EQUITY RELEASE REPORT 2005

EQUITY RELEASE WORKING PARTY

THE ACTUARIAL PROFESSION'

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PRICING CONSIDERATIONS

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Contents

1 Introduction

Pricing and capital considerations for home equity release mechanisms (ERMs) cover a wide range of complex actuarial issues. Aside from the more obvious demographic assumptions, which are themselves far from straightforward to set, it is also necessary to consider economic factors such as the no-negative-equity guarantee (NNEG) risk in the case of lifetime mortgages, house-price inflation (HPI) risk in the case of home reversions and, possibly, interest-rate risk on the funding obtained. In addition, there are product development, distribution and maintenance expense considerations.

For any product offering and product provider, the relative importance of these respective considerations may differ materially.

The target market for the ERM product will have a significant bearing on the eventual experience. For all but the largest of providers, credible past experience will be very hard to obtain and will still be relatively select. Even for such providers, the relevance of past experience, obtained in a rapidly expanding market, as a sound basis for current pricing and reserving must be considered carefully. As the ERM market grows and embraces a broader base of homeowners, possibly transforming itself from being a product of last resort to a life-style maintainer, the underlying experience may change considerably. Changes to sales processes and increasing regulation will no doubt also impact on future experience.

This lack of a solid basis upon which to set the pricing assumptions should lead product providers to back such risks with commensurately high capital allocations that, in turn, will need servicing at the appropriate rate. ERM products may hence appear costly relative to other, better understood (from a provider perspective) and hence finely priced, financial products. An increase in the number of providers may put pressure on product margins. However, it seems difficult to see how these wide margins for uncertainty will be eliminated until the risks are better understood or products are redesigned to pass more of the difficult to quantify, hedge or manage risks back to the customer. Any such redesign would obviously have to be within the context of having to provide secure products to a vulnerable market, and is not considered further in this supplement.

2 Overview of risks associated with ERM products

ERMs expose the product providers to a range of risks. The key financial risks amongst these are:

- Demographic risks - covering longevity, long-term care (LTC) entry and other miscellaneous reasons for early redemption or pre-payment;
- Market risks – including interest-rate risk, the NNEG risk on lifetime mortgages and HPI risk on home reversions; and
- Expense-related risks – the need to cover product development costs and to live within the pricing expense-margins.

ERM products may well be assembled by a combination of manufacturers each taking on the specific risks in which they have relative expertise. An end-product may, for example, see a life insurer or reinsurer taking the demographic risks, a building society or mortgage lender providing funding, an investment bank taking the interest-rate risk, an insurer taking the NNEG risk and a business originator taking much of the expense risk. Likewise, securitisation vehicles may place different risks – or different levels of risks – with different categories of bondholders, possibly supported by some direct risk placement. The relative importance of the various risks will therefore differ between the constituent manufacturers of the product.

The nature of these risks is overviewed below. We have restricted ourselves to considering these issues from the perspective of a subset of ERM products, namely, Rollup Mortgages, Fixed-Repayment Mortgages and Home Reversions.

Inevitably, any business venture will also expose providers to business and operational risks (eg. mis-selling and legal risks). We do not consider these explicitly, though the amount of capital set aside and profit targets will need to recognise such risks, if only in a fairly broad-brush manner.

2.1 Demographic Risks

2.1.1 Longevity Risk

Death of the homeowner or, in the case of joint homeowners, the last to die, is the dominant cause of repayment of the mortgage. (In the case of home reversions, death results in the reversion of the relevant share of the property to the provider.) The nature of the mortality risk run by the provider differs depending on the actual ERM product.

Reversions and fixed-repayment lifetime mortgages expose the product provider to the risk of people living too long. This is because the provider will have priced the product assuming a certain profile of mortgage repayments (or property reversions). To the extent that people exit their homes later than expected, which will occur mainly as a result of greater than expected longevity, the provider will receive his repayments later than expected, thereby adversely impacting profitability (whilst possibly also being faced with refinancing expenses). It should be noted that in the case of reversions, the unit of currency should be viewed as being the portion of the home, rather than a monetary amount.

Rollup mortgages expose the product provider(s) both to people dying too soon and, depending on loan to value ratios, to people living longer than expected. The early-death risk, which falls to the party providing the longevity cover, arises because, in the absence of favourable interest-rate movements, the rate of rollup of the mortgage exceeds the amount that can be earned on the redemption proceeds. Hence, if redemption proceeds are received earlier than expected, there is a yield shortfall on the funds received compared to the rate of rollup on the expected profile of repayments. There is also likely to be a shortfall in recouped costs. On the other hand, excess longevity may result in refinancing costs and will effectively increase the cost of the NNEG to the party taking this risk (see Section 2.2). Countering these longevity costs, however, is the beneficial impact of the extra interest-rate margin earned on the mortgages for a longer period.

2.1.2 Long Term Care

The second most prevalent trigger for repayment of the mortgage (or, in the case of home reversions, reversion of the relevant share of the property to the provider) involves the homeowner or, in the case of joint homeowners, the survivor, moving into long-term care. There is usually a grace period before any move into care is viewed as being "permanent".

The nature of the provider's exposure to LTC risk is similar to that of longevity risk.

2.1.3 Early Redemptions/Pre-payments

Borrowers may repay their mortgages for a host of other reasons. These include changes in personal circumstances such as moving in with relatives, moving into rented accommodation, moving to ineligible properties (eg. properties with short leaseholds, property abroad, certain types of sheltered accommodation) or as a result of favourable changes to the borrower's financial circumstances. In all but the latter situation, the borrower will be contractually obliged to repay the loan.

The mortgage could also be repaid as a result of the borrower remortgaging to a more attractive product. Remortgaging exposes providers of rollup mortgages to a significant risk of anti-selection as remortgaging is most likely to occur following a decline in interest rates. Providers may only be able to partially mitigate such exposures through the use of early-surrender penalties.

Of the products being considered in this supplement, voluntary early redemption is only likely to be attractive from the borrower's perspective in the case of rollup mortgages.

Partial repayments may occur when people move to smaller properties or if they partially redeem their mortgages for other reasons.

2.2 No Negative Equity Guarantee (NNEG) and House Price Inflation (HPI)

Almost all ERM mortgage products now include a NNEG. Indeed this is a prerequisite for SHIP membership.

Under rollup mortgages, the provider has effectively written (i.e. sold) a series of put options on the underlying property. These options have successively increasing strike prices (being the rolled-up mortgage amount at various future points in time). In general, the risk (and hence the cost of these options) increases the longer the expected term of the mortgage, both because of the longer term of the option itself and the fact that the strike price of each successive option increases at a rate (the rollup rate) greater than the risk-free rate (and hence each put option is progressively becoming less out of the money).

Under fixed-repayment mortgages, a series of put options is again provided, but as the strike price (i.e. the fixed amount of mortgage repayable) does not increase with increasing term, the cost of the option does not necessarily increase with increasing term. The actual impact will depend on the interaction between the assumed (term structure of) house-price volatility and the (term structure of) risk-free rates.

In the case of home-reversion products, the provider takes direct domestic property investment risk and the concept of the NNEG does hence not arise. Whilst this kind of investment has historically provided good returns, particularly in recent years, it needs to be remembered that house prices, like equities, can go both up and down. A provider taking HPI risk will need to ensure that it can survive a downturn in the property market, either by having an appropriate capital structure or by having in place appropriate hedging and/or diversification measures. The risks are exacerbated by the illiquidity of the property investments themselves, although there is a small secondary market for reversions.

2.3 Interest-Rate Risk

Most lifetime mortgage products leave the borrower with a fixed rate of interest obligation (either explicit or implicit). The provider's cost of funding, however, may be expressed either in terms of fixed or variable rates. In the case of the latter, steps are likely to be necessary to manage the interest-rate risk, usually by entering into an interest-rate swap.

Reversion products can leave the provider with an additional property-risk mismatch to manage, if its own funding costs are expressed in nominal money terms.

2.4 Expenses

The expenses involved in bringing an ERM product to market can be considerable, especially if funds are being raised through securitisations, or if a structured risk approach is being taken, necessitating complicated multi-party legal agreements to be negotiated.

In addition to fixed expenses, each mortgage or reversion will generate direct acquisition expenses and ongoing administrative expenses. The latter will generally be relatively low, provided that the administrator has an efficient method for establishing continued home occupation by the legitimate occupier and that ongoing property insurance is being maintained. This would typically be performed annually. From time to time it may be necessary to inspect the property and/or to perform a valuation.

When the homeowner eventually exits his home, there will be some additional activity. Market practice appears to vary as to whether the expenses of the property sale and any other expenses incurred directly in relation to the sale (e.g. legal fees) are deducted from the proceeds of the property itself (which could have a knock-on impact on the cost of the NNEG in the case of lifetime mortgages) or whether such expenses remain the responsibility of the estate and therefore do not impact the NNEG.

Reversions tend to be somewhat more expensive to administer than mortgages, from inception of the arrangement, all the way through to the eventual sale of the property.

Finally, there will be the ongoing accounting and actuarial expenses involved in running a well managed portfolio.

For startup operations in particular, there will always be a risk that the business will not grow to a critical mass, leaving the providers with a potentially significant expense overrun and a small block of business to run off or sell.

3 Setting Central Assumptions

As there is no publicly available data on decrement experience for ERMs, the approach taken in this supplement has been to derive a basis from first principles using an actuarial approach. We consider how one might go about setting central assumptions for base mortality and for mortality improvements, for base LTC-entry rates and future trends, for early redemptions/pre-payments and where relevant, for the cost of the NNEG. We conclude, in Section 4, with a few remarks on reserving and risk-based capital.

Whilst we believe that the approach that we have adopted is a fairly generic one, readers would need to consider whether our individual assumptions are necessarily appropriate for their specific circumstances.

3.1 Base Mortality

As explained in Section 2.1.1, ERMs generally expose the product provider to the risk of people living too long (the exception being the early years under rollup mortgages, where too many early deaths are a concern). ERM clients are generally older clients, with an average age at entry of around 65 to 75 years. We therefore approach the setting of the mortality assumption in a similar manner to that in which actuaries might attempt to set this assumption for a voluntary-purchase annuity portfolio consisting of older lives. Our population will be assumed to consist of homeowners who are generally “asset-rich” but “cash-poor”.

Unlike the position with annuities where people only leave the population as a result of death, people exit the ERM population as a result of death, entry into LTC and through pre-payment of the ERM for other reasons. Those entering LTC are likely to be in an inferior state of health to those who continue living at home. Consequently, the observed mortality of those living at home (which we will refer to as “at-home mortality”) is likely to be lighter than the annuity-style mortality that would be experienced by the same group of lives, as annuitant mortality includes the combination of the relatively lighter at-home mortality and the relatively heavier mortality of those who have moved into care. We will, however, set the mortality assumption ignoring LTC considerations. The impact of LTC entry and the extra mortality experienced by those in care, on residual at-home mortality, will be considered when setting the residential LTC-entry assumption.

For all but the largest providers, the setting of the base mortality assumption (and indeed most of the other assumptions too, if not more so), will be something of a speculative exercise as there will be no (or possibly only very little) directly relevant and credible past experience to use as a guide. Even for the largest players, their existing experience may be of only limited use, given that it will still be fairly select, is probably growing rapidly and may reflect a different customer profile compared to that of prospective customers.

A key consideration will be the target market for the product, which will include such factors as:

- geographical distribution of business
- lending criteria (i.e. property value/characteristics)
- distribution method.

There are of course, no mortality tables specifically for ERM customers. Whilst there are a number of tables for annuitants in the 92-series mortality tables (CMIR, 1998 and 1999), namely, for life-office pensioners (the PM/FA and PM/FL tables), for immediate annuitants (the IM/FA and IM/FL tables) and for retirement annuitants (the RM/FV tables), none are obviously suitable (without adjustment) for the ERM population. Only the immediate-annuitants tables reflect the voluntary (as opposed to compulsory) nature of the contract.

Figures 3.1 (males) and 3.2 (females) compare mortality rates for the pensioner lives and amounts tables, the retirement annuitants lives tables and the immediate annuitants lives and amounts tables, to population mortality for England and Wales. To avoid clouding the issue with respect to the impact of mortality improvements since the graduation of the 92-series tables, the comparison is performed on the end-1992 mortality rates, which were based on data over the four-year period 1991 to 1994. The ELT15 population table (ONS, 1997) has been used, but as this was based on data for the period 1990 to 1992, the mortality rates have been "improved" for one and a half years to align them with the 92-series rates. Details of the improvement factors and the adjusted ELT15 mortality rates are shown in Appendix 1.

