatively large. The association might want to try to reduce the interest rate risk in this specific period.

Risk-return fields

The scenario clouds can be used to extract risk and return measures. The risk-return field can be used to compare several different strategies on the dimensions risk and return. An adequate choice for the risk and return measures is therefore essential. These measures can indicate both financial and social objectives. In the risk-return field each strategy is summarised in two key figures: the risk measure and the return measure.

The first step in the analysis of strategies by means of a risk-return field is to find inefficient strategies. These are strategies for which another strategy exists with:

- equal risk and higher return; or
- equal return and less risk; or
- both a higher return and lower risk.

Inefficient strategies can be further ignored based on their risk and return characteristics. However, what we often see in practice is that both risk and return are financial measures like probability of insolvency and the expected (average) solvency level. The social objective or, better, the social return then represents an (implicit) third dimension. Therefore, financially inefficient strategies might still be considered because of their social return. Management has to choose between the strategies based upon their risk and return characteristics. This is a subjective choice that depends on the amount of risk one is willing to take in order to obtain higher returns. This choice can differ between associations.

Alternatively, instead of comparing risk and return, it is also possible to compare a social and a financial objective. For instance, the horizontal axis could represent equity and the vertical axis the number of affordable houses offered for rent. Or the horizontal axis could represent a social objective and the vertical axis the financial risk (i.e. probability of insolvency).

An example of a risk-return field is given in Figure 5. This figure shows the influence of the rent setting strategy on the average (or expected) equity level (divided by balance sheet total) and on the probability of insolvency ten years from now. Three different strategies are compared. Strategy one ("no harmonisation") assumes that the rents are raised by inflation on a yearly basis, and in case of a tenant mutation there is no additional rent increase. With strategy two ("rents CPI") the yearly rent increase is also equal to inflation, but now rents are increased to their desired level at once in case of a tenant

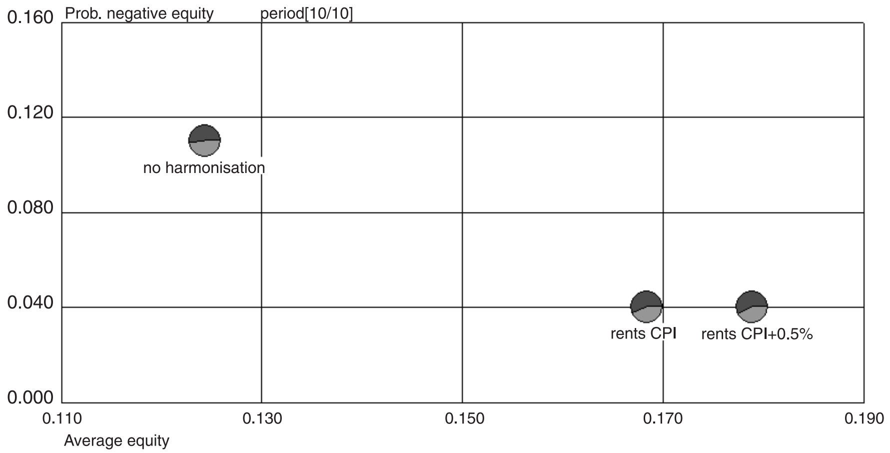

Figure 5.
Risk-return field with financial risk and return measures

mutation (this is called harmonisation). Finally, strategy three ("rents CPI+0.5 per cent") is almost equal to "rents CPI", but now the yearly rent increase is inflation plus 0.5 percentage points.

The management of this housing association has set the maximum acceptable risk of insolvency at 5 per cent. Therefore, the strategy without harmonisation is unacceptable. Based on these two financial measures, only the strategy "rents CPI+0.5 per cent" is efficient. However, management feels responsible for its social task. Therefore, they want to maximise their social return given a restriction of a 5 per cent maximum probability of insolvency. Figure 6 is therefore more relevant for this association. On the horizontal axis it shows the percentage of the total housing stock with a monthly rent level below 600 guilders (current price level). Based on the assumptions presented above, this association would probably choose strategy "rents CPI".

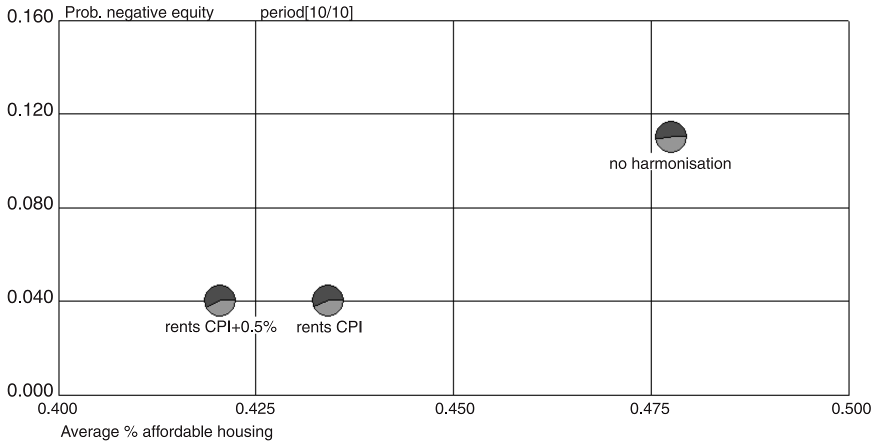

Figure 6.
Risk-return field with a social return and a financial risk measure

By presenting different strategies in risk-return fields like the ones presented above, it is very easy to compare the strategies. Furthermore, acceptable and non-acceptable strategies can be easily distinguished. Finally, it is also possible to analyse the effectiveness of instruments. If we define different strategies that only differ in one specific instrument, we can derive the impact of this instrument by looking at the differences between the variants in the risk-return field(s). When we compare different strategies where different instruments are adjusted relative to the default, we can determine the relative impact of the instruments.

