Pension Schemes *versus* Real Estate

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Abstract. The demographic, economic and social changes that have characterized the last decades, and the dramatic financial crisis that has taken place since 2008, have led to a demand for structural changes in the pension sector and a growing interest in individual pension products. Hence the need, for most elderly people, to liquidate their fixed assets, which are usually the homes in which they live. This highlights products such as reverse mortgages and domestic reversibility plans. Within this context, we propose a contractual scheme where an immediate life annuity is obtained by paying a single-premium in the form of *real estate rights (RERs)*, for example by transferring to an insurer the property title of a house or a similar realty, while keeping its usufruct or a restricted bundle of rights. The level of the installments depends on the *fair value* of the transferred RER at the contract's issue, the life expectancy of the insured and the expected growth rate of the real estate market value. The contract design is developed by considering the control of the financial risk inherent in the contract itself, because of the prospective changes in the value of the RERs, and the level of the insurer's leverage. Finally, we provide some numerical evidence of the proposed contractual structure, in order to compare the level of the installments according to the house return forecasts in different European countries.

Keywords: Reverse mortgage; home reversion plan; real estate; personal pension product

1. Introduction

A severe financial crisis that has been affecting markets for over a decade is still causing significant socio-economic shifts that now appear to have developed into established structures. Its major impact on the pension sphere has accelerated changes that had already been unfolding within this sector, leading to striking consequences in an economic, social and political sense. This is evident if one considers the involvement of specific population segments, such as the elderly and those in need of care and medical

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assistance. The high number of over-65 individuals in most industrialized countries and the prospective increase of the "oldest old" (80+) in the near future challenge the financial sustainability of traditional and public security pension schemes (first pillar); thus, governmental reforms in individual countries have raised pension age and/or reduced their installments in financial and in real terms. Such reductions have not been offset by decreases in the costs of health care systems, which are the most relevant part of the monthly budget of the above population group. This is true even in those countries where most treatments are provided by governmental health care structures [in Italy, for example, the amount of the contribution expected from the patient has crept-up and the contribution exemption standards have been raised].

The other two *pillars*, namely *employer pensions* and *personal pension products*, are currently also affected by financial deficiencies and lack of stability (cf. Fornero et al. (2016), Guerin (2016)). A number of the former have collapsed as a consequence of the crisis and many others have been conceived as additional support to a good basic plan and not a substitute for it. That is why economic sciences Nobel laureate Robert Merton has urged us to re-imagine pension provision structures (cf. Guerin (2016)), adding that the responsibility to do so would fall into future users' hands.

The described situation has led many elderly people to *liquidate* their fixed assets, (noting that, for many of the elderly, the house in which they live is the predominant fixed asset) and some *financial institutions* to satisfy the resulting demand by developing products such as *reverse mortgage* and *home reversion plans* (cf. e.g. the report of the Institute and Faculty of Actuaries (May 2014)).

The aim of this paper is to set a contractual scheme where a single premium is paid by the insured by transferring to an insurer *real estate rights* (RERs) such as the full or the bare property of a house. We will describe the contract details and provide an analysis of the interest rates involved. In sect.2, subsections 2.1, 2.2 and 2.3, we describe the reverse mortgage plans and the home reversion plans, providing the most relevant contributions on the topic from the scientific literature. In sect.3 we present a new contract in the context of the real estate pension schemes (REPS), paying attention to both the Insurer's and the Insured's perspectives, considering also an analysis from a welfare viewpoint.

We also consider the differences between REPS and other home-asset based financial products existing on the market. Sect.4 deals with the contractual details, highlighting in particular, in addition to the demographic risk, the financial risk that emerges from the contract in question. Section 5 is devoted to a numerical application aimed at quantifying the amount of installments in different countries, according to the house return forecasts. Finally, some conclusions close the paper.

2. Reverse mortgage and home reversion plans. Academic literature

2.1. Reverse mortgage plans

With a reverse mortgage, the house owner may use a part or the totality of the home equity value to get a *loan* in the form of a lump sum (for example, for paying for long-term care expenses) or a retirement income stream (or a combination of both), without selling the house. In the guide to Reverse Mortgages presented by the National Reverse Mortgage Lenders Association in the United States, the following definition appears: "*The product was conceived as a means to help retirees with limited income use the accumulated wealth in their homes to cover basic monthly living expenses and pay for health care. However, there is no restriction how reverse mortgage proceeds can be used. (...) The borrower is not required to pay back the loan until the home is sold or otherwise vacated. As long as the borrower lives in the home he or she is not required to make any monthly payments towards the loan balance. The borrower must remain current on property taxes, home owners insurance and homeowners association dues (if applicable)"*. (NRMLA, 2018). This is confirmed in the guidelines by the UK Equity Release Council, according to which a *lifetime mortgage* constitutes a long-term loan determined on the basis of the ownership of a home, given up under specific conditions: "*these flows as well as the loan are repaid by means of the house when the house owner dies or move into long term care. A Lifetime Mortgage allows to receive a lump sum or periodic amounts*" (Equity Release Council UK).