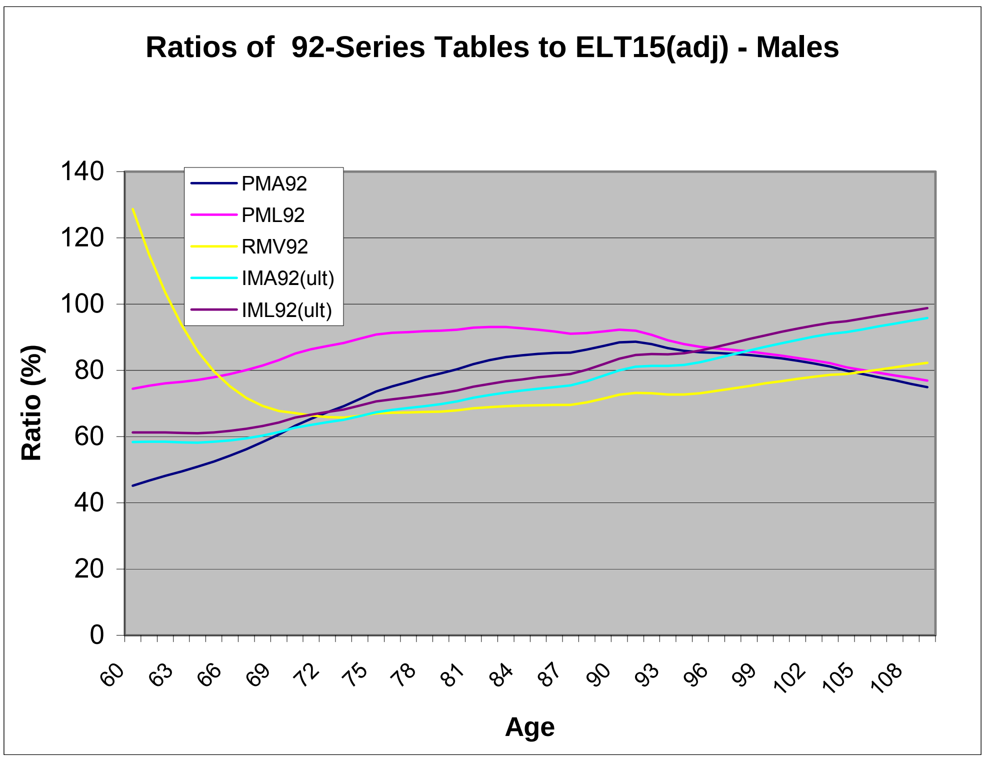

Figure 3.1. Comparison of mortality rates from 92-series tables against ELT15 (advanced to end-1992) – males

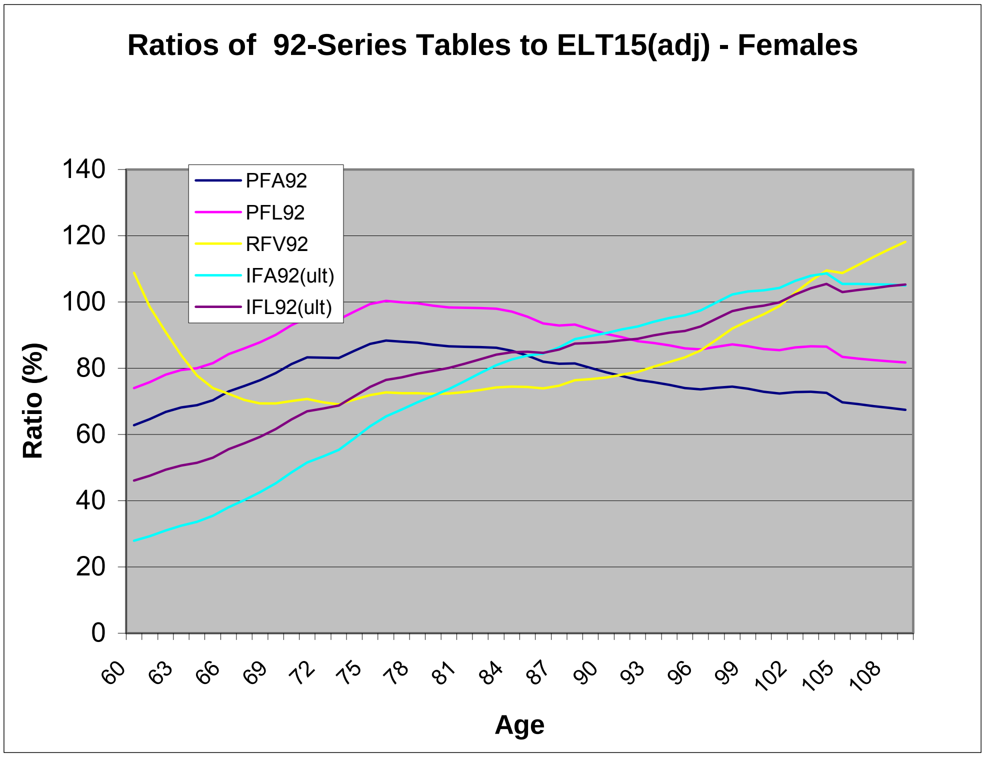

Figure 3.2. Comparison of mortality rates from 92-series tables against ELT15 (advanced to end-1992) – females

Tables 3.1 and 3.2 show the numbers behind Figures 3.1 and 3.2 for specimen ages.

Age	PMA92	PML92	RMV92	IMA92(ult)	IML92(ult)
60	45.2	74.5	128.8	58.4	61.2
65	52.5	77.9	79.8	58.4	61.3
70	63.3	85.1	67.0	62.7	65.7
75	73.6	90.8	67.0	67.4	70.6
80	80.4	92.3	67.9	70.6	73.9
85	85.0	92.3	69.5	74.4	77.9
90	88.5	92.3	72.6	80.0	83.6
95	85.5	87.1	73.1	82.5	86.0
100	83.6	84.5	76.7	88.2	91.6
105	78.9	80.1	79.6	92.4	95.6
109	74.9	76.9	82.3	95.8	98.8

Table 3.1. Comparison of mortality rates from 92-series tables against ELT15 (advanced to end-1992) – males (percentages).

Age	PFA92	PFL92	RFV92	IFA92(ult)	IFL92(ult)
60	62.8	74.0	108.8	27.9	46.1
65	70.4	81.5	74.0	35.5	53.0
70	81.3	93.0	70.1	48.6	64.6
75	87.4	99.3	71.9	62.5	74.4
80	86.6	98.4	72.4	73.7	80.1
85	83.9	95.6	74.3	83.8	85.0
90	78.7	90.4	77.2	90.6	87.9
95	74.0	86.0	83.3	96.0	91.3
100	72.9	85.8	96.3	103.5	98.9
105	69.8	83.4	108.7	105.5	103.0
109	67.5	81.7	118.2	105.0	105.3

Table 3.2. Comparison of mortality rates from 92-series tables against ELT15 (advanced to end-1992) – females (percentages).

Tables 3.1 and 3.2 (and the corresponding graphs) highlight a somewhat counterintuitive relationship between the pensioner mortality tables (the “P” tables) and the population tables at the advanced ages. The mortality differential between these respective tables and population mortality increases with advancing age, whereas one might have expected the differential to narrow, given the increasing degree of homogeneity in the population with increasing age. This feature probably reflects the manner in which the 92-series tables were graduated and in particular, the manner in which the mortality rates at the older ages were set, given the lack of credible life-office pensioner experience. For further information see CMIR16 (CMIR, 1998). (As we observe below, estimating population mortality at the very old ages is itself not straightforward.)

Aside from the advantage that they reflect voluntary-purchase arrangements, the male immediate annuity tables also appear to exhibit a more “satisfying” relationship to ELT15 across the age spectrum. Admittedly, the lives versus amounts differential for the male immediate annuity tables, does appear to be rather small compared to the differential under the pensioner tables for both males and females and compared to the lives-amounts differential for female immediate annuitants. The female immediate annuitant tables appear to look rather light relative to population mortality at the younger ages whilst appearing to be relatively too heavy at the very older ages.

The retirement annuitant tables (the “R” tables) are clearly influenced at the “younger” ages by the impact of the less select and impaired lives.

All the above mortality tables suffer from a lack of a credible body of data at the older ages (90+). This is particularly the case for the tables based on life-office data, where the graduation formulae are generally anchored on data under age 90. (We understand that the CMI have had discussions regarding the approach to the setting of mortality rates at the extreme ages (given the lack of data) and it is therefore possible that the forthcoming “00”-series of tables will show more consistency with population mortality at the very old ages.)

Of course, for ERMs, as opposed to current life-office portfolios of annuities, the relative importance of the mortality rates at the older ages is far greater. Figure 3.3 compares expected payments under a simple annuity to the expected mortgage redemption proceeds recoveries (gross of any NNEG cap) under a rollup mortgage and a fixed-repayment mortgage respectively. In each case a female age 70 at commencement has been assumed and the cash flows have been scaled to be of broadly equal present value. The increased significance of older-age mortality under the ERM products is obvious. In practice the difference between annuity portfolios and ERM portfolios would be exacerbated by the fact that annuities, particularly pension annuities, commence at ages about 5 to 10 years younger than the ages at which ERM products tend to be taken out.

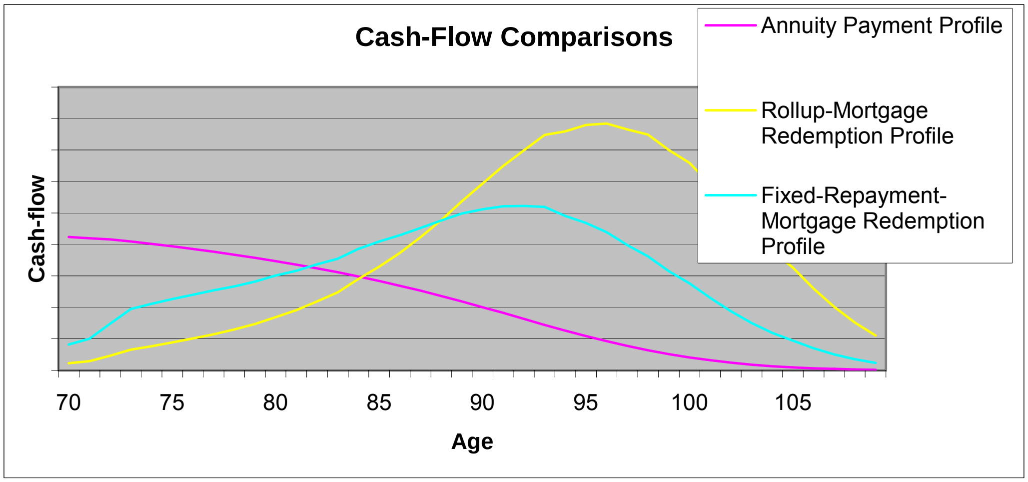

Figure 3.3 Comparison of cash-flows under an annuity and under ERM products

The added significance of mortality at the very old ages under ERM products, where the population tables are, we feel, somewhat more credible than the actuarial tables, leads us to take population mortality as our starting point for the purposes of setting a basis. We then adjust this downwards to take account of the lighter experience expected by the body of lives taking out ERMs, all of whom are, by definition, homeowners. (This adjustment does not take the impact of lives entering residential LTC into account. That is considered in Section 3.3.)

Given the "intuitively satisfying" relationship between IMA(ult) mortality and male population mortality over the range of ages of interest to us, our suggestion is to adjust both male and female population mortality downwards by the proportion that IMA(ult) mortality bears to male population mortality, as shown in Table 3.1. (For males, this effectively adjusts population mortality back to IMA(ult) mortality.) We would suggest that this is a reasonable starting point for products sold to individuals who are asset rich but cash poor and provided that the mix of business broadly reflects the population mix, both by geographical distribution and by marital status.

If the product is being sold to wealthier individuals as a life-style maintainer, additional deductions from population mortality would be appropriate.

The analysis thus far has been based as at the end of 1992. We need to transfer our end-1992 basis to a more contemporary basis. At the time of writing, the latest population tables available (from the Government Actuary's Department website) are the Interim Life Tables covering the period 2000 to 2002 (GAD, 2003a). These tables have been partially graduated, but only contain mortality rates up to age 100. We have extended these tables to age 109 such that the mortality rates at these extreme ages broadly reflect the shape under ELT15. When the new population tables (ELT16) are eventually published, a more up to date and fully graduated set of mortality rates, including mortality rates at the extreme ages, will be available.

