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Innovative social sales programs: valuation and risk issues

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ABSTRACT

In recent years, Dutch housing associations have introduced a number of innovative types of sale, having in common that a house is sold to the tenant at a discount. In this way, buying a house becomes affordable for lower-income households. On the other hand the housing association obtains cash, which can be used for (social) housing investment. The innovative types of sales differ in the conditions under which the house is sold. These conditions range from sharing the profit (or loss) at turnover, repaying the (indexed) discount at turnover or only buying the dwelling and leasing the land. Therefore, even if the discount is the same, the risk – return profile of the different types of social sale can differ. In this paper, we look at the valuation and the risk – return characteristics of three different innovative types of sale from a housing association perspective. We use Monte Carlo simulation to establish the expected cash flows and Net Present Values, and the uncertainties herein measured as Value at Risk.

Keywords: valuation, risk analysis, risk management, social housing, affordability

JEL Classification: R31, C15, G32

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1. Introduction

One of the biggest problems on the current Dutch housing market is the large gap between the rental and the owner-occupied market. Affordability for first-time buyers is a serious problem in the owner-occupied market, which is characterized by high prices due to shortages because of low supply. And in the social rented sector, typified by rents significantly below market rents, long waiting lists exist. The Netherlands Council of Housing, Spatial Planning and the Environment[3] concludes that this gap has to be reduced by, amongst others, innovations on the supply side of the housing market (VROM-Raad 2004, 2007). To be more specific, more attention should be paid to so-called hybrid forms of sale or innovative social sales types. The Scientific Council for Government Policy[4] (WRR) also concludes that more attention should be paid to a social owner-occupied sector and to innovative social sales types (Brandsen & Helderman, 2004). These innovative social sales programs should increase the flexibility of the supply side of the market, and weaken the strict distinction between the owner-occupied and the (social) rental market. Within these social sales programs, discounts are given on the market value of the house. However, these discounts are at least partly compensated by conditions on the sales contract.

Dutch housing associations have been experimenting with innovative social sales programs for around 30 years. Until recently, these experiments only concerned small numbers of houses. In these earlier years, these programs were developed by individual housing associations, and types and conditions differed between associations. There was hardly any standardization. Therefore, most experiments have never grown to maturity. In recent years, however, a limited number of standardized social sales types have emerged. In this paper we will discuss three of these standardized types: *Koopgarant*, *Koop Goedkoop* and *Sociale Koop*.

Not much literature exists on valuation and risk of innovative social sales programs from a housing association perspective; neither for the Netherlands nor for the UK (Homebuy and Shared ownership). Furthermore, the role of the housing associations or social landlords within these social sales programs is somewhat different in the UK compared to the Dutch situation. For strategic policy making, it is very important that housing associations know the (policy) value and the risks involved with the potential social sales programs. To be able to choose between (for instance) continuing social renting, full sale or one of the innovative social sales programs, a housing association has to have insight into the (financial and social) value and risk of all alternatives. In this paper we will focus on financial value and risk. This paper is the first to discuss valuation and risk issues of

[3] The Council is charged with advising government and parliament on the main aspects of policy with regard to the sustainability of the environment and on other main elements of policy relating to housing, spatial planning and environmental management.

[4] The aim of the WRR is to advise the government about future developments of great public interest using a scientific approach.

Koopgarant, *Koop Goedkoop* and *Sociale Koop* in a quantitative manner. We use Monte Carlo simulation to establish the expected cash flows and Net Present Values, and the uncertainties herein measured as Value at Risk. First we will describe the Dutch social housing market in some more detail to provide a proper setting.

1.1 Dutch social housing trends

Housing associations constitute the biggest group of players in the Dutch residential market, with around 2.3 million individual housing units owned. Social rental housing currently covers about 35 per cent of the total housing stock (Elsinga *et al.*, 2008), and about 77% of the Dutch rental market. In the Netherlands, housing associations are non-profit organizations which are required to operate in the interest of housing. This is reflected in the Housing Act and the Social Rented Sector Management Decree (BBSH). The BBSH, which is established by the Dutch government, contains the rights and duties of Dutch housing associations. Essentially, housing associations have the task of providing good, affordable housing for those who are unable to find a dwelling in the market.

In 1995, the Dutch government completely withdrew the direct financial support to the Dutch housing associations. The housing associations redeemed all outstanding government loans and received all the property subsidies pledged for the future. At the same time, all property subsidies for new and existing dwellings were stopped. As the long-term interest rate remained at a lower level than had been anticipated, and as all the proceeds from the sale of rented homes went to the housing associations, the capital of the housing associations grew rapidly (Priemus, 2008). This capital surplus is, to an increasing degree, a social and political problem. There is a political debate on the performance of the social rented sector. And the image of the sector is decidedly poor (Boelhouwer, 2007). The housing associations are challenged to increase their efforts on the social side (Priemus, 2008). It is important to realize that in practice, housing associations are making a lot of socially acceptable investments. The amount of investments and the direction are however not controlled or steered by government bodies (Boelhouwer, 2007).

Since the new Dutch government took office at the beginning of 2007, the financial independency of housing associations is at stake. In the Budget for 2008, the Dutch government announced that the entire housing association sector would be subject to corporation tax starting from 1 January 2008. This is expected to generate at least € 500 million per annum for the treasury (Priemus, 2008). In fact, the planned corporation tax regime is heavier than that for commercial property investors. In addition, the government plans to oblige the housing associations to deposit € 75 million a year in a private investment fund over the next 10 years. This fund can then be used to invest in urban renewal projects in 40 problem neighborhoods throughout the country. Finally, the annual rent increase is maximized at price inflation. Due to these developments, at least one housing association (De Veste in the town of Ommen) is planning to step out of the social housing system. As the minister of Housing has forbidden this step, this issue is now brought for the High Court.

Recently, the Netherlands Bureau for Economic Policy Analysis (CPB) issued a document on the economic effects of regulating and subsidizing the rental market (Romijn & Besseling, 2008). In this document, the authors state that rent control reduces the rents by almost 50%, leading to an annual cost of € 14.5 billion. However, only € 6.75 billion reaches the low income households. Thus, many cheap (social) rental units are occupied by middle and high income families; whereas low income families cannot find affordable housing and first time renters typically have to wait several years before they are eligible for a house.

In the year 2000, Dutch government stated the promotion of home ownership and selling-off sections of the social housing stock as a major goal. However, unlike the Right to Buy scheme in Britain, the Netherlands employs an 'offer to buy' strategy (Aalbers, 2003). Sales, however, have been disappointing so far. One important reason for this is the high prices in the owner-occupied market. For low and even for middle income groups, buying is often not an option due to much higher costs compared to renting. Where a social rental house would cost up to around € 500 per month, a € 200,000 single family home would cost around € 850 per month (Noordenne & Vos, 2006). To be affordable, this would require a gross income of around € 47,500, or more than 150% of the modal income in the Netherlands. The average sales price of a house was over € 250,000 at the end of 2007 (source: Kadaster).

In order to increase affordability, housing associations have been experimenting with innovative social sales programs. That is, houses are sold at a discount. In this way, buying a house becomes affordable for lower-income households. And the housing association obtains cash, which can be used for (social) housing investment. The innovative types of sales differ in the conditions under which the house is sold. These conditions range from sharing the profit (or loss) at turnover, repaying the (indexed) discount at turnover or only buying the dwelling and leasing the land. In this paper we look at valuation and risk issues for three common types.

1.2 Outline of this paper

The paper is organized as follows. In section 2, we describe the most common social sales types used by Dutch housing associations. And we look at comparable developments in the UK. Valuation of three common types is the subject of section 3. In section 4 we have a look at the risk profile of each type. This risk profile is established for a stylized example by means of Monte Carlo simulation. We establish the expected cash flows and Net Present Values, and the uncertainties herein measured as Value at Risk. The relevant conclusions are drawn in section 5. The focus of this paper will be on valuation and risk issues concerning social sales types from a housing association perspective. In section 5, we will also draw some conclusions for buyers.