With a *reverse mortgage,* when the person dies or moves from the house, the loan is repaid together with the rolled-up interest (which might also be paid during the loan period) and any difference in value is paid to the home owner or his/her heirs. The loaned lump sum or income stream needs to be proportional to the liquidation value of the home/asset whose property remains with the borrower, and who is entitled to continue using it as long as alive, until his/her death. Merton maintains that "this is going to become one of the key means of funding retirement in the future" (cf. Guerin (2016)).

Reverse mortgages are usually made available to homeowners 62 years and older and are currently experiencing a rapid diffusion in the USA (cf. Nakajima et al. (2017)), as illustrated by the American Housing Survey data (United States Census Bureau), denoting how this trend can be expected to rise even further in the near future. In the US (cf. Merton et al. (2016)), the most common reverse mortgage is provided by the Federal Housing Administration; other forms exist, too, such as the so-called proprietary reverse mortgages, provided by private firms, which, however, are little past their infancy at present. However, it is spreading to other parts of the world, too, such as Canada, Australia, some Asian economies (e.g. China), as well as some European countries, albeit with diverging connotations and legal profiles. In the UK, in particular, they are usually referred to as "Equity Release" (contracts) and are divided into two macro-categories: Lifetime Mortgages and Home Reversion Plans, both available to 55+ year-old home owners.

2.2. *Home reversion plans*

By a *home reversion plan*, instead, the homeowners may use all or part of their property's value, while keeping the right to remain in the house for their entire life. In accordance with the homeowner's age and health, the provider furnishes a tax-free (according to jurisdiction) lump sum or regular cash payments and a lifetime lease. The property of the asset is usually transferred in full to the contract provider while the homeowner gets the right to continue living in the house as an effect of the lifetime lease included in the contract scheme. *Home reversion plans* are considered *high risk products*, since the homeowner transfers to the contract provider an *equity* that may turn out to be much higher than what he/she gets in compensation if he/she dies earlier than expected. This, of course, may also happen even if a person purchases a single-premium life annuity and dies after a short while, but in such a case the "game" is to be considered *fair* because of the actuarial calculations and the pooling of risks that underpin any such insurance contract.

2.3. *Academic literature*

Recent academic studies have concentrated on reverse mortgage products, as well as other contract architectures that are able to effectively respond to market demands. Several studies have identified and analyzed the evolutionary dynamics and innovation perspectives of this market, such as Scanlon et al. (2008) and Valente et al. (2013), while Najakima et al. (2017) have explored the dominant features of reverse mortgage demand, considering the life-cycle of retirement. Subsequently, Merton et al. (2016), have proposed reverse mortgage contracts, also considering the role of the government as regulator and risk-bearing provider.

In addition, a wider range of studies have concentrated on identifying risk sources and their measurement. In Shao et al. (2015), the interplay of (i) house price risk, (ii) longevity risk on pricing and (iii) reverse mortgage loan risk analysis was considered within a stochastic multi-period model. This study has focused, in particular, on house price risk impact, constituting an idiosyncratic element.

Alai et al. (2014) have investigated cash flows and risk components in the context of reverse mortgage and home reversion contracts, approaching them from the provider's perspective. Chen et al. (2010) have analyzed the manifold connections between risk sources and reverse mortgage contracts' capital adequacy.

De La Fuente et al. (2018) consider the case of no-negative-equity guarantee (NNEG), i.e. the guarantee that ensures that the debt never exceeds the overall value of the property. They provide a sensitivity analysis when the NNEG embedded in the reverse mortgage varies with some relevant factors, such as the value of the mortgage roll-up rate, the rental yield rate, the gender and the age of the borrower.

A considerable portion of the existing literature has concentrated on the homeowner's perspective. Among these studies, Hanewald et al. (2016) focus on equity release products from a retired homeowner's point of view, thus taking into account longevity, long-term care, house price and investment risk; this study addresses some relevant issues regarding the optimal choice decision problem, drawing attention to the comparison between house equity release products and different home-reversion plans. Fornero et al. (2016) have provided an economic analysis of the reverse mortgage demand's determinants.

3. *Real estate pension schemes (REPS)*

Within the context of personal pension products, a new contractual scheme is proposed where an immediate life annuity is obtained by paying a single-premium in the form of *real estate rights (RERs)*, for example by transferring to an insurer some of the rights subsumed in the full property of a house or a similar realty.

The level of the installments should depend upon the *fair value* of the transferred RER(s) at the inception of the life annuity (which is a part of the *real estate asset full value*, for example, the property title), the life expectancy of the insured [that determines the expected number of the installments and may influence the *fair value* of the transferred RER(s); for example, the value of the property title increases with the aging of the holder of the usufruct (or other rights) and turns into the full property at his death and the expected growth rate of the real estate market value].