Summary and conclusions

Figure 7 summarises the risk analysis process we have propagated in this paper. First of all, we propagate scenario analysis by means of Monte Carlo simulation. The economic scenarios (preferably hundreds) can be based on a combination of historical patterns (i.e. volatility and dynamics) and management's assumptions concerning the expected development of series like inflation and interest rates. Furthermore, we propagate the use of microsimulation for the housing associations' most important asset (dwellings) and liability (debt) class. Before a risk analysis can be performed, management has to define its ALM strategy. Ideally, an ALM strategy is characterised by an integrated choice on all relevant instruments (such as investment strategy, rent setting strategy, treasury strategy, and etc.). Given the ALM strategy and the simulated scenarios for the economy, for the dwellings, and for debt, we can generate scenarios for the housing association as a whole. That is, we can simulate future profit and loss accounts, balance sheets, and cash flow statements. Furthermore, from this we can derive social and financial risk and return measures. In order to improve the risk-return profile of the association, management can then use the scores on these measures to adjust its strategy. Furthermore, management can analyse the impact of new plans on risk and

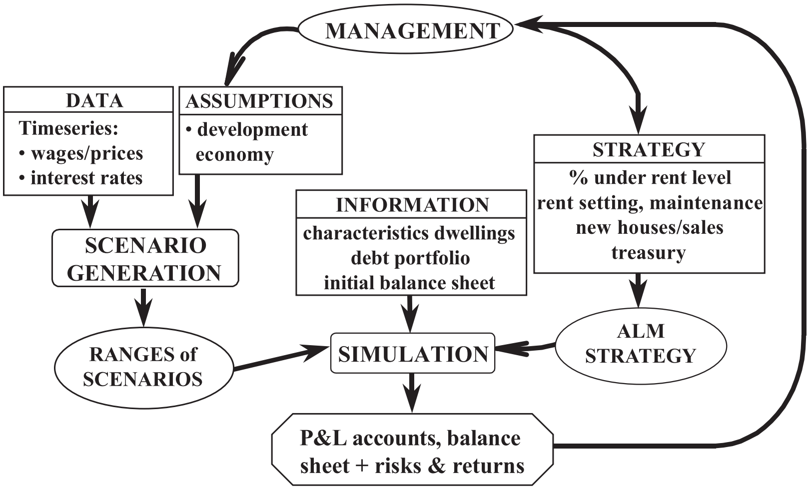

Figure 7.
The iterative risk analysis process

return. This leads to an iterative process that can be used to further refine and improve the strategy.

The approach described in this paper can provide management with essential insight into the associations' risk-return profile, the relevant risk drivers, and into the (relative) effectiveness of the available instruments. Furthermore, it can lead to an improved, integral, management of the association. With this model, strategic choices can be found. Furthermore, this model can be used to justify/communicate the choices to the stakeholders (such as employees, supervisors, and tenants). Finally, it has also been used in merger talks to support the negotiations.

Notes

1. An economic scenario is characterised by one possible future development of a set of important economic factors, such as price inflation and interest rates.
2. The model has been developed in Microsoft Visual C++.
3. In the model, consumer price, wage, construction and house price inflation are defined as rates of change of the underlying index. This is necessary to induce stationarity of these series. The indices can be recalculated by assuming that the starting year of the analysis (i.e., simulation/scenario year 0) has an indexvalue of 100.

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Appendix: The term structure of interest rates

The term structure of interest rates relates the interest rate $r(l)$ to the term l. In order to generate scenarios for the term structure of interest rates, we first use the VAR-model to obtain scenarios for the interest rate on three-month treasury bills and for the effective yield on long-term government bonds. These two series are used as the ultra short and the ultra long interest rates. Values for intermediary terms are obtained by means of the Nelson and Siegel (1987) yieldcurve model.

Starting from theory, Nelson and Siegel (1987) derive a parsimonious function that can be used to describe term structures and yieldcurves. The function, which is based on only four parameter values (β_0, β_1, β_2 and τ), is

$$r(l) = \beta_0 + (\beta_1 + \beta_2)\frac{(1 - e^{-l/\tau})}{(l/\tau)} - \beta_2 e^{--l/\tau},$$

where $r(l)$ is the interest rate with term l. For this function the following properties hold:

$$\lim_{l \to \infty} r(l) = \beta_0,$$

$$\lim_{l \to 0} r(l) = \beta_0 + \beta_1.$$

Therefore the β_0 parameter can be interpreted as the interest rate with the longest term (infinity) while the parameterβ_1 is the difference (spread) between the interest rate with the shortest term (instantaneous rate) and the interest rate with the longest term. The economic interpretation of the parameter values is one of the advantages of the Nelson and Siegel (1987) model above other models of the term structure. For β_0 we can use the effective yield on long-term government bonds. For β_1 we can use the spread between the interest rate on three-month treasury bills and the effective yield on long-term government bonds.

The parameters β_2 and τ determine the shape of the term structure. Positive values of β_2 cause a hump in the mid segment of the curve while negative values cause a dip. With β_2 equal to 0, the curve increases or decreases monotonically. The τ parameter determines the rate of convergence to the limit value β_0. Large values of τ cause slow convergence and low values cause fast convergence. Based on Dutch historical data, τ is estimated to be 2.8. The expected value of the β_2 parameter is estimated to be zero, with a standard deviation of 2.5 per cent and a correlation of –0.4 with the short interest rate and –0.1 with the long interest rate.