2. Innovative social sales programs

2.1 General trends in the Netherlands and the UK

Elsinga (2004) lists a number of possibilities for an affordable social owner occupied housing sector:

1. Discount on initial sales price in combination with sharing the profit or loss (like socially bound ownership in the Netherlands, see section 2.2);
2. Joint ownership (like cooperatives in the USA);
3. Partial ownership (UK – Shared ownership, Homebuy; Finland – Right of Occupancy; Netherlands: *Sociale Koop*, *Koop Goedkoop*; see sections 2.3 and 2.4)

In the remainder of this section, we will focus on the Dutch and UK cases. For a more thorough description of the US and Finish cases, see Elsinga (2004).

In the Netherlands, the first experiments with social sales programs date from the 1970s (Noordenne & Vos, 2006). In the city of Rotterdam housing associations introduced the so-called socially-bound ownership (*Maatschappelijk Gebonden Eigendom*) concept. In this concept, that is very similar to the *Koopgarant* concept described in section 2.2, the buyers received a large discount on the market value of a house. At turnover, they were obliged to resell the house to the housing associations. The buyers profited from value increases due to their own investment in / improvements of the house, but not from general market developments.

In the 1990s, housing associations developed a number of alternative concepts like *Koophuur* ('Shell and interior' scheme) where the interior structure of the dwelling was sold to the tenant, while the exterior structure was rented from the housing association. Due to a tightened fiscal regime, these concepts did not become successful, and have disappeared from the market. As the interest payments on the mortgage were not tax deductible, they became too expensive.

To promote home ownership and freedom of choice of their customers, Dutch housing associations have continued to develop new innovative social sales programs in the last decade. To (partly) overcome the affordability problems, all of these new concepts include a discount on the initial sales price. The current concepts have been approved by the Exchequer. Interest payments on the mortgage are therefore tax deductible. A large number of types have been introduced in recent years. We will only discuss three common types. Common characteristics of these three types are that they are standardized and that they are used by more than one housing association via a licensing system.

Apart from offering one specific social sales type to their customers, a number of housing associations have extended the freedom of choice concept. That is, they offer the so called Client's Choice (Te Woon) program to their customers. The Client's Choice Program offers tenants freedom of choice in tenure. In this program, a housing associations offers tenants the choice between a traditional rent contract, fixed rent or fixed rent increase contracts for a five- or ten-year period, socially bound ownership (see section 2.2), and

ownership with a buy-back option. By the introduction of this program, housing associations aim to contribute to their social objectives by improving tenants' satisfaction with their dwellings and to improve the market position of their stock as well. For a more thorough description of the Client's Choice program and their benefits and risks for tenant and landlord, the reader is referred to Gruis *et al.* (2005) and Kramer *et al.* (2008).

Up till now, only *Koopgarant* (socially-bound ownership, see section 2.2) has been quite successful, with around 10,000 dwellings sold up to mid 2008. And even with *Koopgarant*, the success rate (probability that a customer actually buys a dwelling) is very low for existing rental units. This concept is mainly successful for new-built houses and new customers, not for existing tenants. Staalduinen (2006) gives a number of impediments for the success of social sales programs, amongst others:

1. These programs only add value for a very limited part of current tenants (3%-7%), due to affordability problems;
2. In the first few (i.e., at least five) years after the sale, housing expenses are higher than renting;
3. Social sales programs are only offered to a limited number of tenants by a limited number of housing associations.

In the UK, the major measures to increase owner occupation were the Right to Buy and low cost home ownership schemes like shared ownership and Homebuy. The Right to Buy regime, introduced in 1980, enabled tenants to buy their rental homes at a large discount. The height of the discount depends on the length of tenancy and on the type of dwelling. The average discount has been around 50% in the 1990s, but has dropped somewhat in recent years due to changing discount rules (Munro, 2007).

Between 1980 and 2003, 2.2 million houses were sold in the UK under the Right to Buy scheme (Munro, 2007). That is, 13 per cent of owners in the UK are living in a house that was owned by a social landlord in 1981. Households buying under the Right to Buy regime were systematically more advantageous than those remaining as tenants. This has left behind a council sector that is increasingly characterized by households out of the labor force. This contributed to the broader stigmatization of socially rented housing, confirming its position as 'welfare' housing of last resort, only for those with no other options (Munro, 2007). This stigmatization of social rented housing is currently much less of a problem in the Netherlands.

In the 1980s and 1990s, shared ownership, whereby owners buys some percentage (25%-75%) of their house and rent the remaining part from a registered social landlord, has been the most important form of low cost home ownership in the UK. Shared ownership is usually applied to new built houses. An alternative name for this regime is New Build HomeBuy (see Rowland & Murie, 2008). Up to 2001, around 85,000 houses or 0.4% of the entire housing stock have been sold under the shared ownership regime (Elsinga, 2004). The purchaser has the option to 'staircase' at a later stage, that is, to buy an additional portion of the house. The Dutch *Koop Goedkoop* concept has some similarities with shared ownership. See section 2.3.

In the last decade, the (Open Market) Homebuy scheme, introduced in Wales in the early 1990s and in England in 1999, has taken over as the main low cost home ownership mechanism. It operates as a form of equity loan. Part of the initial purchase cost (up to 25%) is met by the registered social landlord, which is then treated as an interest free loan to the purchaser. Upon subsequent resale or 'staircasing' (whereby the owner buys an additional portion of the equity), the registered social landlord is paid the relevant percentage of the current market value. The purchaser can buy a house on the free market and can go to a registered social landlord for the interest free loan. In order to be eligible for this interest free loan, a number of conditions apply. The Dutch *Sociale Koop* concept is quite similar to the Homebuy scheme. See section 2.4.

In 2006, a pilot has started for the Social HomeBuy scheme (Rowland & Murie, 2008). This scheme offers tenants the opportunity to buy a share in their rented home. This in contrast to shared ownership / New Build HomeBuy that focuses on new build houses; and in contrast to Open Market HomeBuy that focuses on the free market. Tenants may purchase a minimum initial share of 25% of their home. The remainder of the equity is retained by their landlord who will levy a charge of up to 3% of the capital value of their retained equity. Buyers receive a discount on the share purchase. Again, purchasers are responsible for all repair and maintenance costs. Buyers can 'staircase'. If they do not own 100% of equity, they sell as a shared ownership property.

Munro (2007) concludes that schemes like Homebuy do not make any new opportunities for owner occupation available because they simply help some people to buy in the open market (in direct competition with 'normal' purchasers). Given the lack of supply responsiveness in the private housing market, there is a clear danger that expenditure on such schemes will simply be capitalized into higher house prices, pushing the goal of affordability ever further away. This is also a serious problem in the Dutch housing market.

Munro (2007) concludes that the low cost home ownership schemes have remained too small in scale to have made a really significant impact on enhancing access to owner occupation for excluded households. They have lacked a strategic focus, and continue to suffer from a lack of widespread understanding, both amongst potential purchasers and possible lenders. Furthermore, there is a danger that growing families can be trapped because of limited mobility within the tenure and a lack of resources to staircase up to full ownership. The current Dutch innovative social sales programs also (still?) suffer from low sales volumes, and are generally poorly understood by potential purchasers.

2.2 *Koopgarant* (Socially-bound ownership)

Koopgarant is the successor of the socially-bound ownership (*Maatschappelijk Gebonden Eigendom*) concept, first introduced in the 1970s. Tenants buy the dwelling at a discount on the market value on the condition that they resell their dwelling at turnover to landlord at the same discount and share profit or loss. The housing association is obliged to buy-back the dwelling at turnover. *Koopgarant* is the most successful social sales type with around 70,000 dwellings offered to the tenants, and around 10,000 dwellings actually sold up to mid 2008. Housing associations have to buy a license to apply this concept. In June 2008, 125 housing associations have a license (see press release dated 5 June 2008 at www.koopgarant.com).