Insurer's perspective

During the installment payment period – usually the residual life of the insured – the insurer capitalizes the holding gains of the acquired RER, which, in most jurisdictions, are tax free until the liquidation of the RER and/or the real estate asset in which such rights are incorporated. At the end of the installment payment period, the insurer may decide to liquidate the capitalized RER and/or the other rights that may have come to existence during or at the end of such period (for example, the full property of the real estate asset), make them cash-profitable (for example by leasing the real estate asset) or use them for other purposes.

Even though the insurer undergoes a financial stress due to the fact that the insurance premium is not paid in cash while insurance installments are, the insurer, sooner or later, might resell (even through installment payments) the acquired RERs or design and sell *reverse financial products,* for example endowment plans, containing options for the holder to buy the RERs. On a large scale and long term basis, the development of this kind of contract is not expected to be much different from investing traditional cash premium payments in real estate portfolios.

A welfare perspective

Most home owners in Europe and the USA are older than 60 years (Mudrazija et al, 2017). The countries with the leading statistics are considered to be Spain, Italy and the USA where homeowners older than 60 have been increasing in numbers during the crisis period (2012-2016), probably due to the difficulties in selling (or adequately selling) their properties; in Italy, one third of homeowners are 65 or older (Agenzia delle Entrate, 2017). These people, who, in the middle term, will face the burden of ageing with limited pensions and increasing long term care costs, might be able to cope with these financial stresses by annuitizing their housing wealth (Mudrazija et al, 2017).

On the other hand, the accessibility to homeownership for younger adults (30 to 40 years) has been seriously impaired in the last ten years, due to lower real incomes, precarious employment conditions, and higher mortgage deposit requirements (Aalbers, 2012). Many people have not been able to accumulate savings for down payments and mortgage offers have been reduced due to credit restrictions and money shortage (Lennarz et al, (2016)), a trend that is expected to continue in the middle range.

In such a context, a large scale development of REPS and *reverse financial products* (for example, saving plans convertible into the RERs that insurers have obtained at the inception of REPS) may build a bridge to the transfer of home properties among the abovementioned generations by compensating for their money shortages and savings shortcomings with positive effects on the quality of life of those. Besides, in those countries where the private building sector plays an important role in economics (like Italy, Spain and France), an additional boost to the national economy might come from the recovery of the home property market and the possible development of derivative financial products linked to the portfolio of RER that the insurers may collect.

Insured's perspective

During the installment payment period – usually his/her residual lifetime – the insured receives an annuity whose amount is a function of the *fair value* of the RER he/she transfers to the insurer. Even though such a transfer is made immediately at the inception of the contract, the taxation of the annuity, *if any*, is diluted in his/her residual life-time at a rate that, in most progressive taxation systems, would be lower than the one he/she would pay on the capital gain he/she made whether selling the asset. The proposed contract might be entered also by people whose credit profiles are poor or deficient, and as such would be prevented to access any form of bank credit.

Basic differences between REPS and other home-asset based financial products

The proposed REPS is an *assurance type* which differs from the *financial types*, such as lifetime mortgage or home reversion plans.

In a basic *lifetime mortgage*, the home owner retains the real estate ownership while receiving an amount of cash that will be repaid through the liquidation of the asset when the owner dies. Variants of such products include the payment of interests, that may be made by the home owner during and for the rest of his/her life or rolled up until the asset is liquidated and the mortgage is repaid or the portion of the equity value (upon which the mortgage is made) is released.

Home reversion plans are compound financial products. In a basic arrangement, the contract provider, usually a bank or a real estate entity dealer, buys the house, or a part of it, and delivers the seller an amount of money that is the difference between the value of the (part of the) house at the time of purchase and the value of a lifetime lease at the same date. The value of the second component is a negative one and depends upon the life expectancy of the seller. There is a limited number of home reversion plans or contracts in the market. They are considered *high-risk products* and may have a strongly speculative nature, precisely because they are not included within massive and collective insurance schemes. Contracts of this kind, at present disseminated in the financial market, even if giving the seller the chance to get regular payments instead of a lump sum, remain exactly financial products.

RERs in an international environment

The composition of the bundle of rights forming the full property of an estate vary in form and number according to jurisdictions; and so the RERs or the combination of those that may be transferred to the insurer.

In countries whose legal systems are largely based on the Civil Law heritage (Germany, Netherlands, Italy, France, Spain and so on) the 'rights in *rem*' govern most of the transaction relating to realty rights. In such countries, selling a *bare property*, that is the title of the property while keeping the right to use and exploit until death, that is the *usufruct* [Grundstücksnießbrauch, in Germany, vrauchtgebruik, in the Netherlands, usufrutto in Italy], is quite common. Less common but not rare is the seller to keep a permanent dwelling right.

In Common Law legal system countries, on the other hand, *personal rights* prevail, which usually implying an extended flexibility in segregating the rights the homeowner may decide to transfer to the insurer from those he intends to keep (leasehold).

An attempt to placing real property rights in a theoretical framework regardless of which legal system they belong to is in Paasch (2003, 2008, 2011).

§4 – Contractual details.