Figure 3.4 compares the mortality in England and Wales, as per the Interim Life Tables for 2000-2002 to that of ELT15. For females in particular, it is, at first sight, a little puzzling that the more recent mortality at the extreme ages appears to be heavier than that of a decade earlier. Besides simply arising as a result of random mortality fluctuations, it could also have arisen as a result of the inherent difficulty in estimating the exposed-to-risk at the older ages (given that the ONS only publish aggregate population estimates above age 90) or as a result of the different approach taken to the graduation of mortality rates at the extreme ages. We have simply accepted the Interim Life Tables as exhibiting appropriate population mortality as at mid-2001.

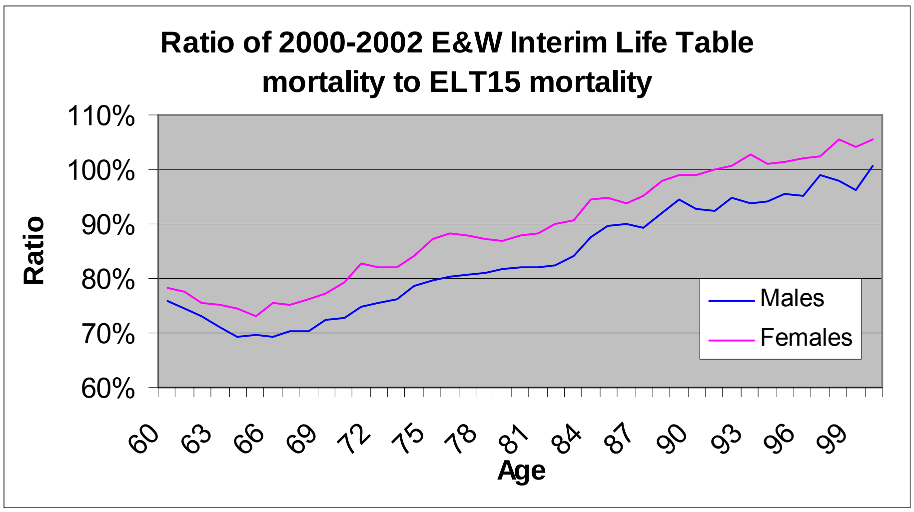

Figure 3.4 Comparison of Interim Life Table (2000-2002) mortality rates to ELT15 mortality rates

We suggested above how the population tables could be adjusted to make them appropriate for the ERM population. Those adjustments were assumed to be appropriate as at the end of 1992. Willets *et al* (2004) observe that mortality improvements for male assured lives appears to be on average 25% to 30% greater than that of the general population. They conjecture that a similar pattern may also underlie female assured-lives mortality. We therefore need to further adjust the previously derived ERM-population adjustments (as at the end of 1992) to allow for faster-than-population improvements for the 8½ years to mid-2001 (which is the central date of the 2000-2002 Interim Life Tables referred to above). If we assume that the ERM population enjoyed better-then-population mortality improvements, but less-than-insured-population improvements, say 15% on top of population improvements, one can, with several further simplifying assumptions, derive the following additional adjustments to mid-2001 population mortality:

Approximate average population mortality improvements, for the relevant ages, over the 8½ years to mid-2001:

Males – 2%pa

Females – 1.5%pa.

Accordingly, the additional proportional reduction to population mortality assuming that ERM-population mortality improvements are 115% of population mortality improvements for 8½ years is:

Males – 3%

Females – 2%.

The resultant base mortality tables, assumed applicable as at mid-2001, are set out in Appendix 2. These tables exclude the further suggested reduction to mortality in the event that a provider's ERM products are being sold as a life-style maintainer.

The rates derived above take no account of any select-ultimate mortality differential. One would expect ERM purchasers to be in better than average health initially. This will particularly be the case for those products where the client (or his estate) will suffer a large loss upon early death. Fixed-repayment mortgages and home-reversion products would therefore be most likely to exhibit strong self-selection effects, but one would also expect rollup mortgages to exhibit some, albeit reduced, self-selection effect.

We would suggest that the initial discounts to ERM base mortality, shown in Table 3.3, may be appropriate for those ERM products likely to exhibit strong self-select tendencies. This selection impact is greater than that contained in the 1-year select 92-series immediate-annuity tables (IM/IF), but less than that contained in the 5-year select temporary-assurance tables (TM/TF). Discounts of half this amount might be appropriate for the rollup-mortgage products.

Contract Year	Discount to base mortality rates (%)
1	45
2	30
3	15
4	5
5+	0

Table 3.3 Allowing for initial selection – discounts to base mortality

Given all the approximations involved, we have not created a set of ultimate mortality rates, being slightly higher than the base rates of mortality derived above (to reflect the impact of introducing a set of select factors).

3.2 Mortality Improvements

The prevalence of a cohort effect driving the pattern of mortality improvements seems now to be generally acknowledged. Willets *et al* (2004) observe that the cohort effect for both males and females in the England and Wales population is centred around a year of birth of 1931. This means that at the time of writing (2004), individuals taking out ERMs are riding (almost) on the crest of the cohort-effect wave, as typical ages at purchase are around 65 to 75.

Several models of mortality improvements incorporating the cohort effect are now available, including the short-, medium- and long- cohort models of the CMI (2003), the model developed by the Government Actuary's Department for the 2002-based national population projections for the United Kingdom (GAD, 2003b) and the two broad benchmark models illustrated by Willets *et al* (2004). Furthermore, it is understood that the CMI hope to issue an updated set of mortality improvement models in 2005.

As to what allowance for future mortality improvements to make is largely a matter of opinion. If the GAD model is used, it may be advisable to make an addition to the improvement factors, especially for males, as Willets *et al* (2004) observe that mortality improvements for male assured lives appears to be on average 25% to 30% greater than that of the general population. Male pensioner mortality improvements show an even greater differential. Willets *et al* hypothesise as to why such a feature is not readily apparent in the female experience, the implication being that it is present, but is being masked by changes in the mix within the female assured lives and pensioner populations.

For the purposes of this supplement, we have adopted an adjusted version of the aforementioned GAD model as our central mortality improvement basis. The adjustment that we have used is to load the year-on-year improvements by 15% in recognition of the fact that ERM customers are likely to be "better lives" than in the population generally, albeit that they may not be quite as affluent as the assured lives and pensioner populations. In addition, we hold mortality improvements constant beyond 2027. Specimen improvement factors are given in Appendix 3. It should be noted that the GAD model actually relates to central rates of mortality (m_x) rather than to initial rates of mortality (q_x). We have simply applied our adjusted GAD factors to the initial mortality rates and therefore slightly overstate the improvements relative to the theoretical intent of the GAD model.

3.3 LTC-Incidence Rates and residual At-home mortality

As a general rule, people moving into residential LTC will be less healthy than those remaining in their own homes. (In this supplement, when we refer to residential care, we include nursing care.) Consequently, the setting of parameters relating to residential LTC entry includes two facets, namely the determination of an appropriate set of LTC-incidence factors and the knock-on impact of care-entry incidence on the mortality of those remaining in their own homes, i.e. on "at-home" mortality. From an ERM pricing perspective, LTC incidence can be viewed as an addition to mortality (as derived in Section 3.1), whilst the impact of care incidence on at-home mortality (i.e. the healthier lives tend to remain in their homes) can be viewed as a reduction in that mortality.

The setting of LTC-incidence assumptions and the knock-on impact on at-home mortality requires a significant number of assumptions and simplifications to be made. However, as will be shown below, it would appear that the net LTC-entry impact is not nearly as significant as the mortality assumption and hence more approximate approaches are appropriate.

There are at least two possible approaches to setting the LTC impact, each requiring many assumptions to be made *en route*.

The first approach, the "disability-prevalence" driven approach, starts with population disability-prevalence information for different levels of disability. This is used to determine population disability incidence and transition rates. By making assumptions about the relationship between the level of disability and care-entry incidence rates for those living in their own homes, it would be possible to derive overall LTC-entry incidence rates for the at-home population.

The second approach, the "residential-LTC prevalence" driven approach, starts with population residential-LTC prevalence statistics and derives population residential-LTC incidence rates from this. These population LTC-incidence rates then need to be adjusted in recognition of the fact that those living in their own homes may tend to delay, or experience reduced, care entry relative to the population as a whole.

Whichever approach is adopted, a further reduction to the LTC incidence rates is necessary in order to take account of the fact that purchasers of ERMs are making a positive statement about their desire to remain in their own home as long as possible and are therefore probably less likely to enter LTC than an ordinary homeowner. This differential may wear off as time passes since taking out the ERM and may therefore best be handled as a select impact.

Both the disability-prevalence driven approach and the residential-LTC prevalence driven approach involve the making of a large number of assumptions, thereby reducing the degree of confidence that one may have in the output.

In this supplement we have adopted the residential-LTC prevalence driven approach, believing that the use of current, observed LTC-prevalence rates as a starting point gives one a slightly more stable platform from which to set the necessary parameters.

3.3.1 The residential-LTC prevalence driven approach

Step 1: Identifying current population residential-LTC prevalence

The first step in this approach is to identify the current prevalence of residential LTC amongst the population as a whole. Tables 3.4 and 3.5 set out details of people living in communal establishments in England and Wales, for males and females respectively, as obtained from the 2001 census (ONS, 2003). Also shown are the total population sizes. It is assumed that the care population of interest to us consists of those having a limiting long-term illness. In any event, at the older ages, such people make up the bulk of the residential population in communal establishments.

Age	All people resident in communal establishments (excluding staff and their families) (Source: Table S065 of census report)				Age by sex and resident type (Source: Table S001 of census report)		
	ALL PEOPLE	ALL PEOPLE: Limiting long-term illness	ALL PEOPLE: No limiting long-term illness		Total Population	All residents in communal establishments (incl. staff and their families)	% of Population with limiting long-term illness resident in communal establish-ments
55 – 59	8,543	6,555	1,988		1,466,976		0.45%
60 – 64	7,230	5,895	1,335		1,249,632		0.47%
65 – 69	7,803	6,594	1,209		1,100,967		0.60%
70 – 74	10,650	9,470	1,180		944,034		1.00%
75 – 79	15,452	14,232	1,220		733,119		1.94%
80 – 84	16,846	15,680	1,166		435,262		3.60%
85 – 89	17,296	16,137	1,159		205,152		7.87%
90 and over	13,354	12,413	941		75,669		16.40%
		(Approx.)					
90 - 94		9,481			62,275	11,329	15.22%
95 - 99		2,587			11,656	3,091	22.19%
100+		346			1,738	413	19.89%
		12,413			75,669	14,833	

Source: Office for National Statistics - Census 2001: National Report for England and Wales (HMSO 2003), own calculations.

Table 3.4. Total population and population in communal establishments – England and Wales, males.

	All people resident in communal establishments (excluding staff and their families) (Source: Table S065 of census report)			Age by sex and resident type (Source: Table S001 of census report)		
Age	ALL PEOPLE	ALL PEOPLE: Limiting long-term illness	ALL PEOPLE: No limiting long-term illness	Total Population	All residents in communal establishments (incl. staff and their families)	% of Population with limiting long-term illness resident in communal establish-ments
55 – 59	5,146	4,040	1,106	1,495,297		0.27%
60 – 64	5,275	4,407	868	1,295,122		0.34%
65 – 69	7,344	6,441	903	1,191,515		0.54%
70 – 74	14,257	12,976	1,281	1,130,516		1.15%
75 – 79	30,524	28,480	2,044	1,021,904		2.79%
80 – 84	50,428	47,284	3,144	743,052		6.36%
85 – 89	70,328	66,150	4,178	471,526		14.03%
90 and over	79,374	74,612	4,762	260,058		28.69%
		(Approx.)				
90 - 94		52,374		202,905	62,082	25.81%
95 - 99		19,192		50,331	22,749	38.13%
100+		3,046		6,822	3,611	44.65%
		74,612		260,058	88,442	

Source: Office for National Statistics - Census 2001: National Report for England and Wales (HMSO 2003), own calculations.

Table 3.5. Total population and population in communal establishments – England and Wales, females.

Of course, it does need to be recognised that current residential-LTC prevalence will be a function of current and recent trends in such factors as government policy regarding the funding of LTC and care in the community, the number of care homes, family attitudes and family structure.

Step 2: Deriving population residential-LTC incidence rates

Having derived population residential-LTC prevalence rates, the next step is to attempt to convert these into population residential-LTC incidence rates. This requires two key assumptions, namely (i) that of a stationary population and (ii) the amount of additional mortality experienced by those in LTC.

Additional mortality in LTC is significant. Rickayzen & Walsh (2002) suggest a model for extra mortality for different levels of OPCS (Office of Population, Censuses and Surveys) disability categories. Specimen, non gender-specific, values are shown in Table 3.6.