The share of the housing association and of the purchaser in the value increase of the house depends on the discount on the market value at the initial purchase. The relationship between initial discount and profit share is based on a fair value calculation. That is, the fair value profit share is calculated from the view point of the purchaser, taking into account the conditions of the sales contract. See Conijn & Schweitzer (2000) for the fair value calculations. The parameters differ between existing and new built dwellings. The reason is, that there are differences in the savings on the additional costs (like transfer tax) related to the discount. The discounts and profit shares are presented in table 2.1.

Table 2. 1: Discounts and profit shares with Koopgarant

Discount for buyer	*Share of housing association in value increase or decrease*	
	existing dwellings	*new-built dwellings*
15%	30%	22.5%
20%	40%	30%
25%	50%	37.5%
30%	50%	45%
35%	50%	50%

Source: Netherlands Ministry of Housing, Spatial Planning and the Environment, MG2006-06, 10 July 2006.

The minimum profit and loss share for the purchaser is 50%. With less than 50% of the price risk for the purchaser, the Exchequer does not allow tax deduction of the interest payments of the mortgage. Value increases due to improvements by the purchaser are entirely for the purchaser. For example:

Example	**A**	**B**
Initial market value	160,000	160,000
Discount	25%	25%
Sales price (A)	120,000	120,000
Market value at turnover	200,000	150,000
Value increase due to improvements (B)	10,000	10,000
Value increase due to market development (C)	30,000	-20,000
Buy back price = A + B + 0.5*C	**145,000**	**120,000**

After buy back, the housing association is free to decide what to do with the dwelling. For a more thorough description, the reader is referred to Noordenne & Vos (2006).

2.3 Koop Goedkoop

Within the *Koop Goedkoop* concept (literally translated as Buy Cheap), a tenant buys the dwelling and leases the land. The value of the land is assumed to be 30% of the total market value. That is, no separate appraisal of the value of the land takes place. The purchaser therefore initially pays 70% of the market value. He or she receives a discount on the market ground rent in the first 10 years after the sale. The discount percentages are presented in Table 2.2.

Table 2.2 Discount on ground rent for *Koop Goedkoop*

Years	*Discount on ground rent*
1st year	100%
2nd year	90%
3rd year	80%
4th year	70%
5th year	60%
6th year	50%
7th year	40%
8th year	30%
9th year	20%
10th year	10%
11th year and further	0%

The initial yearly market ground rent is set to 5% of the market value of the land, or 1.5% of the total market value at purchase. The ground rent is paid monthly, and indexed with price inflation once a year during the contract (i.e., until turnover). Both the interest payments on the mortgage and the ground rent paid by the purchaser are tax deductible. Note that from a buyer perspective, it could be rational to sell the house before the discount period of 10 years has passed. The turnover rate might therefore be higher than for other types of sale.

At turnover, the purchaser is obliged to offer the dwelling to the housing association. The housing association is, however, not obliged to buy back the dwelling. If the housing association does not want to buy back the dwelling, the purchaser is free to sell the dwelling at the free market. He receives the entire value increase of the dwelling. The second purchaser therefore does not buy from the housing association. But he or she leases the land from the housing association. The two standard models are:

- Model A: each subsequent buyer is entitled to the discount on the ground rent;
- Model B: only the first buyer is entitled to the discount on the ground rent.

If the housing association wants to get rid of a *Koop Goedkoop* dwelling, it can buy back the dwelling at turnover and sell it, without restrictions, at the free market.

Since its introduction in 2004, around 2,000 dwellings have been sold within this concept. Sixteen housing associations participate in this program.

2.4 Sociale Koop

With *Sociale Koop* (literally translated as Social Sale), a tenant buys the dwelling at a discount and repays the (indexed) discount at turnover. The size of the discount is determined by the purchaser. The maximum discount is 65% of the market value. The repayment of the discount at turnover is not based on the actual resale price, but on the development of a price index based on the region and type of dwelling. 'Staircasing' (whereby the owner buys an additional portion of the dwelling) is allowed. Customers can also buy a house on the free market via a housing association.

At turnover, the purchaser is obliged to offer the dwelling to the housing association. The housing association is, however, not obliged to buy back the dwelling. If the housing association does not want to buy back the dwelling, the purchaser is free to sell the dwelling at the free market. He receives the entire value increase of the dwelling and has to pay the indexed discount to the housing association. In that case, the second purchaser buys from the first purchaser without a discount. The second purchaser is therefore not bound to the housing association.

Since its introduction in 2007, around 100 dwellings have been sold within this concept. Four housing associations participate in this program.

2.5 Valuation and risk

Noordenne & Vos (2006) present the following effects on the balance sheet of a housing association:

- *Koopgarant*: buy-back obligation kept off-balance;
- *Sociale Koop*: the outstanding claim on the repayable (indexed) discount as an asset on the balance sheet.

Furthermore, Noordenne & Vos (2006) present the following risks for *Koopgarant*:

- Buy-back risk; only relevant in case resale is not the policy or not possible due to market problems (short demand).
- End of economic life risk: in case *Koopgarant* is applied up to the end of economic life of a dwelling, additional costs for the housing association apply.

For *Sociale Koop* and *Koop Goedkoop*, buy-back risk is only relevant when the housing association actually uses its buy-back right.

Gruis *et al* (2005) discuss a number of risk factors for socially-bound ownership (*Koopgarant*):

1. If willingness to buy is low in the first few years of the program, revenues are much smaller.
2. A drop in house prices after the start of the program means that the housing association has to share losses with buyers who want to sell. Moreover, people are less likely to buy a dwelling in a declining housing market. This might lead to an increased number of dwellings let and a decreased number of dwellings sold, leading to an additional loss.
3. The program involves a lasting commitment, which could end with the obligation to buy back many dwellings at the end of their lifespan.

The risk of a low willingness to buy is valid for all types of sale. Furthermore, with *Sociale Koop* the housing association will also suffer from a drop in house prices as the value of the claim will decline. Gruis *et al* (2005) conclude that the main financial risk lies in using up too much of the revenues too early. Accordingly, risk management must become a crucial part of strategic policy.

As we will see in section 3.1, with *Sociale Koop* there is a probability of default of the first purchaser. This could lead to a situation where (part of) the claim cannot be collected. Furthermore, given the lack of supply responsiveness in the housing market, there is a danger that the lower house prices in social sales programs will simply be capitalized into higher house prices, pushing the goal of affordability ever further away. Furthermore, there is a danger that purchases can be trapped because of a lack of resources to staircase up to full ownership. Especially the lower income groups will have problems to move to another house. This could lead to low turnover rates (and it will thus take long to collect the outstanding claims), and to the effect that higher incomes move away and lower incomes stay behind.

The most important characteristics of the three social sales types discussed in this paper are summarized in Table 2.3. For a more extensive overview see Appendix 1.A in Noordenne & Vos (2006).

Table 2. 3 Summary of social sales types characteristics

	Koopgarant	*Sociale Koop*	*Koop Goedkoop*
Freedom of choice buyer	Sometimes buyer can choose discount	Sometimes buyer can choose discount. Buyer can also choose a dwelling on the free market	No
Initial discount	10%-50%	0%-65%	30%
Buy-back obligation housing association	Yes	No	No
Profit / loss sharing	Buyer receives at least 50% of market value increase or decrease	Buyer receives value increase or decrease for the part bought	Buyer receives entire value increase or decrease of the dwelling excl. land.
Land lease	No land lease paid by buyer	No land lease paid by buyer	Discount on land lease in first 10 years. Land lease indexed yearly by consumer price index. Discount on land lease for 2nd buyer optional.
Transfer tax	Based on price paid.	Based on full market value.	Based on full market value.