In our assessment, the relationship between the insured, aged x at the issue time, and the insured is based on the contractual arrangement of a basic life annuity, in which what the insured/house owner is prepared to receive for the rest of his/her life at the end of each period is financially equivalent, at the contract issue time, to the value of the full ownership of the house itself. From this point of view, the financial equilibrium at $t = 0$ is plainly of the following type:

$$\mathrm{A} = \mathrm{R}a_x \tag{1}$$

in which R, the installment the insurer will pay at the end of each period, is the unknown entity to determine and:

A is the *fair value* (usually a market value) of the RER that is transferred to the insurer

x is the insured's age at issue time

a_x is the actuarial present value of one monetary unit paid at the end of each period for the entire duration of the policyholder's life, calculated using an appropriate interest rate $i*$ (see details about $i*$ in the following section).

In equation (1), we can immediately recognize two thorny issues for the insurer, to be addressed for a prudent determination of the installment R. They concern the two main risks of the contract, that is the demographic risk and the financial risk.

The demographic risk

The demographic risk arises from the underestimation of the life expectancy of the policyholder because of which the insurer may be obliged to pay the installment for a longer period than expected, so incurring a capital loss. Hedging of this risk can be directed towards:

(a) a reduction in the amount of the installment, resulting from an adjustment of the i^* rate. Since the value of A is fixed and given the same residual lifetimes, this implies a reduction in the i^* rate;

(b) a prudent demographic forecast that takes due account of the longevity effect, which is characteristic of each population.

In the following we consider that the longevity effect is not contained in the interest rate but is absorbed by a consistent projection of future mortality rates.

The financial risk

The financial risk inherent in the contract is the risk of prospective changes in the value of RERs and the insurer leverage. In this paper, it is incorporated into the rate i^* used for the actuarial valuation of the installments and is determined by the difference between a risk-adjusted real estate rate of return i_{re} and a financial rate adjusted for the insurer's leverage, and whose purpose is to allow the insurer to hedge against the risks:

i) of underperformance of the real estate market in relation to expectations;

ii) of possible increases in the interest rate that the insurer will pay for borrowing money during the installment payment period until the liquidation of RERs (which may be an opportunity cost).

From the preceding considerations, the interest rate i^* in (1) is given by the difference:

$$i^* = \alpha i_{re} - \beta i_{rf} \qquad \text{with } 0 < \alpha \leq 1 \text{ and } \beta \geq 1 \qquad (2)$$

in which i_{rf} is a general, long term risk free financial interest rate and the two parameters α and β are respectively calibrated as explained below:

α: is related to the volatility of the real estate market and is intended to mitigate the risk that the insurer bears in this regard; this works as a protection against the volatility of i_{re} in the long run.

β: is a weight which represents the insurer's financial situation and rating that may influence the cost that the insurer pays for borrowing money. This cost, for an insurer that does not need to borrow money for paying the installments, constitutes, in the limit, an opportunity cost and, as such, can be equivalent to the above said general, long term financial risk free interest rate, for $\beta = 1$.

As a consequence of the above, i^* might assume negative values if the second term of the right hand side of the formula 2 is higher than the first one. This may happen if the return of the real estate market value (i_{re}), weighted by the α parameter, is lower than the risk free financial rate (i_{rf}), weighted by the β parameter.

While in the long run, i_{re} is expected to be higher than i_{rf}, the contrary may happen in the contract term. The same effect may be induced by the α parameter, in the case of a high volatility of such rate, even in the medium term.

On the other hand, for those providers whose β parameter is higher (or significantly higher) than 1 (depending on their own financial position which influences their cost of borrowed capital), the second term of the right hand side of formula 2 may assume significantly high values. In this respect, the β parameter is an indicator of the competitiveness of the provider, since the worse is the provider's financial position, the lower is the annuity that can be offered to the insured. In the limit, the optimal provider is the one whose financial position is such that he does not need to resort to the financial market for financing the annuity (this implying that for him i_{rf} is just an *opportunity cost*).