Age	OPCS Category				
	6	**7**	**8**	**9**	**10**
60	0.03	0.06	0.09	0.12	0.14
65	0.03	0.06	0.10	0.13	0.16
70	0.03	0.07	0.10	0.14	0.17
75	0.04	0.07	0.11	0.15	0.18
80	0.04	0.08	0.11	0.15	0.19
85	0.04	0.08	0.12	0.15	0.19
90	0.04	0.08	0.12	0.16	0.20
100	0.04	0.08	0.12	0.16	0.20
110	0.04	0.08	0.12	0.16	0.20

Source: Rickayzen & Walsh (includes some own calculations)

Table 3.6. Extra Mortality for different OPCS disability categories
(Rickayzen and Walsh model)

Nuttall *et al* (1994), classify those with OPCS disability categories 9 and 10 as having an ongoing LTC need, whilst Dullaway & Elliot (1998) observe that the failure of 3 out of 6 ADLs (Activities of Daily Living) broadly corresponds to a level of disability in the 8-10 and 9-10 OPCS disability categories. They observe that the OPCS disability category 9-10 prevalence by age and sex bears some similarity to the nursing-home prevalence rates coming out of the 1985 US National Home Survey (NNHS) study.

We shall assume that extra mortality in LTC corresponds to that of OPCS level 9 of the Rickayzen and Walsh model. These extra-mortality rates were derived to be applicable in 1986. It would seem appropriate to improve this extra mortality in some way for the 15 years to 2001 (which is the base year for our mortality assumption). We have done this simplistically, by applying a 2%pa reduction to extra mortality in care at all ages, which is broadly meant to reflect average population mortality improvements.

Step 3: Deriving net combined impact of residential-LTC entry and lighter at-home mortality

Using our derived additional mortality in care assumption and taking population mortality as per the Interim Life Tables for England and Wales for 2000-2002, we went on to derive (i) LTC-incidence rates, (ii) the degree to which at-home mortality is lower than overall population mortality as a result of people moving into care and (iii) the combination of these two factors. They are set out in Table 3.7 and are expressed in terms of population mortality.

Age	Males: LTC incidence rate/Population mortality rate (%)	Males: At-home mortality/Population mortality (%)	Males: Net LTC incidence and at home mortality impact as a %'age of population mortality	Females: LTC incidence rate/Population mortality rate (%)	Females: At-home mortality/Population mortality (%)	Females: Net LTC incidence and at home mortality impact as a %'age of population mortality
60	5.2	96.7	1.9	6.2	96.1	2.2
65	5.1	96.9	1.9	7.8	95.9	3.6
70	4.2	97.3	1.4	6.9	96.0	2.8
75	6.6	97.0	3.3	18.0	93.6	11.1
80	6.7	96.5	2.7	19.1	90.9	9.1
85	12.5	94.9	5.9	31.4	86.8	15.7
90	14.2	93.0	4.7	31.2	83.4	10.7
95	19.1	91.0	5.2	40.9	78.7	11.8
100	20.6	89.5	2.9	43.2	74.0	6.2

Table 3.7. LTC impact as a percentage of population mortality

Table 3.7 suggests that although LTC-incidence rates as a proportion of underlying population mortality are fairly significant, particularly for females, the net care-entry impact on population mortality, after allowing for the lighter mortality of those remaining in their own homes, is relatively small. Expressed differently, in the context of ERMs, residential LTC entry is equivalent to a modest acceleration of mortality. The somewhat irregular net impact of LTC expressed as a proportion of mortality, as set out in Table 3.7, is probably due to the various simplifying assumptions adopted. The overall net impact of LTC is not overly sensitive to changes in the additional-mortality-in-care assumption. This is because the degree of LTC incidence and the degree to which at-home mortality is lighter than population mortality, have offsetting influences in the overall net LTC impact.

The care-impact values derived above are for the entire population (homeowners and non-homeowners). Homeowners show evidence of having lower care-incidence rates (see, for example Scott *et al* (2001)). As our ERM-population mortality assumption (per Section 3.1) is lighter than population mortality, and given the relative insignificance of the LTC-impact assumption, we shall simply “transfer” the net LTC-impact percentages relative to population mortality (as derived above), to ERM-population mortality. However, in order to avoid any spurious impression of accuracy, we have produced a simplified set of central LTC-impact assumptions (i.e. mortality uplifts) and these are set out in Table 3.8. Linear interpolation would be used to derive intermediate values.

Age	Males	Females
≤70	2	3
80	4	12
90	5	13
≥100	4	8

Table 3.8 Net increase of residential LTC as a percentage of ERM mortality – central assumption

The allowance that we made for initial selection (in Section 3.1) when setting the mortality assumption is assumed to apply to the net LTC impact as well.

At this point it is worth recognising that whilst the above modelling treats an individual as being in care at the actual point of entry into care, the situation under ERM products is somewhat different in that there is usually a six-month delay between moving into care and being counted as an LTC-entry for ERM purposes (at which point a house sale may be triggered). During this six-month transitional period, any actual deaths occurring may, in practice, be recorded as at-home deaths rather than in-care deaths. Whilst this does not impact the overall level of home exit, it does mean that for monitoring purposes, home exits arising from at-home deaths may be slightly overstated compared to those expected under the methodology adopted for deriving the statistics above. The opposite will be the case for care-entry incidence.

3.3.2 Joint Lives

Statistics show (see Section 3.3.3) that care incidence is very much impacted by marital status. Couples living together will tend to care for one another, thereby significantly delaying any care-entry compared to the case were the individuals living alone. However, the relevant decrement for ERM purposes is that of the last life vacating the home for whatever reason. Therefore the question to address is whether the two lives collectively are able to support each other as a unit so that they are able to remain in their home for a longer period than the healthier of the two would have been able to remain at home, had he or she lived alone. One might intuitively suspect this to be the case (from a combination of the mutual support provided by the individuals concerned, the increased cost-effectiveness of home care and the increased likelihood of the existence of offspring that might offer support). Hence, if one's target ERM population was expected to include a greater proportion of couples living together than is present in the population more generally, a rough adjustment to reduce the care-incidence impact somewhat may be appropriate.

3.3.3 Factors impacting care incidence

Scott *et al* (2001) develop a multivariate model for institutional care entry using data from waves 1-8 of the British Household Panel Survey.

They observe that age is overwhelmingly the single most important factor impacting on institutional entry. Interestingly, they found that they could exclude gender from their multivariate model; the higher female rates of entry into care were largely explained by the higher average age of females compared to that of males. Marital status (lower for couples) and occupation class (lower for professionals/managers) were (amongst others) found to be significant demographic/background discriminants.

Some of this extra detail might be useful if a multi-state modelling approach were to be adopted (see Section 3.6). However, given the fairly simplistic approach used for setting the LTC-entry impact above, and its relative insignificance (compared to the mortality assumption), it will probably suffice simply to make very broad adjustments to reflect the impact of a target sales mix being very different to that assumed in deriving the rates above. For example, if the sales mix is expected to include a larger than average proportion of couples, somewhat lower care-incidence rates may be appropriate. Conversely, if one's target population is likely to consist of a greater proportion of single lives (particularly those never married), a modest increase to the care-impact assumptions would be justified. In both cases, however, adjustments to the base mortality assumption discussed in Section 3.1 may be deemed to swamp any second order LTC-entry impact!

3.4 Future LTC-entry trends

In Section 3.3.1 we made an attempt at estimating base levels of LTC incidence using a simplistic model. As with the base-mortality assumption, the LTC-incidence assumption is unlikely to remain stationary in absolute terms.

When considering future trends in care incidence, one needs to consider -

- future trends in disability incidence – people, particularly those who have taken out ERM products, are unlikely to enter care if they are not disabled,
- government policy – increasing emphasis on home care will reduce the tendency to leave the home and move into care, and
- future trends in care places – if the care places don't exist, people cannot move into care (though to some extent the number of care places will be impacted by the first two points and the overall size of the elderly population).

Given the lower significance of the LTC impact assumption and the very broad-brush manner in which we have estimated it, our suggestion would be to simply assume that the net LTC impact, expressed as a proportion of base mortality, subsequently reduces in line with the mortality improvement model assumed.

3.5 Early Redemptions/Pre-payments

The primary reasons for the redemption of any individual ERM arrangement are the death or entry into LTC of the homeowner (or, in the case of joint-life arrangements, upon the survivor of the two lives dying or entering LTC).

The arrangement may, however, terminate prematurely for a number of reasons. These can be divided into two categories, namely, changes in personal circumstances and remortgaging.

3.5.1 Changes in personal circumstances

Changes in personal circumstances include moving in with relatives, moving into sheltered accommodation or into any other non-qualifying property, trading down to smaller accommodation and, less commonly, marriage or divorce. ERM arrangements may also be terminated prematurely if the borrower unexpectedly comes into money, as elderly people do not like having debt hanging over them. Of course, given the age of ERM clients, windfall inheritances are unlikely to be all that common!

In the case of fixed-repayment mortgages and reversions, there would be a strong disinclination for borrowers to terminate their arrangements prematurely as the amount of mortgage repaid, or the portion of the home forfeited in the case of reversions, is not generally reduced as a result of the early redemption. One would therefore expect a substantial initial selection effect for such redemptions, followed by a modest number of redemptions, probably best expressed as a proportion of the inforce. One might expect arrangements that were sold on a joint-life basis to show a higher propensity to prepay once the first of the partners had died (or moved into care).

Providers may choose to ignore these windfall profits in their pricing. Alternatively, they might feel comfortable making some allowance for pre-payments arising from changes in personal circumstances, perhaps along the lines shown in Table 3.9 (which is based on our subjective view, rather than on firm experience).

	Pre-payments arising from changes in personal circumstances as a percentage of in force	
Contract Year	Single Life Contract	Joint Life Contract
1	0.0%	0.0%
2	0.0%	0.0%
3	0.25%	0.15%
4	0.5%	0.3%
5	0.5%	0.3%
6+	0.5%	0.75%

Table 3.9. Allowances for pre-payments arising from changes in personal circumstances expressed as a percentage of in force – Home Reversions and Fixed-Repayment Mortgages.

In the case of rollup mortgages, unless there are early redemption penalties, the anti-early redemption deterrent is very much reduced. It is also more important, in the case of rollup mortgages, for providers to make some allowance for such early redemptions, because each such early redemption results in reduced profit margin and, in the absence of adequate redemption penalties, an acquisition expense loss. However, each such early redemption does relieve the provider of the associated NNEG costs.

In the absence of any firm past experience, providers would need to make a judgement call as to how much of an allowance to make for such early redemptions. Perhaps an allowance along the lines of Table 3.9 would be appropriate if adequate early redemption penalties apply, failing which it may be reasonable to move directly to the ultimate rates shown in that table.

Those prepaying as a result of changes to their personal circumstances may well consist of a relatively more infirm group than those who do not prematurely terminate their arrangements. In theory, therefore, some adjustment might be made to the mortality and LTC experience of the "stayers". However, given the very approximate manner in which this pre-payment assumption has been set, we would not propose to make any further adjustments.

3.5.2 Remortgaging

Pre-payments as a result of remortgaging, which is of course a voluntary decision (as opposed to the changes in personal circumstances considered in Section 3.5.1, which we regard as being largely involuntary), are unlikely to be at all common for fixed-repayment mortgages and reversion schemes. This is because the borrower has nothing to gain from such an action. Providers of such products would not therefore normally anticipate any remortgage windfalls.

On the other hand, pre-payment through remortgaging is a significant issue for the providers of rollup mortgages. Such pre-payments can occur for one of two key reasons, namely (i) as a result of pricing tightening in the event of an increase in competitive pressures in the market and (ii) as a result of falling interest rates, leading to new mortgages becoming cheaper. Remortgaging is more likely to occur in the earlier years than in the later years of the arrangement. There are a number of reasons for this, for example (i) the intermediary is more likely still to have some contact with the client, (ii) the ERM is more likely to be on the homeowner's mind and (iii) depending on the movement in house prices, it may be more difficult to remortgage for the then outstanding sum, the longer one survives.

Remortgaging that arises purely from a tightening of margins results in loss of profit and potential failure to recover acquisition expenses.

Of more concern, however, is the impact of remortgaging as a result of falling interest rates. Not only will the provider experience an adverse impact on profitability as above, but the provider is also likely to suffer an interest-rate loss with respect to his funding of the mortgages. These losses would arise if the provider has raised funds at a fixed rate of interest, or if he has a variable cost of capital and has swapped out his interest rate exposure. A sudden surge in pre-payments as a result of a fall in market yields will leave the provider with a yield shortfall on these funds relative to his funding costs. In fact, the provider has given the borrowers a valuable option on fixed-interest rates (i.e. a swaption).