3. Valuation of innovative social sales programs

In the following subsections, we will discuss potential valuation models for the three innovative social sales programs. In all valuation formulas, the initial sales revenue is excluded from the value at time 0. This initial revenue is assumed to be certain. Furthermore, sales and buy-back costs are also not included. The formulas can, however, easily be extended to include these factors. Details can be obtained from the author. The valuation models also assume constant discount and growth rates for the price and house price index. This is done to keep the models relatively simple. The models can be easily extended at the cost of more complexity. We will start with the simplest case, *Sociale Koop*.

3.1 Valuation of *Sociale Koop*

Current practice is to put the nominal value of the claim on the balance sheet as an asset. That is:

$$\begin{aligned} V(0) &= d \cdot MV(0), \\ V(t) &= V(t-1) \cdot (1+m(t)), \end{aligned} \tag{3.1}$$

Where *V(t)* is the nominal value of the claim in year *t*, *d* the discount given to the purchaser on the market value of the dwelling at the time of sale *MV(0)*, and *m(t)* the increase of the house price index in year *t*.

As the housing association is not free to decide when to collect the claim but is dependent on the purchaser, current valuation practice is too optimistic about the value of the claim in case the expected house price increase is lower than the discount rate. The correct value of the claim should not be the free market value, but an equivalent of the market value of rented properties. This value will depend on the relevant discount rate *r*, the expected yearly development of the house price index *E(m)* and the expected time to resale *E(N)*, which is equal to the inverse of the average turnover rate. That is, the present value *PV* of the claim in year *t* equals:

$$PV(t) = V(t) \cdot \frac{(1+E(m))^{E(N)}}{(1+r)^{E(N)}}, \tag{3.2}$$

In case *E(m)* is lower than the discount rate, this value is less than the nominal value of the claim. In recent years, the national house price index increase has been around 4%, which is lower than the most commonly used discount rate of 6%. Note that formula (3.2) assumes no memory in the turnover rate. That is, the expected time to resale is independent of how long ago the purchaser has bought the dwelling. An alternative valuation would be to replace the expected time to resale with a probability distribution of the time to resale:

$$PV(t) = V(t) \cdot \sum_{i=1}^{\infty} P(i) \cdot \frac{(1+E(m))^{i}}{(1+r)^{i}} = V(t) \cdot \sum_{i=1}^{\infty} p \cdot (1-p)^{i-1} \cdot \frac{(1+E(m))^{i}}{(1+r)^{i}}, \tag{3.3}$$

Where *P(i)* is the probability that the purchaser wants to sell the dwelling *i* years from now and *p* the turnover rate. Under the assumption that $(1-p)\cdot(1+E(m)) < 1+r$, this formula can be rewritten into the following closed form formula (see Appendix A):

$$PV(t) = \frac{V(t)\cdot p}{1-p}\cdot\left[\frac{1+r}{(1-p)\cdot(1+E(m))}-1\right]^{-1}, \qquad (3.3')$$

Formula (3.3') leads to slightly higher values than formula (3.2). The difference is larger for higher discounts, with lower turnover rates and with a lower expected development of the market index. For realistic values, the difference will be less than 5%. When the assumption for (3.3') applies, this formula should be preferred above formula (3.2).

The buy back option will usually not be exercised by the housing association. Exercising this option is not interesting from a financial point of view. The present value of letting the dwelling is usually much lower than the market value. Furthermore, there are transaction costs involved in buying and reselling the dwelling. So the option will only be exercised for social or portfolio reasons. Therefore, this option is not included in the valuation. Noordenne & Vos (2006) also state that *Sociale Koop* is mainly suitable when the housing association has no plans to return the dwelling to the social rented portfolio.

In contrast to the other two social sales types, with *Sociale Koop* the housing associations can suffer a loss when the buyer defaults at the time of resale. After all, this is the only type where the buyer has to pay the housing association at turnover. The buyer might default when the market value of the house at turnover is less than the sum of the repayment of the mortgage and the claim of the housing association. That is, if

$$\begin{aligned} &MV(t) < f\cdot(1-d)\cdot MV(0) + d\cdot(1+CMI(t))\cdot MV(0) \Rightarrow \\ &\frac{MV(t)}{MV(0)} < f + d\cdot\left(1+CMI(t)-f\right), \end{aligned} \qquad (3.4)$$

Where *MV* is the market value of the dwelling, *f* the fraction of the initial sales price funded via a mortgage (this can be larger than 1 due to the costs of buying a house such as transfer tax, house-agent costs, notary …), *CMI(t)* the cumulative market index increase and *d* the initial discount. If *f* equals 1, this equation simplifies to:

$$\frac{MV(t)}{MV(0)} - 1 < d\cdot CMI(t), \qquad (3.4')$$

The left hand side is the cumulative price increase of the house. Thus, there is a probability of default when the price increase of the house falls short of the price increase of the market with 100*(1-*d*)%. With an initial discount of 30%, this means that the price increase of the house should be more than 70% below that of the market. Default is therefore mainly a risk in case of a high discount. These are usually also the buyers with the least favorable financial position. This group of customers will also have most problems with funding maintenance, which could also lead to a price increase below the market. The value of the

claim can be adjusted to the probability of default by multiplying the value from formula (3.2) or (3.3') by one minus the expected probability of default.

3.2 Valuation of *Koop Goedkoop*

Current practice is to put the nominal market value of the land on the balance sheet as an asset. That is:

$$\begin{aligned} V(0) &= 0.3 \cdot MV(0), \\ V(t) &= V(t-1) \cdot (1 + m(t)), \end{aligned} \tag{3.5}$$

Note that this leads to exactly the same balance sheet value as *Sociale Koop* with a 30% discount. While the expected future cash flow patterns are very different.

As was mentioned in section 2.3, there are two models:

- Model A: 10 year discount on ground rent also after resale(s);
- Model B: no discount after resale.

As the housing association is not free to decide when to sell the land but is dependent on the purchaser, the current valuation practice is questionable. The correct value of the asset should not be the free market value, but an equivalent of the market value of rented properties. In this section we will propose valuation formulas for both models.

For both models, the value of the first contract (i.e. with the first purchaser) PV_1 is identical. Given that the first price indexation takes place one year after the sale, and that the ground rent is paid monthly (and thus the average cash flow takes place in the middle of the year), this value is given by:

$$\begin{aligned} PV_1(t) &= \sum_{i=1}^{E(N)} W(i+t) \cdot g \cdot d \cdot MV(0) \cdot CPI(t) \cdot \frac{(1+E(cpi))^{i-1}}{(1+r)^{i-0,5}}, \\ CPI(0) &= 1, \\ CPI(t) &= \prod_{i=1}^{t} (1 + cpi(i)), t > 0, \\ W(x) &= MIN[1; 0.1 \cdot (x-1)], \end{aligned} \tag{3.6}$$

Where g is the yearly ground rent as a percentage of the market value of the land (i.e., 5%), d the market value of the land as a percentage of the total market value (i.e., 30%), $cpi(i)$ the consumer price inflation in year I, $CPI(t)$ the cumulative consumer price index from the year of sale up to year t plus 1 and $W()$ is the discount on ground rent as presented in Table 2.2. Thus, $g \cdot d \cdot MV(0)$ is the market ground rent at the time of sale. The first term within the summation gives the discount on the market ground rent.

If we assume that land has an infinite economic lifespan, and thus that the land lease contract runs infinitely, the value of **model A**, PV_A, can be approximated as follows (PV_1 infinite number of times, if $E(m) < r$ - for proof see Appendix A):

$$PV_A(t) = PV_1(t) + \left(\left\{ 1 - \left[\frac{1+E(m)}{1+r} \right]^{E(N)} \right\}^{-1} - 1 \right) \cdot PV_1(0) \cdot \frac{MV(t)}{MV(0)}, \qquad (3.7)$$

Again, like with *Sociale Koop* we assume that the turnover rate has no memory.