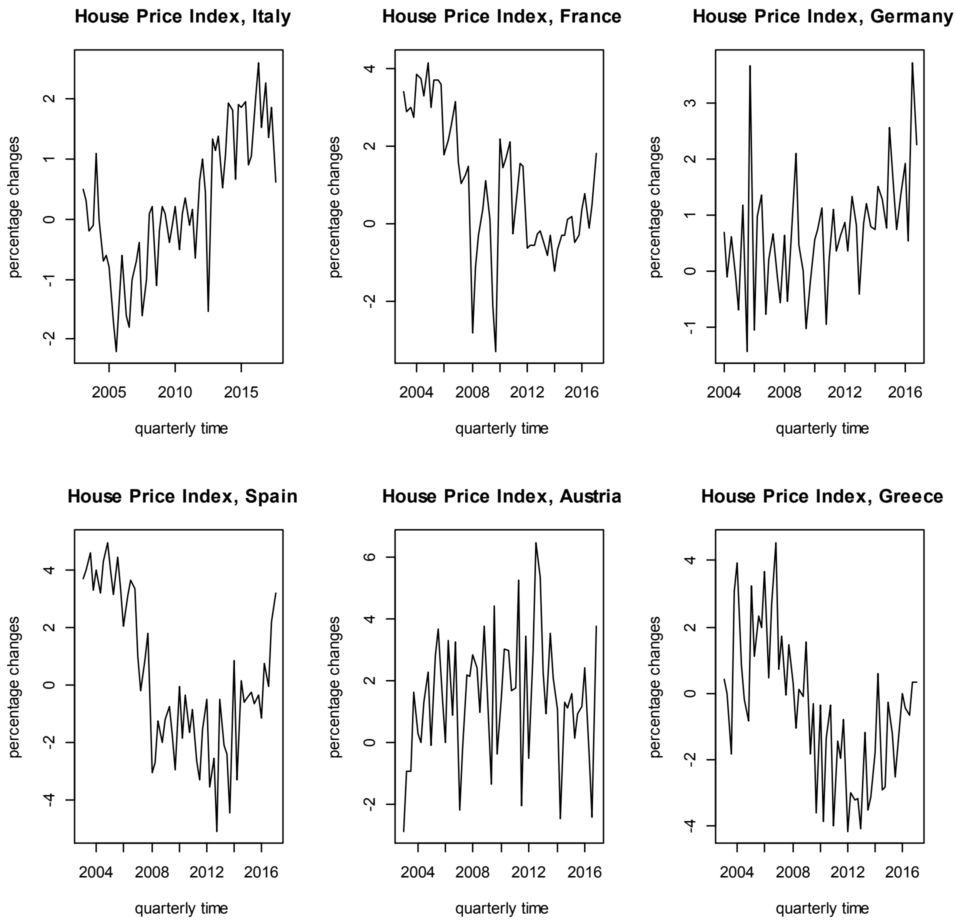
5. Numerical Applications

In this section we provide some numerical evidences of the new contractual structure proposed in the previous section. In particular we will calculate the level of the installments according to the house return forecasts for different European countries.

The property price statistics are collected from a variety of national sources. In particular, the Global Property Guide provides financial information for the residential property buyers for most regions around the world.

The property price time series are typically grouped into monthly series, quarterly series and annual series. In this section, we show a comparative analysis of the quarterly percentage changes since the previous period of the house price index (from herein HPI) among a group of European countries: Italy, France, Germany, Spain, Austria and Greece. The data are collected from 2004 to 2016 for Germany, from 2003 to 2016 for Austria, and from 2003 to 2017 for Italy, France, Spain and Greece. The data collected by the Global Property Guide are provided by several databases of Central Banks and National Statistical Institutes. In particular, the statistics offered by Global Property Guide in the case of Italy are based on the data of the Istituto Nazionale di Statistica-ISTAT. The house price statistics for France come from two different sources: the National Institute of Statistics and Economic Studies (INSEE) and La Chambre des Notaires de Paris. The Germany house price statistics come from the European Central Bank. According to the Global Property Guide, in the case of Spain, the statistics of Banco de España, Ministerio de Fomento, and portals Facilismo, Kyero, Fotocasa and Idealista are used to gather a more up-to-date dataset. For Austria, the Global Property Guide provides the data offered by the Oesterreichische National Bank (OeNB) which releases a residential property price index that is calculated by the University of Technology in Vienna in cooperation with AiB (Austria Immobilienbörse, a platform of 18 real estate agencies). For Greece, Global Property Guide furnishes the data collected by Bank of Greece which publishes quarterly indices of prices of dwellings by region.

Fig. 1. *House Price Index for Italy, France, Germany, Spain, Austria and Greece*



The panel reported in figure 1 shows a marked increase of the HPI trend for Italy and Germany from 2005 to 2017. The French HPI increases just from 2014, after a decreasing trend as for Spain and Greece. The Austrian market exhibits a more stable trend on average.

In order to model the house price returns and construct projections of future house prices, we follow the methodology of Chen et al., 2010, Chinloy et al., 1997, and Li et al., 2010. In particular, in order to model the house price returns we select the best fitting ARMA-GARCH process, which is given in the following equations:

$$y_t = \Psi_j + \sum_{i=1}^{p} \varphi_j y_{t-i} + \sum_{j=1}^{q} \vartheta_j z_{t-j} + z_t \quad (3)$$

$$\sigma_t^2 = \Psi_{\sigma^2} + \sum_{i=1}^{m} \mu_i \sigma_{t-1}^2 + \sum_{j=1}^{n} v_j z_{t-j}^2 \quad (4)$$

where y_t is the continuously compounded house price return at time t, Ψ_j is the constant term for house price returns series, p is the lag length of the autocorrelation term, φ_j is the coefficient for the i^{th} autocorrelation term, q is the lag length of the moving average term, ϑ_j is the coefficient for the j^{th} moving average term, z_t is a series of independently distributed normal disturbances, σ_t^2 is the conditional variance of z_t given information up to time $t-1$, Ψ_{σ^2} is the constant term for the conditional variance process, m is the lag length of the GARCH term, μ_i is the coefficient for the ith GARCH term, n is the lag length of the ARCH term and v_j is the coefficient for the jth ARCH term (according to Shao et al. 2018).