Whilst it is true that these options would not be efficiently exercised by all borrowers, some allowance needs to be made for this product feature in the pricing. There are two ways in which this may be done. The first involves charging those borrowers who remortgage, an appropriate "mark to market" exit fee to compensate the provider for the losses sustained as a result of the client terminating the arrangement prematurely. Those borrowers who do not remortgage will be unaffected by this charge. The second approach would be to levy a more modest exit fee on those who remortgage and spread the balance of the losses expected to arise through remortgaging across all borrowers. The result would be a somewhat less competitive product with the "stayers" subsidising those who remortgage. Since the provider is running the risk that his remortgaging assumptions turn out to be too light, additional risk is being run and this would need to be reflected in the overall product terms.

It seems to us that from a risk-management point of view, the most appropriate way to mitigate the risk of losses as a result of pre-payments driven by either falling yields or tightening margins is to charge an appropriate exit charge to those customers that prepay. This exit charge should reflect any interest-rate losses to the provider and any acquisition expense losses. Possibly, a certain amount of lost profit might also be included in the redemption charge. Credit could, however, be given for the value of the NNEG, which the borrower is forfeiting. Of course, the niceties of a financial-economics approach to exit penalties would not be appreciated by the average borrower! Simplifications would therefore need to be adopted. In addition, it may be necessary to apply a cap to the exit charge so as not to fall foul of the FSA's requirements in the new environment of mortgage regulation. Such a cap does of course have a value to the customer, but provided it is set appropriately, there should not be any material residual risk to the provider.

Providers may however feel unable, either for marketing reasons or based on their interpretation of the early-repayment charges permitted by the new FSA regulations, to levy a technically adequate charge on those clients who remortgage. A common alternative approach adopted is to levy a more modest exit charge (typically 5% of the mortgage in year 1 reducing by one percentage point each year to zero in year 6 and beyond). Presumably, the additional costs expected to arise as a result of remortgaging (particularly when interest rates decline) are factored in to the overall product terms. A provider adopting this approach to exit penalties may be able to go some way towards mitigating significant interest-rate losses arising as a result of remortgaging, by purchasing appropriately structured swaptions based on a prudent pre-payment assumption. The cost of these swaptions would be factored into the overall product terms. We have not considered any further what an appropriately prudent remortgage assumption might be other than to recognise that it would need to be related to the provider's view as to the extent that future interest rates might fall.

If early redemption charges are set broadly on a technically correct "mark to market basis", it would seem to us that there is no need to build an additional decrement for pre-payment as a result of remortgaging, into the product pricing. However, a remortgage assumption may still be made for financial projection purposes to improve the shape of future revenue accounts.

3.6 Multi-state models

In theory at least, it would appear that the setting of the base decrement assumptions and their evolution over time, lend themselves to a specification via a multi-state model.

Rickayzen & Walsh (2002) develop a multi-state model to project the number of people with disabilities in the United Kingdom over a 35-year period. However, one of their key conclusions is that their projections must be treated with caution, given the uncertainties surrounding certain of the assumptions.

Dullaway & Elliot (1998) considered a multi-state approach in the context of long-term care insurance, but after citing certain significant disadvantages (including the large number of unknown or poorly specified assumptions), opted for the inception/annuity approach.

We too, have shied away from a multi-state modelling approach. Given the difficulty in specifying and parameterising the model, the apparent sophistication of the model will most likely be negated by the additional uncertainty surrounding the output. In addition, as the LTC-impact assumption is substantially less significant than the mortality assumption, the creation of an elaborate and sophisticated model for the LTC impact would appear to be unwarranted.

3.7 The No Negative Equity Guarantee

The No Negative Equity Guarantee (NNEG), is a feature of most lifetime-mortgage products. Through the NNEG, the provider guarantees the borrower that the redemption amount of the mortgage will be capped at the lesser of the face amount of the mortgage and the sale proceeds of the home. Products may differ as to whether the NNEG extends to the sale expenses or not (see Section 3.7.3 of the accompanying Equity Release Report, 2005).

If we define the face amount of the mortgage at the time of sale of the home at time t as X_t, and the sale proceeds of the home (possibly net of sales expenses) as S_t, then the NNEG restricts the amount of mortgage repaid to $\min[X_t, S_t]$. The shortfall to the provider upon redemption at time t as a result of the NNEG is:

$$X_t - \min[X_t, S_t] = -\min[0, S_t - X_t] = \max[0, X_t - S_t].$$

This last formulation can be recognised as the payoff under a European put option having an option term t.

In effect, by incorporating a NNEG in the product, the provider has “written” a series of put options, the total value of which (V_{NNEG}) can be expressed as follows:

$$V_{NNEG} = \int_{t=0}^{t=T} {}_t p_x . \mu_{x+t} . P(t+\Delta, X_{t+\Delta}, S_0)\, dt \ ,$$

where

- ${}_t p_x$ is the probability of a life aged x at inception surviving in the house until time t,
- μ_{x+t} is the force of home exit for a life aged x+t,
- $P(t+\Delta, X_{t+\Delta}, S_0)$ is the value of a put option of term t+Δ on the underlying house price, where the strike price of the option, $X_{t+\Delta}$, is the face amount of the mortgage at time t+Δ and S_0 is the estimated net realisable value of the home when the ERM is taken out,
- Δ is the average delay in time from the point of home exit at time t (through death, LTC entry or other pre-payment), until the actual sale of the property, and
- T is the point such that x+T is the uppermost age of the life table.

For joint-life mortgages, appropriate adjustments would be made to the demographic components of the formula above.

We assume that all future values of X_t are known in advance, either because we are dealing with a rollup mortgage having a fixed rate of rollup, or with a fixed-repayment mortgage, in which case the X_t would be constant.

Whilst the formulation of the value of the NNEG in terms of a series of options has been fairly straightforward, the actual pricing of this option is no simple matter. In what follows we have attempted to gain and present insights into the value of the NNEG using simple option-pricing methodology. We have been unable to locate any published material on this topic. What follows should therefore be viewed as an initial and fairly elementary analysis.

A natural starting point for placing a value on the put options implied by the NNEG is to attempt to price them using the Black-Scholes option-pricing methodology. Each constituent option, $P(t+\Delta, X_{t+\Delta}, S_0)$, on the underlying property may be considered to be comparable to an option on a dividend-paying equity share. This is because the total return from a property can be viewed as consisting of both its capital growth and a "dividend" i.e. its rental income (even if only notional) net of insurance and maintenance costs.

A key assumption in the Black-Scholes formula is the volatility assumption. Here the usual (and preferred) approach is to infer (or "back out") the appropriate volatility assumptions from corresponding market option-prices (this is known as market-implied volatility). This approach ensures that the options being priced are priced consistently relative to the prices of other quoted options. Unfortunately, this possibility does not exist in the case of the NNEG options. Not only is there only a very limited market in housing derivatives, principally futures-type derivatives (called "spread bets") marketed by the spread-betting firms, but any derivative would in any event most likely be based on a broad-based housing index whereas what is required in this case are options specific to individual properties.

This inability to replicate the NNEG obligation, whether by purchasing a hedge or by dynamically replicating the position, means that any cost derived by the Black-Scholes methodology, based on historical or estimated future volatilities, can at best be regarded as a lower bound for the "market consistent" cost of the NNEG. In addition, the Black-Scholes price also excludes transaction costs and makes several other simplifying assumptions. Considerable capital will therefore have to be set aside to protect against the inherent variability of the actual outcome. (See Section 4, in which we briefly discuss capital issues.)

Faced with the inability to derive market-implied volatilities, we have calculated historical volatilities of quarterly and annual house-price returns (or more precisely, volatilities of the natural logarithms of these price movements). The source for our data was the Regional Quarterly House-Price Indices of the Nationwide Building Society (2004) over the 30-year period from quarter-4 1973 to quarter-4 2003. These indices are not seasonally adjusted. The results are set out in Table 3.10.

Region	Annualised Volatility (%) Quarterly price movements	Annual price movements
NORTH	7.0	9.7
YORKS & HSIDE	7.1	10.9
NORTH WEST	5.6	8.8
EAST MIDS	6.5	10.5
WEST MIDS	6.6	9.8
EAST ANGLIA	7.5	11.3
OUTER S EAST	6.7	11.3
OUTER MET	6.2	10.6
LONDON	6.6	10.8
SOUTH WEST	6.6	10.9
WALES	6.7	10.0
SCOTLAND	5.3	6.9
N IRELAND	6.3	6.8
All UK	5.2	8.7

Source: Nationwide Building Society, Regional Quarterly House-Price Indices, own calculations.

Table 3.10. Annual house-price volatilities

As one would expect, regional indices are generally more volatile than the aggregate UK index. Were one to drill down to individual boroughs and indeed, to individual houses (which is of course, not possible), one would expect price movements to exhibit significantly greater proportional variation.

Our analysis also showed that volatilities do change over time.

House-price returns show a strong positive autocorrelation effect. This accounts for the observation in Table 3.10 of lower annualised volatilities for the quarterly price-movement series than for the annual price-movement series. This is contrary to the situation in the equity market.

Table 3.11 compares autocorrelations (with a one-period lag) of the logarithm of price movements of the FTSE100 index and of the aforementioned Nationwide Building Society index for the UK as a whole. The 19-year period ending 31 December 2003 has been examined. Both quarterly and annual price-movement series are considered. Also shown in this table are the annualised volatilities.

	FTSE 100 Index	Nationwide House-Price Index (all UK)
Autocorrelations – 1-period lag		
Quarterly (log) price movements	-3.5%	65.0%
Annual (log) price movements	8.6%	51.7%
Annualised volatility		
Quarterly (log) price movements	17.7%	5.4%
Annual (log) price movements	15.4%	9.0%

Table 3.11. Autocorrelations (one period lag) and Annualised Volatilities – FTSE 100 Index and Nationwide Building Society all-UK House-Price Index – January 1984 to December 2003 (own calculations)

We have investigated whether the autocorrelation feature in the housing market has any impact on the theoretical option costs, for a given volatility (assuming that the option continues to be priced and replicated using the Black-Scholes model). Our conclusion was that the Black-Scholes prices continue to be valid. However, given that the provider's NNEG position is unlikely to be hedged, this autocorrelation feature increases the potential losses under adverse scenarios (because a series of adverse price movements is more likely when the autocorrelation feature is present than when there is no positive autocorrelation).

The autocorrelation impact does make the selection of the appropriate time interval for the calculation of historical volatilities more complicated (e.g. whether to base the volatility on quarterly price movements or on annual price movements). Arguably, were a liquid derivative market in house prices to emerge, which might be useful for hedging purposes, some of the very high, short-term, positive autocorrelation effect would not carry over into such a derivative market. Historical house-price index movements may not suffer from the same degree of "smoothing" (i.e. underestimation of true transactional volatility) as is the case for certain valuations-based commercial property indices (see, for example, Booth & Marcato (2004)). However, there must be some possibility that the very low observed short-term volatilities are more of a reflection of the relative illiquidity of housing stock and the corresponding transaction length (neither of which sit comfortably with Black-Scholes), than a reflection of "true" underlying volatility.

It is not straightforward to determine the "correct" volatility assumption. In what follows we assume a central individual-property volatility assumption of 12% (without wishing to claim that this is the "correct" assumption to use – we do consider the impact of a 15% volatility assumption below, as well). This largely discounts much of the short-term low volatility observed and was also chosen to reflect the fact that not only are the regional variations in volatility greater than those for the UK as a whole (see Table 3.10), but also the fact that individual house-price movements will display even greater price volatility, particularly over shorter horizons (see for example Iacoviello & Ortalo-Magné (2002)). (Expressed in more conventional equity-option terms, we are having to price options on individual equities that make up an index rather than an option on the entire index. The individual equities exhibit far greater volatility than the index as a whole. One would expect to see a similar feature, if somewhat less pronounced, in the housing market.) In setting our central volatility assumption, we are assuming that the provider's underlying property exposure is well diversified.

This volatility assumption, together with several other simplifying assumptions, can then be used to obtain some understanding of the cost of the NNEG using the Black-Scholes option-pricing methodology. As mentioned above, even if we have chosen the "correct" volatility assumption, these derived costs might be regarded as being a lower bound to the true option price as it is not an enforceable or replicable value.

The other key assumptions that we have made for the purposes of parametising our Black-Scholes formula are:

- Risk-free rate of return - 4.75%pa, continuously compounding, across the term structure
- "Dividend Yield" i.e. rents less insurance and maintenance costs - 2%pa, continuously compounding
- The "spot price" required by the Black-Scholes formula has been taken as the current value of the property less 2.5% disposal costs (under the assumption that the NNEG is set against the net sale proceeds rather than the gross sale price)
- Tax – we have ignored this, effectively assuming that the provider is taxed on profits.