For model B, the second and following purchasers do not receive a discount. Therefore, PV_1 is only received from the first purchaser. For successive purchasers, PV_2 is relevant. The value of **model B**, PV_B, can therefore be approximated by (PV_2 infinite number of times, if E(m) < r):

$$\begin{aligned} PV_2(t) &= \sum_{i=1}^{E(N)} g \cdot d \cdot MV(0) \cdot CPI(t) \cdot \frac{(1+E(cpi))^{i-1}}{(1+r)^{i-0,5}}, \\ PV_B(t) &= PV_1(t) + \left(\left\{ 1 - \left[\frac{1+E(m)}{1+r} \right]^{E(N)} \right\}^{-1} - 1 \right) \cdot PV_2(0) \cdot \frac{MV(t)}{MV(0)}, \end{aligned} \qquad (3.8)$$

Formulas (3.7) and (3.8) are approximations, as we use the expected time to resale *E(N)* in stead of the probability distribution of the time to resale. As we have seen in section 3.1, this leads to a slight underestimation of the true value. However, in contrast to the *Sociale Koop* case, there are no closed form solutions of the valuation formulas when we use the probability distribution in stead of the expected time to resale. Exact valuation is therefore very complex. An alternative would be to use Monte Carlo simulation for valuation purposes, in which case a large number of random drawings from the probability distribution of the time to resale would be used to value the contract. Formulas (3.7) and (3.8) are better approximations than using the nominal market value of the land, and should therefore be preferred.

Like with *Sociale Koop*, the buy back option will usually not be exercised by the housing association. The option will only be exercised for social or portfolio reasons. Therefore, this option is not included in the valuation. Noordenne & Vos (2006) also state that *Koop Goedkoop* is mainly suitable when the housing association has no plans to return the dwelling to the social rented portfolio.

3.3 Valuation of *Koopgarant*

Most housing associations currently keep the obligation to buy back the dwelling and share profit or loss off balance (i.e., value = 0). The Rotterdam based housing association Woonbron, one of the pioneers of socially-bound ownership, uses the following rule to establish the balance sheet value of the buy back obligation for their *Koopgarant* program with a 25% discount en 50% profit and loss sharing (Woonbron, 2005):

1. Asset if PV of letting at time t > 0.53·MV(t)+0.265·MV(0);
2. Liability if MV(t) < 0.56 MV(0);
3. Else 0.

Criterion 1 compares the present value of letting with the buy back price based on a 25% discount and 50% profit share, including 6% transfer tax[5]. That is, if the present value of letting exceeds the buy back price, than the buy back obligation is valued as an asset. However, it is unlikely that with a social rent level the present value of letting exceeds 70%-80% of the free market value. Criterion 2 compares the free market value at buy back with the buy back price, again including transfer tax. As a cumulative drop in house prices of 44% is unlikely, criterion 2 will usually also not be met.

Woonbron does not commit itself to a specific strategy after buy back. For valuation purposes, the most negative option (letting) is used in case of a positive market price development; and the most profitable option is used in case of negative market price developments (sale on the free market). For accounting purposes, this is defendable as long as the housing association is really free to decide what to do after buy back. However, to support strategic policy making, this valuation approach does not suffice. In that case, the actual values of the options available should be known including the risk profile. Therefore, in the remainder of this section we discuss possible valuation models for the separate options that are available after buy back. In our models, we do not take improvements by the purchaser into account.

We will discuss the following three options after buy back:

A. sell against market value;
B. continue as *Koopgarant*;
C. let the dwelling.

For all options, the buy back price at time *t*, *P(t)*, is equal to:

$$P(t) = (1-d)\cdot MV(0) + s\cdot(MV(t) - MV(0)), \tag{3.9}$$

where *s* is the profit share for the customer. In case *t* lies in the future, *MV(t)* is uncertain and should be replaced by the product of the current market value and the expected

[5] The transfer tax only has to be paid by the housing association in case the dwelling is not resold within 6 months after the buy back.

indexation until the time of buy back. As in the previous sections, transfer tax is not included in our valuation models, but would be 6% of *P(t)* if applicable.

For **option A** (resale against market value), the present value is based on the difference between the resale price and the buy back price and can be calculated as follows:

$$PV(t) = (1+r)^{-E(N)} \cdot E\left[MV(t+E(N)) - P(t+E(N))\right] \Leftrightarrow$$
$$PV(t) = (1+r)^{-E(N)} \cdot \left[(d+s-1)\cdot MV(0) + (1-s)\cdot MV(t)\cdot(1+E(m))^{E(N)}\right], \quad (3.10)$$

Note that $d+s-1 < 0$ (between -0.25 and -0.35 depending on discount and profit share). However, in line with formulas (3.3) and (3.3') a more exact valuation would be to use the probability distribution of the time to buy back in stead of *E(N)*:

$$PV(t) = \left(\frac{p}{1-p}\right)\cdot$$
$$\left\{(d+s-1)\cdot MV(0)\cdot\left[\frac{1+r}{1-p}-1\right]^{-1} + (1-s)\cdot MV(t)\cdot\left[\frac{1+r}{(1-p)\cdot(1+E(m))}-1\right]^{-1}\right\}, \quad (3.11)$$

which would lead to slightly different values. The same observations apply as with formula (3.3'). Only, in this case (3.11) can also lead to values slightly lower than (3.10) with a large expected house price increase.

For **option B** (continue as *Koopgarant*) we distinguish two cases: infinite and finite economic life of the dwelling. The assumption of an infinite economic life of the dwelling is mainly relevant for single family homes. The underlying assumption is that purchasers will keep their property well maintained, thus infinitely expanding economic life. For multi family homes this assumption might be too strong. With **infinite economic life**, we can derive a formula comparable to (3.7) when E(m) < r. That is:

$$PV(t) = (1+r)^{-E(N)} \cdot (d+s-1)\cdot MV(0)\cdot\left\{1-\left[\frac{1+E(m)}{1+r}\right]^{E(N)}\right\}^{-1}$$
$$+ (1-d-s)\cdot MV(t)\cdot\left(\left\{1-\left[\frac{1+E(m)}{1+r}\right]^{E(N)}\right\}^{-1}-1\right), \quad (3.12)$$

For option B, **finite economic life** the formula becomes:

$$PV(t) = (1+r)^{-E(N)} \cdot (d+s-1)\cdot MV(0)\cdot \sum_{i=0}^{i\cdot E(N)+X<el}\left[\frac{1+E(m)}{1+r}\right]^{i\cdot E(N)}$$
$$- s\cdot MV(t)\cdot\left(\sum_{i=0}^{i\cdot E(N)+X<el}\left[\frac{1+E(m)}{1+r}\right]^{i\cdot E(N)}-1\right) \quad (3.13)$$
$$+ (1-d)\cdot MV(t)\cdot\left(\sum_{i=0}^{(i+1)\cdot E(N)+X<el}\left[\frac{1+E(m)}{1+r}\right]^{i\cdot E(N)}-1\right) + EV\cdot\frac{(1+E(dEV))^{el}}{(1+r)^{el}},$$

Where *el* is the remaining economic lifespan of the dwelling at time *t*, *EV* the end value of the dwelling, and *E(dEV)* the expected price development of the end value. The end value could be positive (with sale at the free market) or negative (in case of renovation or demolishment). In this formula, we assume that the dwelling is not resold when the remaining expected economic lifespan is shorter than *X* years (for instance: 5 or 10 years). The potential costs and risks around the end of the economic life of a dwelling can have a large impact on the value of a *Koopgarant* dwelling (see for instance Gruis *et al* (2005)). Housing associations should therefore pay careful attention to this issue.

For the option B cases, using the probability distribution of the time to buy back will become too complex. No closed form formulas exist. Like with formulas (3.7) and (3.8), an alternative would be to use Monte Carlo simulation for valuation purposes, in which case a large number of random drawings from the probability distribution of the time to buy back would be used to value the contract.