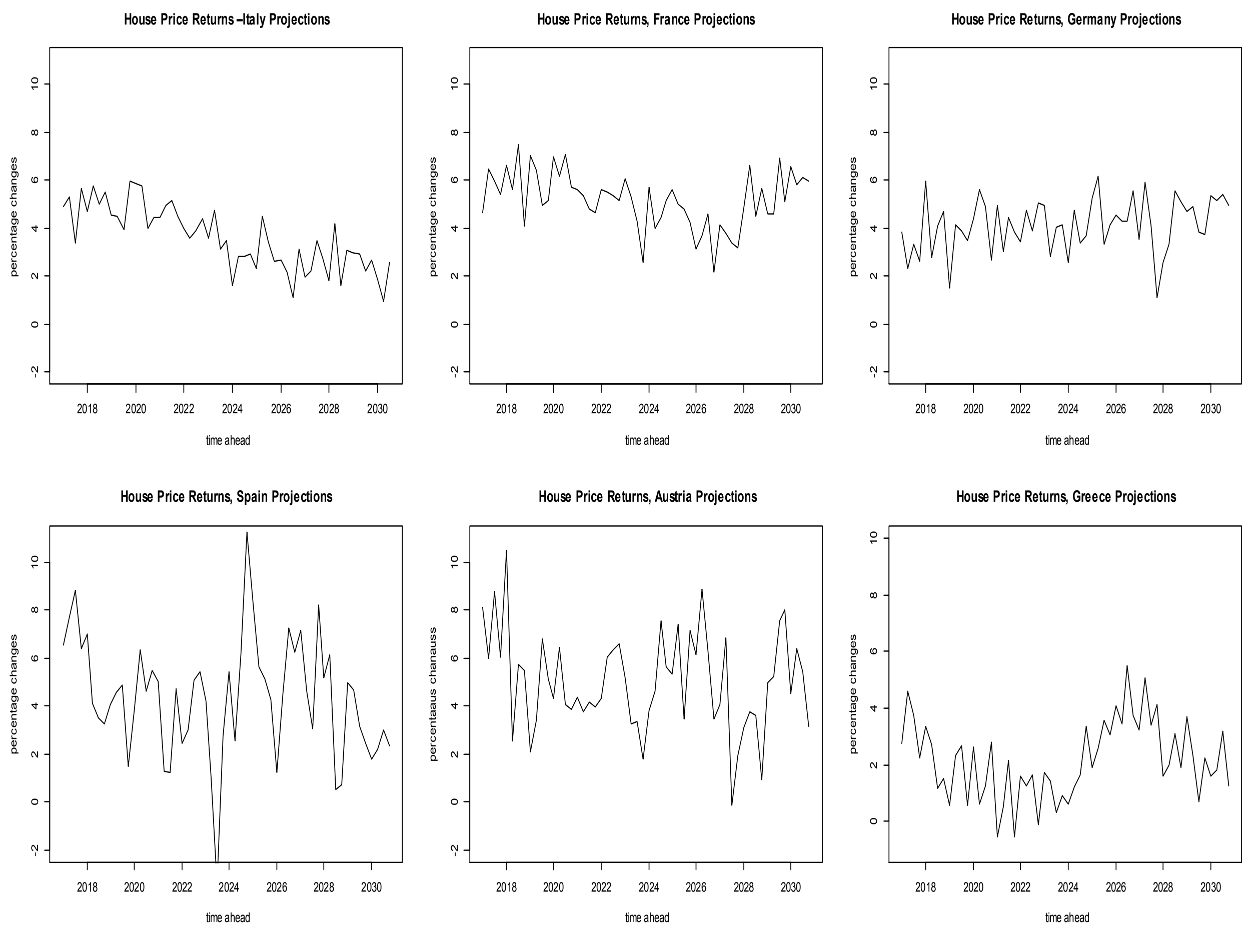
Then, the house prices' percentage changes are forecasted for the six European countries under consideration – Italy, France, Germany, Spain, Austria and Greece - by selecting the best fitting ARMA-GARCH process associated with the lowest value of the following 4 information criteria, Akaike, Bayes, Shibata and Hannan and Quinn, as shown in table 1.

	ARMA GARCH	**AIC**	**BIC**	**Shibata**	**Hannan-Quinn**
ITALY	ARMA(2,2) –GARCH(1,1)	2.3801	2.5914	2.3618	2.4626
FRANCE	ARMA(1,1) – GARCH(1,1)	3.3778	3.5928	3.3583	3.4614
GERMANY	ARMA(1,1) – GARCH(1,1)	3.1485	3.3737	3.1254	3.2349
SPAIN	ARMA(0,1) – GARCH(1,1)	4.5982	4.7774	4.5844	4.6679
AUSTRIA	ARMA(0,0) – GARCH(1,1)	4.3768	4.5215	4.3675	4.4329
GREECE	ARMA(1,2) – GARCH(1,1)	3.9878	4.2387	3.9618	4.0853

Table 1 – *The best ARMA-GARCH model associated with the lowest information criteria for Italy, France, Germany, Spain, Austria and Greece*

Future house returns are simulated on the basis of the selected model for each country. The number of simulations is set to 100,000. Figure 2 shows the comparative analysis among the six different countries and reports the average of 100,000 simulations.