Of the above, the appropriate "dividend" or net rental yield to assume within the Black-Scholes framework is least straightforward. The higher the value chosen, the greater will be the cost of the NNEG. Real world (notional) net rental yields are currently well above our 2% assumption. They are probably influenced, to a degree, by the borrowing costs of home investors and home owners, which would tend to be above our 4.75% risk-free interest-rate assumption. In view of this uncertainty, we also consider the impact of a 3% net rental yield assumption, below.

Using the above methodology and assumptions, we have made an attempt at putting a price on the NNEG for a rollup-mortgage product.

The key product and age assumptions are set out in Table 3.12. The product features are broadly in line with at least one product currently available on the market. We have assumed, in each case, that the house value is equal to the minimum value permitted in Table 3.12. In practice, however, it is not uncommon for the ratio of cash advanced to initial home value (the LTV) to be lower than the maximum permitted LTV ratio for the product.

Rollup Rate (annual effective rate)	7.50%
Cash Advanced	£30,000

	Minimum Initial House Value			
Sex/Age	**60**	**70**	**80**	**90**
Female	£176,500	£111,000	£81,000	£60,000
Male	£176,500	£111,000	£81,000	£60,000
Joint	£176,500	£111,000	£81,000	£60,000

Table 3.12. Key product and age assumptions (Rollup Mortgage)

We adopted a simplification to the V_{NNEG} formula above, in that rather than using a continuous function, we used discrete annual time-steps, i.e. we assumed that home-exit occurs mid-year and that home-sale takes place six months later.

The decrement assumptions that we have made are those derived in Sections 3.1 to 3.5. For simplicity, all loans are assumed to have incepted at the start of 2005. No allowance has been made for pre-payment as a result of remortgaging, on the assumption that the exit penalty recovers the necessary costs (and that it includes some credit for the forfeiting of the NNEG option) as discussed in Section 3.5.2.

The resultant NNEG values, expressed both as a percentage of the cash advance and as an annual yield cost, are set out in Table 3.13. Appendices 4 and 5 contain more detailed calculations, showing how the costs for the female, aged 70, were derived.

	NNEG cost as % Cash Advance				**NNEG cost as % pa**			
Sex/Age	**60**	**70**	**80**	**90**	**60**	**70**	**80**	**90**
Female	37.3	23.8	9.7	3.9	0.66%	0.76%	0.66%	0.60%
Male	31.0	20.0	8.7	3.9	0.61%	0.71%	0.63%	0.60%
Joint	48.4	33.2	15.2	6.7	0.75%	0.88%	0.79%	0.75%

Table 3.13. Lower bound of NNEG costs – Central case

Given the uncertainty inherent in the assumptions that we have made above, it is instructive to consider the sensitivity of the calculated NNEG costs to changes in some of these assumptions.

Tables 3.14 to 3.18 set out the sensitivities of the NNEG values to key Black-Scholes and product assumptions.

	NNEG cost as % Cash Advance				**NNEG cost as % pa**			
Sex/Age	**60**	**70**	**80**	**90**	**60**	**70**	**80**	**90**
Female	48.6	31.1	13.6	5.8	0.89%	1.02%	0.93%	0.91%
Male	41.2	26.5	12.2	5.7	0.83%	0.96%	0.90%	0.91%
Joint	61.6	42.2	20.6	9.7	0.99%	1.15%	1.09%	1.10%

Table 3.14. NNEG values – Volatility up by 3 percentage points

	NNEG cost as % Cash Advance				**NNEG cost as % pa**			
Sex/Age	**60**	**70**	**80**	**90**	**60**	**70**	**80**	**90**
Female	57.2	35.0	14.2	5.4	1.08%	1.17%	0.98%	0.85%
Male	48.1	29.6	12.7	5.4	1.00%	1.09%	0.94%	0.85%
Joint	73.1	48.3	21.9	9.3	1.22%	1.34%	1.17%	1.06%

Table 3.15. NNEG values – Net rental yield 1 percentage point higher than central assumption

Sex/Age	NNEG cost as % Cash Advance 60	70	80	90	NNEG cost as % pa 60	70	80	90
Female	83.2	46.3	17.1	6.1	1.14%	1.23%	1.02%	0.87%
Male	69.5	39.1	15.4	6.1	1.06%	1.15%	0.98%	0.89%
Joint	107.6	64.5	26.7	10.5	1.27%	1.40%	1.21%	1.09%

Table 3.16. NNEG values – Risk-free rate down by 100 basis points (impacting both the value of the NNEG option and the present value of NNEG margins). The net rental yield is not assumed to reduce.

Sex/Age	NNEG cost as % Cash Advance 60	70	80	90	NNEG cost as % pa 60	70	80	90
Female	85.3	54.7	26.4	13.9	1.44%	1.72%	1.78%	2.18%
Male	72.9	47.1	23.8	13.7	1.36%	1.63%	1.72%	2.18%
Joint	106.3	72.6	38.4	21.5	1.57%	1.89%	2.00%	2.47%

Table 3.17. NNEG values – Combination scenario involving 50 basis points reduction in risk-free rate, 2 percentage point increase in volatility and 25% reduction in opening house prices

Sex/Age	NNEG cost as % Cash Advance 60	70	80	90	NNEG cost as % pa 60	70	80	90
Female	19.8	11.0	3.3	0.8	0.34%	0.34%	0.22%	0.12%
Male	16.2	9.2	3.0	0.8	0.30%	0.31%	0.21%	0.13%
Joint	26.7	16.2	5.5	1.5	0.39%	0.40%	0.27%	0.16%

Table 3.18. NNEG values – maximum LTV reduced by 33%

As the NNEG option is not readily hedgeable (either through the purchase of appropriate hedging instruments or through the purchase of insurance), the potential value variability will need to be met be backing the product with significant amounts of risk-based capital and charging for this appropriately. This variability may arise both as a result of selecting the "wrong" Black-Scholes assumptions (eg. volatility, net rental yield, etc) and as a result of the (unhedged) actual evolution of house prices. As mentioned above, the Black-Scholes result should be viewed as providing a lower bound for the NNEG value.

The figures in Tables 3.13 to 3.18 suggest that, taking an option-pricing approach to the valuation of the NNEG, both the value and variability of the NNEG associated with these mortgages are material. These costs, including the costs of capital supporting the writing of such risks, would need to be factored into the product pricing. The alternative of removing the NNEG feature from the products may be unacceptable from a marketing and compliance perspective and impracticable from an underwriting perspective (i.e. how would one establish whether the borrower, or his estate, will have the means to top up any shortfall in the home sales proceeds relative to the mortgage repayable?).

The approach to assessing the value of the NNEG that we have described above, namely, the use of the Black-Scholes option-pricing framework, is not without its difficulties and shortcomings. We believe however, that our approach is consistent with the approach that many life offices are currently adopting in establishing their market-consistent or realistic liabilities. Whilst residential property may not feature significantly in many with-profit asset portfolios, commercial property holdings are more common and we understand that market-consistent option-pricing approaches are also commonly used for this asset class when assessing costs of guarantees, albeit after making adjustments to the observed volatility to remove the smoothing effect that is present in the valuation of such property.

Others may however, prefer to approach the assessment of the NNEG using more of a "real-world" stochastic modelling approach. Booth & Marcato (2004) outline possible approaches, though the emphasis of their paper is on commercial property. Iacoviello & Ortalo-Magné (2002) and references contained in their paper, use an approach more directly relevant to residential property.

Each provider will have to assess the costs of the NNEG against their own circumstances, product terms and view as to the appropriate modelling approach to adopt and parameterisation of those models. In practice we would expect there to be significantly different assessments of costs between different providers.

3.8 House Price Inflation

We assume that providers of property reversions either have an appetite for house-price inflation exposure (i.e. they want to invest in properties), or that they will place the exposure with someone who has such an appetite. This therefore becomes an investment decision pertinent to the provider's own circumstances, rather than a pricing risk. Accordingly, we have not analysed the exposure in detail here, and in particular we have resisted any temptation to suggest a "best-estimate" property growth rate!

4 Risk Capital and Reserving

Section 3 focused on the setting of central assumptions for the demographic and economic risks associated with ERMs. The reader cannot have failed to notice that we have had to make many assumptions and simplifications in arriving at our central assumption sets. There is, inevitably, a large amount of uncertainty surrounding our assumptions and this uncertainty needs to be recognised when deciding upon the capital needed to back this business. The uncertainty does not only relate to issues of variability around a known mean – it relates to the mis-estimation of the very mean itself!

To the extent that hedges or insurances are put in place, risks may be mitigated (possibly being exchanged for credit risks unless appropriately collateralised) and the capital needed may be reduced. However, the underwriters of these risks will themselves need to consider the uncertainty surrounding the risks that they are taking on. Unless they in turn, are able to lay these risks off, they will face the same issues as the originators of the risk. The ultimate risk taker will have capital costs to service and these will need to be met by the consumer.

Modern product-pricing techniques concern themselves with pricing to adequately service a quantum of economic capital set in relation to the underlying product risks (known as risk-based capital or RBC). Traditionally, regulatory capital (being the excess of regulatory reserves and solvency margins over best-estimate reserves) has been based on a broad-brush formula-based approach that does not always respond appropriately to the risks assumed under newer or more sophisticated products. Regulatory capital requirements are, however, increasingly catching up with risk-based reality.

Our suggested approach would be to price the product to service a RBC measure of capital even if this exceeds the current regulatory or reporting requirements. (We understand, for example, that there may be restrictions on banks and building societies setting up general provisions for out-of-the-money NNEGs.) Once having established the quantum of RBC, appropriate margins for profit need to be built in to service this capital at the required rate. Given the significant uncertainties involved, providers will need to demand appropriately high returns on their capital.

There is no magical way to decide on how adverse the RBC scenario should be, particularly when faced with such a large degree of uncertainty. It would however seem to us that in the face of so many unknowns, a stress-based scenarios approach rather than a stochastic-scenarios approach to setting RBC would be preferable. Providers may wish to consider stresses both to individual risk factors and scenarios involving adverse movements in several risk factors, and derive their quantum of RBC from these stress tests and adverse scenarios.

We discuss below some of the considerations for setting RBC stress tests and scenarios with regard to the assumptions covered in Section 3.

4.1 Base Mortality

As described in Section 2.1.1, the nature of the longevity risks run by a provider differ depending upon the type of ERM product, with reversions and fixed-repayment mortgages falling into one camp and rollup mortgages into the other. For the first category, it might be appropriate to apply a reduction factor to the central base mortality rates. A larger factor may be used at the relatively younger ages, recognising the greater uncertainty in the ERM-population mortality rates at these ages, compared to the uncertainty at the much older ages, where we are dealing with a more homogenous group of lives (though we have noted, in Section 3.1, that establishing population mortality rates at the extreme ages is itself no easy task).

The position with rollup mortgages is more complicated, given the different directions of the longevity exposure in the early and later product years. (Whether, and the extent to which, increased longevity is costly in the later years will depend on the loan-to-value ratios in the portfolio and hence the interaction with the NNEG costs.) One does not want to add a margin for uncertainty only to find that it has had a beneficial impact! Tests will need to be carried out for an assumed mix of business and the mortality table should be loaded appropriately. This loading is likely to involve uplifts to the base tables for the younger ages and reductions at the older ages.

Smaller portfolios would probably adopt larger factors for adverse deviations than would larger portfolios, in order to allow for the additional inherent volatility in the mortality experienced. This volatility can have a magnified impact on the NNEG costs.

The initial selection factors suggested in Section 3.1 might be retained in the RBC scenario.

4.2 Mortality Improvements

Willets *et al* (2004) observed that mortality improvements do not necessarily need to reduce or dampen with advancing age, for a given cohort. Although all UK actuarial models for mortality improvements have traditionally had a dampening factor with advancing time and age, it may be prudent to ignore (or at least restrict) any such dampening in an RBC scenario for fixed-repayment mortgages and reversions. One may, for example, decide to assume a simple mortality-improvement model for RBC purposes as per our central mortality-improvement assumption for 2001/2 (see Section 3.2), uplifted somewhat, and remaining level into the future (for each year of birth cohort). For rollup mortgages, it will not be prudent to increase the mortality improvements in the early years, though it may be prudent to do so for the later years, depending on the interaction with the NNEG.

4.3 LTC-impact

As our central assumptions for base LTC entry and future trends are expressed in terms of the mortality assumption and they are in any event fairly modest, we would leave the assumptions derived in Sections 3.3 and 3.4 unchanged, but would of course now apply them to the RBC-scenario mortality assumption.