For **option C** (let after buy back), the present value can be calculated similar to formula (3.10), where the market value at time of resale is replaced for the present value of letting:

$$PV(t) = (1+r)^{-E(N)} \cdot \Big((d+s-1) \cdot MV(0) - s \cdot MV(t) \cdot (1+E(m))^{E(N)} + PV_{let}(t+E(N))\Big), \tag{3.14}$$

Of course, the present value of letting $PV_{let}(t)$ strongly depends upon assumptions with respect to the rent etc. As $PV_{let}()$ will depend on the year of buy back, no simple equivalent of formula (3.11) exists for this case.

Measuring financial risk of innovative social sales programs

The future is uncertain. A net present value valuation is based on many assumptions. A housing association runs a risk as the realizations can (and will) differ from the assumptions. There are several reasons why the realization can differ from the expectation. For the innovative social sales programs discussed in this paper, important risk factors are:

a. Development of the house price index;
b. Development of the consumer price index (for *Koop Goedkoop*);
c. Time to buy back or resale.

In this section, we analyze the sensitivity of the valuations for changes in these external parameters. To do this, we use the Monte Carlo simulation tool WALS (housing association asset liability scenario system). That is, we model economical risks by means of scenarios. Monte Carlo simulation is based on historic data sets of economic parameters like interest rates, price inflation and house prices. From these historic data sets, statistical characteristics are extracted like standard deviations and (auto-) correlations. By Monte Carlo simulation a large number of scenarios are generated with the same statistical characteristics as the historic data set. For each of these economic scenarios the net present value is calculated for the formulas in the previous section. In this way, a "cloud" of possible outcomes is generated around the expected value. The spread of this cloud represents the sensitivity for economic parameters. Furthermore, as all scenarios are equally likely we can extract a probability distribution from a scenario cloud. This probability distribution gives the likelihood of a certain value given the economic uncertainties. For a more extensive description of WALS, see Kramer and Van Welie (2001).

To show the sensitivity of the different social sales programs for abovementioned risk factors, we calculate the value of the different programs for one single dwelling with the following characteristics:

- Market value at time of initial sale: € 200,000;
- Initial discount: 30% for all types;
- 50-50 profit / loss sharing *Koopgarant*;
- Expected price inflation: 2%;
- Discount rate: 6%;
- No transaction costs.

We use a standard initial discount of 30% to make the different programs comparable. *Koop Goedkoop* has a standard initial discount of 30%. We calculate the expected value and the 90% confidence interval at the time of initial sale including the initial sales price of € 140,000. For the programs and models that assume infinite life, the 90% confidence intervals are based on 50 years of uncertainty.

For the expected time to resale, we use two cases: 8 years and 14 years. These are the same values as used by Conijn & Schweitzer (2000), and are the average number of years Dutch households stay in their owner-occupied dwelling in the 1990s. For single family homes this was 14 years and for multi family homes 8 years. Recently (i.e., 20 August 2008), the

Dutch Association of Real Estate Brokers and Real Estate Experts (NVM) issued a press release stating that this average has increased to 25 years for single family homes, while 8 years remained the average for multi family homes.

For the expected house price increase, we also use two values: 2% and 4%. The NVM expects house prices in 2008 to increase by 2% compared to 2007. The Rabobank (2008) recently lowered its expectation to 2.5% for 2008 and 2009. From 2003 to 2007, Dutch house prices have increased by around 4% on average.

We look at five different social sales types:

a. *Sociale Koop* – formula (3.3');
b. *Koop Goedkoop* model A (repeated discount) – formula (3.7);
c. *Koop Goedkoop* model B (no discount 2nd buyer) – formula (3.8);
d. *Koopgarant* model A (resale against market value) – formula (3.11);
e. *Koopgarant* model B (continue *Koopgarant*) – formula (3.12).

These five examples are chosen because they are not sensitive to arbitrary assumptions with respect to the expected remaining economic lifespan. The results are summarized in figures 4.1 to 4.4. The numerical results are presented in Appendix B.

From figures 4.1 to 4.4 we can deduce a number of interesting findings. First of all, for ***Sociale Koop*** the expected value lies 4% to 11% below the free market value (in essence, the free market value is used for current valuation of this type of sale). For an expected time to resale of 25 years, this difference would be even larger. *Sociale Koop* has a relatively small range, which indicates relatively low uncertainty for this type. However, this low uncertainty also means low upside potential. A shorter expected time to resale means less uncertainty and a higher present value. A lower expected house price increase means less uncertainty and a lower present value.

A striking conclusion for ***Koop Goedkoop*** is that, at least under the current assumptions, the ground rent appears to be too high. For all cases, the expected present value for **model B** is above the free market value of € 200,000, even in spite of the discount on market ground rent in the first 10 years of the contract. With an expected house price increase of 4%, the expected value is more than 30% above the free market value, and even the 95% certain value (i.e., the downside) is above the free market value. For an expected house price increase of 2% the difference is less pronounced, but still positive. *Koop Goedkoop* model B is the most profitable type from a housing association perspective, as the downside, average and upside is the highest of all types for all cases.

Figure 4. 1: 90% confidence intervals for 14 year expected time until resale; expected house price increase 4%

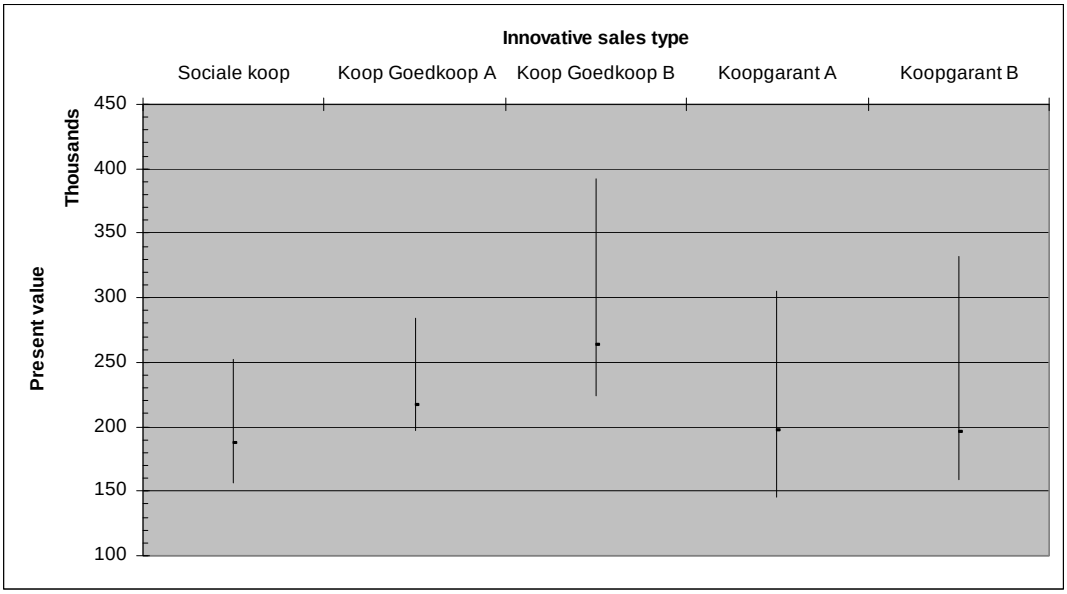


Figure 4. 2: 90% confidence intervals for 8 year expected time until resale Expected house price increase 4%