Fig. 2. *House Return Projections for Italy, France, Germany, Spain, Austria and Greece*



We can observe a more volatile pattern for Spain, Austria and Greece. In the case of Italy, the trend seems to be slightly decreasing, while for France and Germany the evolution appears more stable and slightly increasing.

In the new contractual framework of the Real Estate Pension Schemes, which are formally outlined in section 3, we calculate the level of the annual installments for the European countries of our analysis, on the basis of the house return forecasts. Let us consider the house price equal to 250,000 euros. Our application is developed posing $i_{re}=0$ in equation 2. In this way we have not to assign a value to weight β. For sake of simplicity we have posed $\alpha=1$. Within this context, $i^*= i_{re}$. The values of i_{re} for each payment term are calculated by using the outputs of formula 3 ($y_t's$). We stress the difference in the value of the installments according to two stochastic longevity scenarios: the Age- Period – Cohort model (Renshaw and Haberman 2006) and the Plat model (Plat 2009). The installments are computed referring to a male at the specific ages x=55,60,63,69,72,75 (where typically you can observe the change of property title). In order to calibrate the parameters for these 2 stochastic longevity models, for each of the six Countries that we have considered, we used the corresponding mortality data available in the Human Mortality Database (HMD). We fitted the 2 longevity models to HMD data which consist of numbers of deaths and persons exposed to risk by age and calendar year. In particular we refer to an homogeneous temporal interval ranging from 1950 to 2014 for each Country, except for Germany and Greece: in these two cases data respectively spread out from 1990 to 2014 and from 1981 to 2013, according to the availability of the data.

APC	ITALY	FRANCE	GERMANY	SPAIN	AUSTRIA	GREECE
x=55	5769.90	6533.46	5656.85	5365.13	6191.58	5197.16
x=60	7308.98	8111.41	7156.44	6825.86	7762.06	6637.33
x=63	8562.08	9472.11	8389.14	8007.31	9085.64	7788.18
x=66	10355.81	11442.33	10132.77	9721.69	10885.95	9489.30
x=69	12901.26	13551.13	12622.68	12167.61	13457.67	11911.55
x=72	15678.21	16379.87	15344.21	14843.86	16264.30	14562.49
x=75	19189.29	19883.45	18791.45	18243.20	19803.45	17933.82
PLAT	**ITALY**	**FRANCE**	**GERMANY**	**SPAIN**	**AUSTRIA**	**GREECE**
x=55	5886.96	6485.62	5769.22	5478.874	6301.49	5312.15
x=60	7489.66	8102.73	7331.00	7002,20	7933.56	6815.28
x=63	8.749.29	9458.47	8570.70	8190.48	9264.22	7972.71
x=66	11.020.43	11678.06	10780.83	10371.29	11532.06	10140.79
x=69	13.394.81	14058.32	13105.37	12653.58	13953.37	12400.00
x=72	16.398.92	17058.13	16051.61	15555.11	16966.44	15276.25
x=75	20268.86	20912.77	19854.49	19310.00	20861.45	19003.43

Table 2– *The REPS installments for Italy, France, Germany, Spain, Austria and Greece, according to different demographic scenarios, respectively Age-Period-Cohort model and Plat model*

The evidence illustrated in table 2 shows the sensitivity of the installments to the different house returns projected for the European countries under consideration. The value of the constant installment increases when the age at issue increases; this is due to the lower survival probabilities inferred by the model (implying shorter expected lifetimes) and so the installments related to it are higher. For the same reason, the installments obtained from the Plat model are higher than the ones obtained from the APC model. On the other hand, since the transferred RER *fair value* is a direct function of the insured's age, the real level of the installments is expected to be even higher than the one depicted in the table.

6. Conclusions

In light of the perspective increase of the "oldest old" (80+) in the near future, a tailor-made private pension plan can be an interesting complement to the future public retirement pension. In this study, we propose a new pension product where an immediate life annuity is obtained by paying a single-premium in form of *real estate rights (RERs)*, such as for example by transferring to an insurer the full or the bare property of a house or a similar realty. On the basis of the financial equilibrium principle, we provide the installment formula which depends on the *fair value* of the transferred RER at the contract's issue, the life expectancy of the insured, the expected return of the real estate market and a risk free financial rate, weighted by the financial position of the insurer.

Based on the empirical data analyses, we illustrate the application of the new proposal in a stochastic environment for house price returns and survival probabilities. The outcomes show a significant sensitivity of the pension rights as regards the different European markets under consideration.