4.4 Early Redemptions/Pre-payments

These assumptions are more speculative in nature and may consequently by subjected to relatively large stresses within an RBC framework. The direction of the stress needs to reflect the impact on the provider’s risks. To the extent that any surrender penalties or exit charges protect the provider against loss as a result of such exit, there will be a far more limited impact on the capital requirements.

4.5 The NNEG

Section 3.7 showed that the value of the NNEG, calculated using our options-pricing approach, is rather sensitive to some of the Black-Scholes parameters. Given the uncertainty regarding the values of certain key parameters and the inability to hedge the NNEG, the stress and scenario testing is likely to involve an initial fall in property values, increased volatilities, a reduction in the risk-free rate and possibly, an increase in the net rental yield. When coupled with adversity in some of the demographic assumptions, significant amounts of capital may be necessary.

4.6 HPI

We have not considered an appropriate stress test here. As has already been mentioned, direct property risk is being taken and providers will need to test scenarios in which their property bet goes wrong. The rating agencies do have stress tests that they apply to domestic property portfolios for credit-rating purposes.

4.7 Other

In addition to the above, one would need to ensure that capital is set aside for expense risk and for other business and operational risks. A broad-brush approach is likely to be adopted.

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Any errors remain the responsibility of the authors.

Appendix 1. Adjusted ELT15 mortality rates

This appendix shows how we adjusted the original ELT15 mortality rates, which we assumed were rates as at mid-1991, to rates applicable at the end of 1992 i.e. one and a half years later. The adjustment factors were as per Table 6.11c of Willets *et al* (2004). It is recognised that the mortality improvements quoted in Willets *et al* were centred on the year 1997, but given all the other assumptions and approximations that we make, this is not thought to be material.

	Males			Females			
Age	**Original ELT15 (mid-91)**	**Adjust-ment**	**Adjusted ELT15 (end-92)**	**Original ELT15 (mid-91)**	**Adjust-ment**	**Adjusted ELT15 (end-92)**	**Age**
60	0.01392	0.94060	0.01309	0.00830	0.95239	0.00790	**60**
61	0.01560	0.94207	0.01470	0.00922	0.95091	0.00877	**61**
62	0.01749	0.94354	0.01650	0.01015	0.95239	0.00967	**62**
63	0.01965	0.94502	0.01857	0.01129	0.95534	0.01079	**63**
64	0.02199	0.94796	0.02085	0.01266	0.95830	0.01213	**64**
65	0.02447	0.95091	0.02327	0.01399	0.96274	0.01347	**65**
66	0.02711	0.95386	0.02586	0.01523	0.96570	0.01471	**66**
67	0.02997	0.95534	0.02863	0.01676	0.97015	0.01626	**67**
68	0.03292	0.95830	0.03155	0.01844	0.97312	0.01794	**68**
69	0.03602	0.96125	0.03462	0.02017	0.97461	0.01966	**69**
70	0.03930	0.96125	0.03778	0.02190	0.97610	0.02138	**70**
71	0.04311	0.96274	0.04150	0.02399	0.97610	0.02342	**71**
72	0.04745	0.96125	0.04561	0.02693	0.97610	0.02629	**72**
73	0.05217	0.96125	0.05015	0.03014	0.97610	0.02942	**73**
74	0.05697	0.96125	0.05476	0.03284	0.97461	0.03201	**74**
75	0.06197	0.96274	0.05966	0.03569	0.97610	0.03484	**75**
76	0.06777	0.96570	0.06545	0.03919	0.97758	0.03831	**76**
77	0.07418	0.96867	0.07186	0.04356	0.98056	0.04271	**77**
78	0.08101	0.97164	0.07871	0.04833	0.98205	0.04746	**78**
79	0.08838	0.97461	0.08614	0.05373	0.98355	0.05285	**79**
80	0.09616	0.97610	0.09386	0.05961	0.98355	0.05863	**80**
81	0.10411	0.97758	0.10178	0.06568	0.98504	0.06470	**81**
82	0.11279	0.98056	0.11060	0.07216	0.98653	0.07119	**82**
83	0.12235	0.98205	0.12015	0.07933	0.98653	0.07826	**83**
84	0.13270	0.98504	0.13071	0.08757	0.98802	0.08652	**84**
85	0.14372	0.98802	0.14200	0.09731	0.98802	0.09614	**85**
86	0.15585	0.98952	0.15422	0.10833	0.98952	0.10719	**86**
87	0.16848	0.99251	0.16722	0.11859	0.99101	0.11752	**87**
88	0.18061	0.99251	0.17926	0.12860	0.99101	0.12744	**88**
89	0.19246	0.99251	0.19102	0.14146	0.99251	0.14040	**89**
90	0.20465	0.99251	0.20312	0.15550	0.99251	0.15434	**90**
91	0.21911	0.99251	0.21747	0.17006	0.99251	0.16879	**91**
92	0.23655	0.99251	0.23478	0.18573	0.99251	0.18434	**92**
93	0.25575	0.99251	0.25383	0.20126	0.99251	0.19975	**93**
94	0.27483	0.99251	0.27277	0.21790	0.99251	0.21627	**94**

	Males			Females			
Age	Original ELT15 (mid-91)	Adjust-ment	Adjusted ELT15 (end-92)	Original ELT15 (mid-91)	Adjust-ment	Adjusted ELT15 (end-92)	Age
95	0.29311	0.99251	0.29091	0.23619	0.99251	0.23442	**95**
96	0.31104	0.99251	0.30871	0.25344	0.99251	0.25154	**96**
97	0.32919	0.99251	0.32672	0.26820	0.99251	0.26619	**97**
98	0.34783	0.99251	0.34522	0.28352	0.99251	0.28140	**98**
99	0.36712	0.99251	0.36437	0.30331	0.99251	0.30104	**99**
100	0.38705	0.99251	0.38415	0.32489	0.99251	0.32246	**100**
101	0.40760	0.99251	0.40455	0.34562	0.99251	0.34303	**101**
102	0.42870	0.99251	0.42549	0.36186	0.99251	0.35915	**102**
103	0.45030	0.99251	0.44693	0.37992	0.99251	0.37707	**103**
104	0.47428	0.99251	0.47073	0.40045	0.99251	0.39745	**104**
105	0.49634	0.99251	0.49262	0.43618	0.99251	0.43291	**105**
106	0.51841	0.99251	0.51453	0.45994	0.99251	0.45649	**106**
107	0.54041	0.99251	0.53636	0.48389	0.99251	0.48027	**107**
108	0.56225	0.99251	0.55804	0.50791	0.99251	0.50411	**108**
109	0.58385	0.99251	0.57948	0.53190	0.99251	0.52792	**109**
110	1.00000	1.00000	1.00000	0.67391	0.99251	0.66886	**110**
111	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	**111**

Appendix 2. Derived base mortality rates for ERM population (mid-2001)

The table below shows the derivation of base mortality rates for the ERM population, assumed applicable as at mid-2001, for males and females respectively. Strictly speaking, these rates have been based on England and Wales population mortality (rather than UK population mortality).

		Males				**Females**			
Age	**qx (ILT2000-02 - E&W)**	**Multiplier (x100) for ERM lives as at end-1992**	**Further Adjust-ments for faster ERM-lives improve-ments to mid-2001**	**Derived ERM base mortality as at mid-2001**	**qx (ILT2000-02 - E&W)**	**Multiplier (x100) for ERM lives as at end-1992**	**Further Adjust-ments for faster ERM-lives improve-ments to mid-2001**	**Derived ERM base mortality as at mid-2001**	**Age**
60	0.010578	**58.4**	0.97	0.005992	0.006498	**58.4**	0.98	0.003719	**60**
61	0.011638	58.4	0.97	0.006593	0.007147	58.4	0.98	0.004090	**61**
62	0.012796	58.4	0.97	0.007249	0.007682	58.4	0.98	0.004397	**62**
63	0.013968	58.4	0.97	0.007913	0.008479	58.4	0.98	0.004853	**63**
64	0.015253	58.4	0.97	0.008641	0.009441	58.4	0.98	0.005403	**64**
65	0.017050	**58.4**	0.97	0.009658	0.010207	**58.4**	0.98	0.005842	**65**
66	0.018796	59.3	0.97	0.010804	0.011511	59.3	0.98	0.006685	**66**
67	0.021076	60.1	0.97	0.012291	0.012606	60.1	0.98	0.007427	**67**
68	0.023175	61.0	0.97	0.013708	0.014040	61.0	0.98	0.008390	**68**
69	0.026051	61.8	0.97	0.015627	0.015581	61.8	0.98	0.009443	**69**
70	0.028582	**62.7**	0.97	0.017383	0.017373	**62.7**	0.98	0.010675	**70**
71	0.032214	63.6	0.97	0.019886	0.019814	63.6	0.98	0.012357	**71**
72	0.035860	64.6	0.97	0.022464	0.022089	64.6	0.98	0.013980	**72**
73	0.039726	65.5	0.97	0.025248	0.024716	65.5	0.98	0.015870	**73**
74	0.044742	66.5	0.97	0.028843	0.027662	66.5	0.98	0.018016	**74**
75	0.049368	**67.4**	0.97	0.032276	0.031149	**67.4**	0.98	0.020575	**75**
76	0.054356	68.0	0.97	0.035874	0.034590	68.0	0.98	0.023064	**76**
77	0.059981	68.7	0.97	0.039959	0.038358	68.7	0.98	0.025817	**77**
78	0.065731	69.3	0.97	0.044198	0.042133	69.3	0.98	0.028622	**78**
79	0.072318	70.0	0.97	0.049076	0.046680	70.0	0.98	0.032004	**79**
80	0.078806	70.6	0.97	0.053968	0.052349	**70.6**	0.98	0.036219	**80**
81	0.085318	71.4	0.97	0.059056	0.057872	71.4	0.98	0.040472	**81**
82	0.093110	72.1	0.97	0.065136	0.064828	72.1	0.98	0.045819	**82**
83	0.102888	72.9	0.97	0.072735	0.071918	72.9	0.98	0.051366	**83**
84	0.116022	73.6	0.97	0.082875	0.082805	73.6	0.98	0.059758	**84**
85	0.128809	**74.4**	0.97	0.092959	0.092279	**74.4**	0.98	0.067282	**85**
86	0.140370	75.5	0.97	0.102827	0.101712	75.5	0.98	0.075277	**86**
87	0.150541	76.6	0.97	0.111913	0.113043	76.6	0.98	0.084903	**87**
88	0.166548	77.8	0.97	0.125622	0.125869	77.8	0.98	0.095918	**88**
89	0.181754	78.9	0.97	0.139067	0.139988	78.9	0.98	0.108214	**89**
90	0.189970	**80.0**	0.97	0.147417	0.153728	**80.0**	0.98	0.120523	**90**
91	0.202171	80.5	0.97	0.157865	0.170261	80.5	0.98	0.134319	**91**
92	0.224125	81.0	0.97	0.176095	0.187014	81.0	0.98	0.148452	**92**

Age	qx (ILT2000-02 - E&W)	<u>**Males**</u> Multiplier (x100) for ERM lives as at end-1992	Further Adjust-ments for faster ERM-lives improve-ments to mid-2001	Derived ERM base mortality as at mid-2001	qx (ILT2000-02 - E&W)	<u>**Females**</u> Multiplier (x100) for ERM lives as at end-1992	Further Adjust-ments for faster ERM-lives improve-ments to mid-2001	Derived ERM base mortality as at mid-2001	Age
93	0.239919	81.5	0.97	0.189668	0.206552	81.5	0.98	0.164973	**93**
94	0.258804	82.0	0.97	0.205853	0.219945	82.0	0.98	0.176748	**94**
95	0.279776	**82.5**	0.97	0.223891	0.239697	**82.5**	0.98	0.193795	**95**
96	0.296090	83.6	0.97	0.24022	0.258725	83.6	0.98	0.212070	**96**
97	0.326213	84.8	0.97	0.268266	0.275108	84.8	0.98	0.228572	**97**
98	0.341056	85.9	0.97	0.284244	0.298858	85.9	0.98	0.251643	**98**
99	0.352780	87.1	0.97	0.297916	0.316375	87.1	0.98	0.269927	**99**
100	0.389133	**88.2**	0.97	0.332919	0.342811	**88.2**	0.98	0.296312	**100**
101	0.401262	89.0	0.97	0.346565	0.361008	89.0	0.98	0.315013	**101**
102	0.422034	89.9	0.97	0.367944	0.377971	89.9	0.98	0.332926	**102**
103	0.443298	90.7	0.97	0.390095	0.396835	90.7	0.98	0.352809	**103**
104	0.466905	91.6	0.97	0.414673	0.418279	91.6	0.98	0.375317	**104**
105	0.488622	**92.4**	0.97	0.437942	0.455600	**92.4**	0.98	0.412555	**105**
106	0.510349	93.3	0.97	0.461623	0.480418	93.3	0.98	0.439030	**106**
107	0.532007	94.1	0.97	0.4856	0.505434	94.1	0.98	0.466101	**107**
108	0.553507	95.0	0.97	0.509789	0.530523	95.0	0.98	0.493657	**108**
109	0.574771	**95.8**	0.97	0.534112	0.555582	**95.8**	0.98	0.521602	**109**

Appendix 3. Specimen mortality improvement factors

The tables below show the percentage decrease in mortality rates for specimen ages over specimen calendar years.