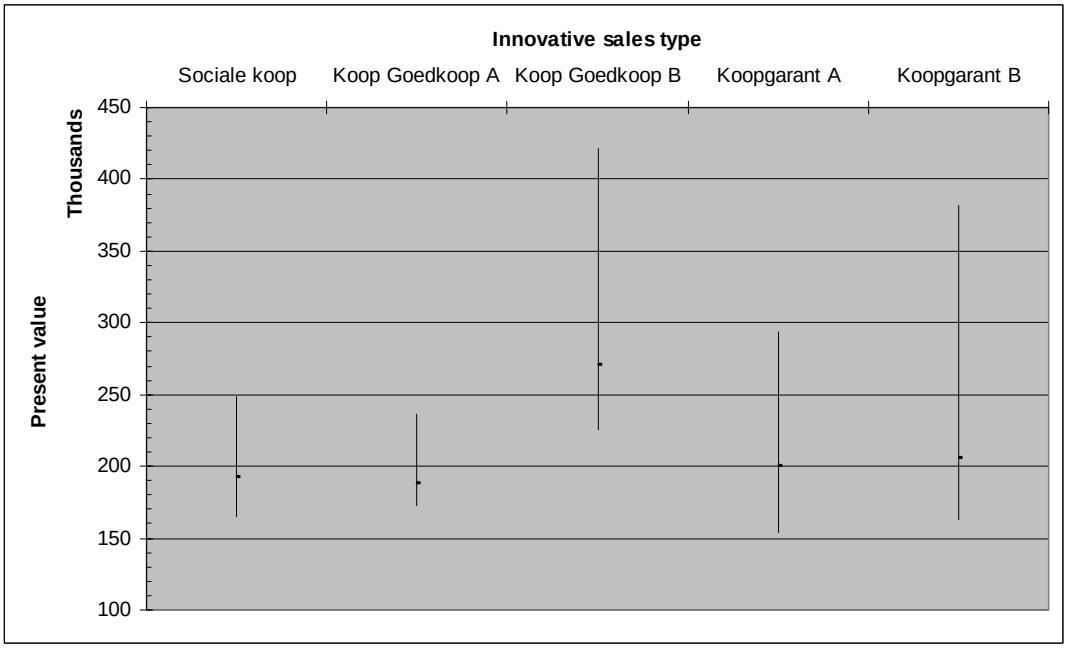


Figure 4. 3: 90% confidence intervals for 14 year expected time until resale
Expected house price increase 2%

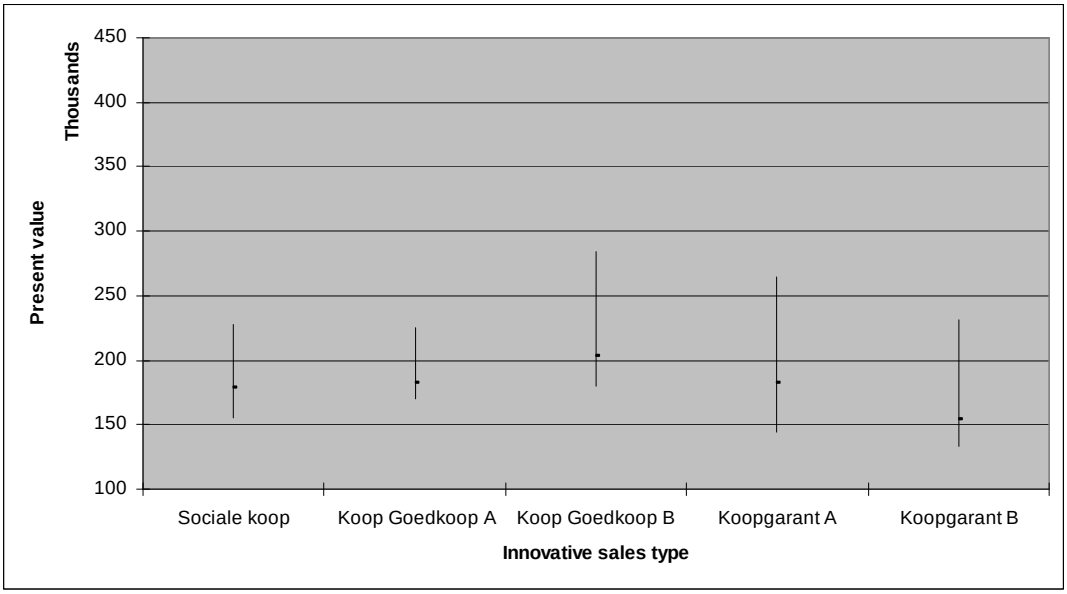
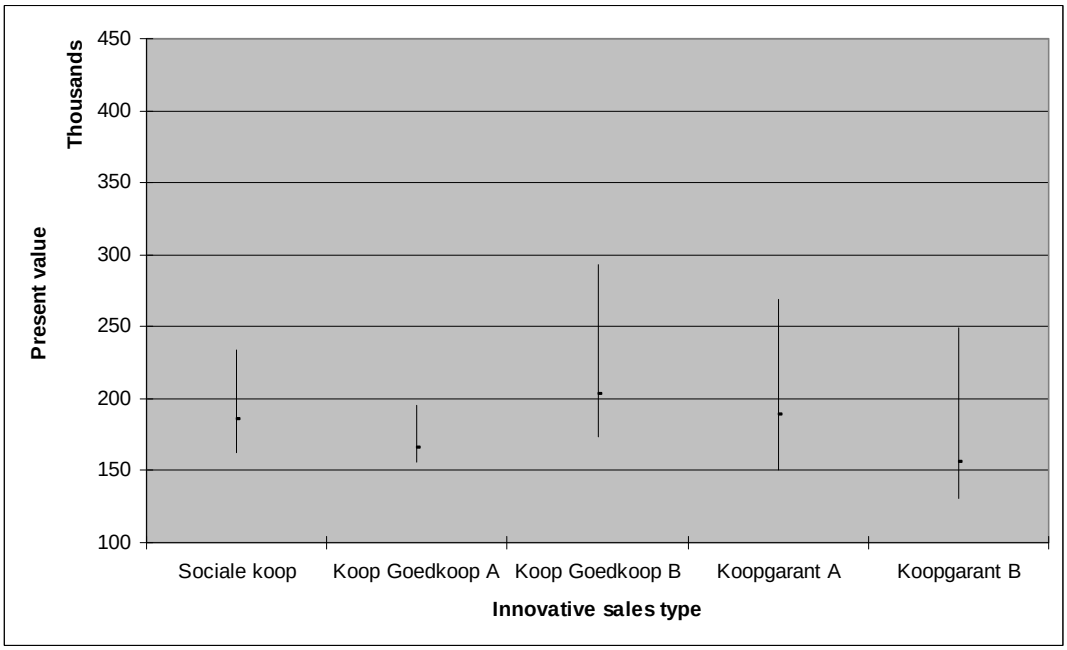


Figure 4. 4: 90% confidence intervals for 8 year expected time until resale
Expected house price increase 2%



***Koop Goedkoop* model A** only has a present value above the free market value for a high expected house price increase and long expected time to resale (see figure 4.1). In all other cases, the expected present value lies below the free market value. So whether current valuation practice (value against free market value) leads to an over- or underestimation depends on the assumptions. This in contrast to *Sociale Koop*, where the current valuation practice always leads to overvaluation of the value of the claim. *Koop Goedkoop* model A has the smallest range and the lowest standard deviation for all cases. Furthermore, it has the lowest upside potential with a 2% expected house price increase.

We can deduce the following general rules for *Koop Goedkoop*. Shorter expected time to resale means more uncertainty and a higher present value for model B but a lower present value for model A (due to the repeated discount on ground rent). A lower expected house price increase or lower expected price inflation means less uncertainty and a lower present value. The expected house price increase has more influence than price inflation.

For low expected house price increases, ***Koopgarant* model B** (continue *Koopgarant* after resale) has the lowest expected value of all types and the highest downside risk (i.e., the lowest 95% certain value or downside value). The downside value is even below € 140,000. In those cases, the housing association looses on the buy back and resale. This happens in scenarios with falling house prices and thus loss sharing. When we would have included transaction costs at the time of buy back, the outcome would be even more negative. As only *Koopgarant* includes an obligatory buy back at turnover, transaction costs will be higher with this type than with other types of sale. Furthermore, *Koopgarant* model B has the largest ranges of outcomes with high expected house price increases (see also tables B.1 and B.2 in Appendix B), due to repetitive profit and loss sharing.

***Koopgarant* model A** has the highest downside risk with 14 years expected time to buy back and a 4% expected yearly house price increase. Furthermore, it is the most uncertain type with a 2% expected yearly house price increase (i.e., largest range of outcomes).

Finally, we can deduce the following relationships for *Koopgarant*: a shorter expected time to resale leads to more uncertainty for model B and to less uncertainty for model A, and a higher present value for both models. Lower expected house price increases lead to less uncertainty and lower present values.

4. Conclusions

In this paper we have discussed valuation and risk issues related to three innovative social sales programs that have been introduced by Dutch housing associations: *Sociale Koop*, *Koop Goedkoop* and *Koopgarant*. These innovative types of sale have in common that a house is sold to the tenant at a discount. The types differ in the conditions under which the house is sold. Therefore, even if the discount is the same, the value and the risk for the housing association differ. Based on the valuation formulas we have proposed, and on the Monte Carlo simulations we have performed to establish the risk of each type, we can draw a number of conclusions.

For *Sociale Koop*, the current valuation practice overestimates the value of the claim. Furthermore, the sensitivity to economic risk factors is much lower than for the other two types discussed, except *Koop Goedkoop* model A. However, in contrast to the other two social sales types, the housing associations can suffer a loss when the buyer defaults at the time of resale. After all, this is the only type where the buyer has to pay the housing association at turnover. Default is mainly a risk in case of a high discount. These are usually also the buyers with the least favorable financial position. From a buyer perspective, *Sociale Koop* is the cheapest social type of sale when prices rise[6].

For *Koop Goedkoop*, the present value of a 5% ground rent without discount exceeds the market value of the land for common values for the discount rate and expected value increases. The present value of a *Koop Goedkoop* contract is strongly influenced by the type of model chosen and by the expected turnover rate. For a short expected time to resale (i.e. a high turnover rate), *Koop Goedkoop* model A is not very profitable. It has the smallest range and lowest standard deviation, though. Finally, it can be easily deduced that *Koop Goedkoop* is the most expensive type for buyers, and therefore the least interesting.

Continuing *Koopgarant* after resale carries the highest risk of the three social sales types discussed here. Furthermore, for low expected house price increases this type is also the worst performing type for housing associations. When we include transaction costs, the relative performance of *Koopgarant* will worsen further as this is the only type with a buy back obligation. *Koopgarant* is the cheapest social sales type from a buyer perspective when house prices fall, due to the loss sharing mechanism. When house prices are expected to remain stable, *Koopgarant* is comparable to *Sociale Koop* from a buyer perspective.

From a buyer perspective, we do not expect *Koop Goedkoop* to become a success. It is financially the least interesting innovative type of sale. *Sociale Koop* is much more interesting for a buyer, and we would therefore expect a larger probability of success. Finally, *Koopgarant* is the oldest type with by far the largest sales volume so far. Its loss sharing part can be interesting for potential buyers in the current difficult housing market.

[6] Compared to *Koopgarant* with the same discount and a 50% profit share. This rule is not shown in this paper, but can be easily deduced. For details, contact the author.

Appendix A: Derivation of valuation formulas

A.1 Formula (3.3')

Derivation of this formula is similar to that of the Gordon Growth model for the valuation of equities.

Formula (3.3) can be rewritten as:

$$PV(t) = \frac{V(t)\cdot p}{1-p}\cdot\left\{\sum_{i=0}^{\infty}\left[\frac{(1-p)(1+E(m))}{1+r}\right]^{i} - 1\right\}, \qquad \text{(A.1)}$$

The following holds:

$$(1-a)\cdot(1+a+...+a^{n}) = 1-a^{n+1} \Leftrightarrow$$

$$\sum_{i=0}^{n} a^{i} = \frac{1-a^{n+1}}{1-a},$$

$$if\,(a<1) \Rightarrow \lim_{n\to\infty} a^{n+1} = 0 \Rightarrow \sum_{i=0}^{\infty} a^{i} = \frac{1}{1-a},$$

If we use this in formula (A.1), we get:

$$a = \frac{(1-p)(1+E(m))}{1+r},$$

$$PV(t) = \frac{V(t)\cdot p}{1-p}\cdot\left\{\frac{1}{1-a} - 1\right\} = \frac{V(t)\cdot p}{1-p}\cdot\frac{a}{1-a} = \frac{V(t)\cdot p}{1-p}\cdot(a^{-1}-1)^{-1},$$

This is equal to formula (3.3').

A.2 Formula (3.7)

This derivation is similar to the previous one. That is:

$$a = \frac{1+E(m)}{1+r},$$

$$PV(0) = (1+a^{E(N)}+a^{2E(N)}+...)\cdot PV_1(0) = \sum_{i=0}^{\infty} a^{iE(N)} PV_1(0),$$

$$(1-a^{N})(1+a^{N}+....+a^{nN}) = 1-a^{N(n+1)} \Leftrightarrow$$

$$\sum_{t=0}^{n} a^{tN} = \frac{1-a^{N(n+1)}}{1-a^{N}} = \frac{a^{-N}-a^{n+1}}{a^{-N}-1},$$

$$if\,(a<1) \Rightarrow \lim_{n\to\infty} a^{n+1} = 0 \Rightarrow \sum_{t=0}^{\infty} a^{tN} = \frac{a^{-N}}{a^{-N}-1} \Rightarrow$$

$$PV(0) = \left(\frac{a^{-E(N)}}{a^{-E(N)}-1}\right)\cdot PV_1(0) = (1-a^{E(N)})^{-1}\cdot PV_1(0).$$

Appendix B: Numerical results section 4

B. 1 Numerical results for Figure 4.1

14 years / 4%	*downside*	*average*	*upside*	*range*	*std. dev.*
Sociale koop	156,414	187,273	252,096	95,681	34,400
Koop Goedkoop A	196,628	216,089	283,714	87,085	30,391
Koop Goedkoop B	224,514	263,017	392,460	167,946	62,855
Koopgarant A	145,618	197,049	305,087	159,469	57,333
Koopgarant B	159,093	195,301	332,250	173,157	88,162

B. 2 Numerical results for Figure 4.2

8 years / 4%	*downside*	*average*	*upside*	*range*	*std. dev.*
Sociale koop	164,765	192,000	248,293	83,527	24,689
Koop Goedkoop A	172,905	187,731	236,822	63,917	23,783
Koop Goedkoop B	225,253	271,003	421,523	196,270	77,826
Koopgarant A	154,249	199,640	293,461	139,212	41,149
Koopgarant B	162,897	205,442	381,372	218,475	106,349

B. 3 Numerical results for Figure 4.3

14 years / 2%	*downside*	*average*	*upside*	*range*	*std. dev*
Sociale koop	155,221	178,734	228,127	72,906	26,212
Koop Goedkoop A	169,455	182,774	225,793	56,338	18,392
Koop Goedkoop B	179,615	202,875	284,536	104,921	36,393
Koopgarant A	143,629	182,818	265,139	121,510	43,686
Koopgarant B	132,912	153,574	231,779	98,867	41,661

B. 4 Numerical results for Figure 4.4

8 years / 2%	*downside*	*average*	*upside*	*range*	*std. dev*
Sociale koop	162,356	185,672	233,865	71,510	21,137
Koop Goedkoop A	155,716	165,469	195,119	39,403	14,042
Koop Goedkoop B	173,437	203,510	293,111	119,674	44,618
Koopgarant A	150,232	189,092	269,415	119,183	35,228
Koopgarant B	130,495	156,264	248,772	118,277	50,195

.. *years*: expected time to resale;
..*%*: expected yearly house price increase;
Upside: 5% probability of a value higher than this value;
Downside: 5% probability of a value lower than this value;
Range: upside – downside;
Std. dev.: standard deviation
Yellow: highest upside / downside / average; smallest range;
Red: lowest upside / downside / average; largest range.

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