Males

Year / Age	2001/2002	2006/2007	2011/2012	2016/2017	2021/2022	2026/2027	2031/2032
60	2.11%	2.22%	1.85%	1.53%	1.28%	1.15%	1.15%
65	5.41%	1.84%	1.85%	1.53%	1.28%	1.15%	1.15%
70	5.49%	4.20%	1.60%	1.53%	1.28%	1.15%	1.15%
75	3.80%	4.26%	3.13%	1.39%	1.28%	1.15%	1.15%
80	3.96%	3.05%	3.17%	2.23%	1.24%	1.15%	1.15%
85	2.54%	3.16%	2.38%	2.25%	1.53%	1.15%	1.15%
90	2.16%	2.15%	2.45%	1.82%	1.54%	1.15%	1.15%
95	0.70%	1.87%	1.80%	1.86%	1.39%	1.15%	1.15%
100	2.30%	0.83%	1.62%	1.50%	1.40%	1.15%	1.15%
105	1.73%	1.97%	0.94%	1.40%	1.27%	1.15%	1.15%
110	1.15%	1.56%	1.68%	1.04%	1.24%	1.15%	1.15%

Females

Year / Age	2001/2002	2006/2007	2011/2012	2016/2017	2021/2022	2026/2027	2031/2032
60	1.62%	1.22%	1.21%	1.19%	1.18%	1.15%	1.15%
65	4.68%	1.56%	1.21%	1.19%	1.18%	1.15%	1.15%
70	4.66%	4.17%	1.48%	1.19%	1.18%	1.15%	1.15%
75	2.64%	4.16%	3.62%	1.40%	1.18%	1.15%	1.15%
80	2.69%	2.42%	3.61%	3.01%	1.30%	1.15%	1.15%
85	1.67%	2.46%	2.19%	3.00%	2.29%	1.15%	1.15%
90	0.70%	1.59%	2.22%	1.93%	2.29%	1.15%	1.15%
95	0.25%	0.76%	1.51%	1.96%	1.63%	1.15%	1.15%
100	0.33%	0.38%	0.83%	1.42%	1.65%	1.15%	1.15%
105	0.12%	0.45%	0.52%	0.91%	1.32%	1.15%	1.15%
110	0.12%	0.26%	0.57%	0.68%	1.00%	1.15%	1.15%

Source: GAD 2002-based population projections for the United Kingdom, adjusted.

Appendix 4. Calculation of NNEG values (costs as a percentage of cash advance)

The table below provides more detail as to how the values in Table 3.13 (costs as a percentage of cash advance) have been calculated. The example considered here is for a female, aged 70 at commencement.

Year (t)	Age at start yr t	Prob(survival to start yr t)	Prob exit in yr t	Mortgage Face Value end yr t	Put Option	Expected NNEG cost
1	70	1.0000	0.0070	32,250.00	0.00	0.00
2	71	0.9930	0.0086	34,668.75	0.00	0.00
3	72	0.9845	0.0128	37,268.91	0.00	0.00
4	73	0.9719	0.0171	40,064.07	0.01	0.00
5	74	0.9553	0.0189	43,068.88	0.14	0.00
6	75	0.9372	0.0207	46,299.05	1.20	0.02
7	76	0.9179	0.0224	49,771.47	5.76	0.12
8	77	0.8973	0.0243	53,504.33	19.10	0.42
9	78	0.8754	0.0263	57,517.16	49.32	1.13
10	79	0.8525	0.0286	61,830.95	106.71	2.60
11	80	0.8281	0.0314	66,468.27	202.69	5.28
12	81	0.8021	0.0341	71,453.39	348.81	9.55
13	82	0.7747	0.0376	76,812.39	555.99	16.21
14	83	0.7455	0.0413	82,573.32	833.89	25.67
15	84	0.7147	0.0470	88,766.32	1,190.74	40.01
16	85	0.6811	0.0522	95,423.79	1,633.14	58.05
17	86	0.6456	0.0578	102,580.58	2,166.16	80.82
18	87	0.6083	0.0647	110,274.12	2,793.39	109.89
19	88	0.5689	0.0727	118,544.68	3,517.19	145.50
20	89	0.5276	0.0820	127,435.53	4,338.79	187.60
21	90	0.4843	0.0916	136,993.20	5,258.49	233.29
22	91	0.4400	0.1023	147,267.69	6,275.85	282.56
23	92	0.3949	0.1138	158,312.76	7,389.86	332.27
24	93	0.3500	0.1272	170,186.22	8,599.02	382.89
25	94	0.3055	0.1371	182,950.19	9,901.52	414.60
26	95	0.2636	0.1508	196,671.45	11,295.29	448.83
27	96	0.2239	0.1650	211,421.81	12,778.12	472.03
28	97	0.1869	0.1777	227,278.45	14,347.74	476.58
29	98	0.1537	0.1951	244,324.33	16,001.83	479.72
30	99	0.1237	0.2084	262,648.66	17,738.12	457.36
31	100	0.0979	0.2277	282,347.30	19,554.39	435.98
32	101	0.0756	0.2422	303,523.35	21,448.51	392.85
33	102	0.0573	0.2562	326,287.60	23,418.47	343.90
34	103	0.0426	0.2716	350,759.17	25,462.39	294.79
35	104	0.0311	0.2887	377,066.11	27,578.54	247.26
36	105	0.0221	0.3166	405,346.07	29,765.33	208.20
37	106	0.0151	0.3360	435,747.03	32,021.36	162.43
38	107	0.0100	0.3553	468,428.05	34,345.36	122.33

Year (t)	Age at start yr t	Prob(survival to start yr t)	Prob exit in yr t	Mortgage Face Value end yr t	Put Option	Expected NNEG cost
39	108	0.0065	0.3745	503,560.16	36,736.22	88.89
40	109	0.0040	0.3933	541,327.17	39,193.01	62.31
41	110	0.0025	0.4230	581,926.71	41,714.95	43.28
42	111	0.0014	0.4520	625,571.21	44,301.43	28.34
43	112	0.0008	0.4803	672,489.05	46,951.99	17.49
44	113	0.0004	0.5078	722,925.73	49,666.30	10.16
45	114	0.0002	0.5345	777,145.16	52,444.20	5.56
46	115	0.0001	0.5605	835,431.05	55,285.66	2.86
47	116	0.0000	0.5857	898,088.37	58,190.79	1.38
48	117	0.0000	0.6104	965,445.00	61,159.83	0.63
49	118	0.0000	0.6345	1,037,853.38	64,193.17	0.27
50	119	0.0000	0.6580	1,115,692.38	67,291.29	0.11

Total NNEG value	7,131.99
NNEG value as a %'age of cash advance	23.8

Appendix 5. Calculation of NNEG values (expressed as a yield cost per annum)

The table below provides more detail as to how the values in Table 3.13 (expressed as a yield cost per annum) have been calculated. The example considered here is for a female, aged 70 at commencement. The NNEG charge of 0.76%pa was derived so as to produce total NNEG margins equal to the monetary cost of the NNEG. The NNEG margins have been discounted at our assumed risk-free rate (of 4.75%).

Year (t)	Age at start yr t	Mortgage Face Value end yr t (incl. NNEG charge)	Mortgage Face Value end yr t (excl. NNEG charge)	Excess mortgage face value in yr t as a result of NNEG charge	Prob exit in yr t	Discount factor at risk free rate	PV of expected NNEG margins
1	70	32,250.00	32,021.75	228.25	0.0070	0.95465	1.52
2	71	34,668.75	34,179.75	489.00	0.0085	0.91136	3.81
3	72	37,268.91	36,483.19	785.72	0.0126	0.87004	8.62
4	73	40,064.07	38,941.85	1,122.22	0.0166	0.83058	15.47
5	74	43,068.88	41,566.21	1,502.67	0.0180	0.79292	21.47
6	75	46,299.05	44,367.43	1,931.62	0.0194	0.75697	28.33
7	76	49,771.47	47,357.43	2,414.05	0.0206	0.72264	35.90
8	77	53,504.33	50,548.93	2,955.41	0.0218	0.68987	44.54
9	78	57,517.16	53,955.50	3,561.66	0.0230	0.65859	53.94
10	79	61,830.95	57,591.66	4,239.29	0.0244	0.62872	64.92
11	80	66,468.27	61,472.86	4,995.41	0.0260	0.60021	78.08
12	81	71,453.39	65,615.62	5,837.76	0.0274	0.57300	91.61
13	82	76,812.39	70,037.57	6,774.82	0.0292	0.54701	108.04
14	83	82,573.32	74,757.53	7,815.79	0.0308	0.52221	125.65
15	84	88,766.32	79,795.57	8,970.75	0.0336	0.49853	150.25
16	85	95,423.79	85,173.13	10,250.67	0.0355	0.47592	173.40
17	86	102,580.58	90,913.09	11,667.49	0.0373	0.45434	197.78
18	87	110,274.12	97,039.88	13,234.24	0.0393	0.43374	225.81
19	88	118,544.68	103,579.57	14,965.11	0.0414	0.41407	256.35
20	89	127,435.53	110,559.97	16,875.56	0.0432	0.39529	288.43
21	90	136,993.20	118,010.80	18,982.40	0.0444	0.37737	317.80
22	91	147,267.69	125,963.75	21,303.93	0.0450	0.36026	345.54
23	92	158,312.76	134,452.67	23,860.09	0.0450	0.34392	368.96
24	93	170,186.22	143,513.67	26,672.55	0.0445	0.32832	389.93
25	94	182,950.19	153,185.30	29,764.89	0.0419	0.31344	390.64
26	95	196,671.45	163,508.72	33,162.73	0.0397	0.29922	394.30
27	96	211,421.81	174,527.86	36,893.95	0.0369	0.28565	389.31
28	97	227,278.45	186,289.60	40,988.85	0.0332	0.27270	371.28
29	98	244,324.33	198,843.97	45,480.36	0.0300	0.26034	354.95
30	99	262,648.66	212,244.41	50,404.24	0.0258	0.24853	323.00
31	100	282,347.30	226,547.93	55,799.37	0.0223	0.23726	295.18
32	101	303,523.35	241,815.39	61,707.96	0.0183	0.22650	256.00
33	102	326,287.60	258,111.75	68,175.86	0.0147	0.21623	216.48

Year (t)	Age at start yr t	Mortgage Face Value end yr t (incl. NNEG charge)	Mortgage Face Value end yr t (excl. NNEG charge)	Excess mortgage face value in yr t as a result of NNEG charge	Prob exit in yr t	Discount factor at risk free rate	PV of expected NNEG margins
34	103	350,759.17	275,506.34	75,252.83	0.0116	0.20643	179.85
35	104	377,066.11	294,073.19	82,992.92	0.0090	0.19706	146.63
36	105	405,346.07	313,891.29	91,454.78	0.0070	0.18813	120.34
37	106	435,747.03	335,044.97	100,702.06	0.0051	0.17960	91.74
38	107	468,428.05	357,624.23	110,803.82	0.0036	0.17145	67.67
39	108	503,560.16	381,725.15	121,835.01	0.0024	0.16368	48.25
40	109	541,327.17	407,450.26	133,876.91	0.0016	0.15626	33.26
41	110	581,926.71	434,909.04	147,017.66	0.0010	0.14917	22.75
42	111	625,571.21	464,218.31	161,352.89	0.0006	0.14241	14.70
43	112	672,489.05	495,502.79	176,986.26	0.0004	0.13595	8.96
44	113	722,925.73	528,895.58	194,030.15	0.0002	0.12978	5.15
45	114	777,145.16	564,538.77	212,606.39	0.0001	0.12390	2.79
46	115	835,431.05	602,584.01	232,847.03	0.0001	0.11828	1.43
47	116	898,088.37	643,193.19	254,895.18	0.0000	0.11292	0.68
48	117	965,445.00	686,539.09	278,905.91	0.0000	0.10780	0.31
49	118	1,037,853.38	732,806.15	305,047.23	0.0000	0.10291	0.13
50	119	1,115,692.38	782,191.23	333,501.15	0.0000	0.09824	0.05
						Total NNEG value	7,131.99