References

Aalbers B. M. Subprime Cities and the Twin Crises, in Subprime Cities: The Political Economy of Mortgage Markets (ed M. B. Aalbers), John Wiley & Sons, Ltd, Chichester, UK. doi: 10.1002/9781444347456.ch, (2012),

Agenzia delle Entrate, Gli immobili in Italia, ricchezza, reddito e fiscalità immobiliare, Ministero delle Finanze e Agenzia delle Entrate, http://www1.finanze.gov.it/finanze3/immobili/contenuti/immobili_2017.pdf., (2017)

Alai D. H., Chen H., Cho D., Hanewald K, Sherris M.: Developing Equity Release Markets: Risk Analysis for Reverse Mortgage and Home Reversion. North American Actuarial Journal, 18:1, pp. 217-241, (2014)

Chen H., Cox S. H., Wang S. S.: Is the Home Equity Conversion Program in the United States sustainable? Evidence from Pricing Mortgage Insurance Premiums and Non Recourse Provisions Using the Conditional Escher Transform. Insurance: Mathematics & Economics, 46 pp. 371-384 (2010)

Chinloy P., Cho M., Megbolugbe I. F.: Appraisals, transaction incentives, and smoothing. Journal of Real Estate Finance and Economics, 14(1), pp. 89-111, (1997),

de la Fuente Merencio I., Navarro E., Serna G.: Estimating the No-Negative-Equity Guarantee in Reverse Mortgages: International Sensitivity Analysis. in New Methods in Fixed Income Modeling. Springer International Publishing DOI: 10.1007/978-3-319-95285-7_13, (2018)

Fornero E., Rossi M., Virzì Bramati M. C.: Explaining why, right or wrong, (Italian) households do not like reverse mortage. Journal of Pension Economics & Finance, Vol. 15, Issue 2 pp.180-202, (2016)

Guerin J.: Feature: Nobel Prize-winning economist Robert Merton. The Reverse review June 2016
https://www.reversereview.com/magazine/features/feature-nobel-prize-winning-economist-robert-merton.html, 2016

Hanewald K., Post T., Sherris M.: Portfolio Choice in Retirement: What is the Optimal Home Equity Reease Product?”. Journal of Risk and Insurance, Vol. 83, Issue 2 , pp. 421-446, (2016) Institute and Faculty of Actuaries: Lifetime Mortgage. A good and appropriate investment for life companies with annuity liabilities?". May 2014 https://www.actuaries.org.uk/system/.../lifetime-mortgage.pdf, 2014

Lennartz, C., Arundel, R., and Ronald, R. Younger Adults and Homeownership in Europe Through the Global Financial Crisis. Popul. Space Place, 22: 823–835. doi: 10.1002/psp.1961, (2016)

Li, J. S. H., Hardy, M. R., and Tan, K. S.: On pricing and hedging the no-negative equity guarantee in equity release mechanisms. Journal of Risk and Insurance, 77(2), pp. 499-522, (2010)

Ljung, G., and G. E. P. Box: On a Measure of Lack of Fit in Time Series Models, Biometrika, 66: pp. 67-72, (1978)

Merton R. C., Lai R. N.: On an efficient design of the Reverse Mortgage: Structure, Marketing and Funding. November 2016 https://www.aeaweb.org/conference/2017/.../paper/3hsNdR4f, 2016

Mudrazija, S., Butrica A.B. , Homeownership, Social Insurance, and Old-age Security in the United States and Europe, Center for Retirement Research at Boston College, http://crr.bc.edu, (2017)

Nakajima M., Telywcava I.: Reverse Mortgage Loans: A quantitative Analysis. The Journal of Finance, Vol. 72, Issue 2 pp. 911-950, (2017)

Paasch, J. M. (2005b). Legal Cadastral Domain Model. An object-orientated approach. In *Nordic Journal of Surveying and Real Estate Research*. 2005, vol. 2:1, pp. 117-136. The Finnish Society for Surveying Sciences, Helsingki.

Paasch, J.M. (2008) Standardization within the Legal Domain: A Terminological Approach. In Doganoglu,T., Holler, M. J. and Tiedeman, J. (Eds.) *Euras Yearbook of Standardization*. 2008, vol. 6, pp. 105-130. Online publication. ISBN 978-3-89265-102-4. *Internet document*.
URL: https://uni.uni-hamburg.de/onTEAM/grafik/1164287680/Paasch.pdf

Paatsch J. M.(2011): Classification of real property rights. A comparative study of real property rights in Germany, Ireland, the Netherlands and Sweden. Real Estate Planning and Land Law, Department of Real Estate and Construction Management, KTH Royal Institute of Technology, Stockholm Sweden

Plat R., On Stochastic Mortality Modeling, Insurance: Mathematics and Economics 45 (3), 393–404, 2009

Renshaw A., Haberman S.: A Cohort-Based Extension to the Lee-Carter Model for Mortality Reduction Factors, Insurance: Mathematics and Economics 38(3), pp. 556–570, (2006)

Scanlon K., Lunde J., Whitehead C.: Mortgage Product Innovation in Advanced Economies: More Choice, More Risk". International Journal of Housing Policy, Vol. 8, Issue 2 pp.1-30, (2008)

Shao A. W., Hanewal K, Sherris M: Reverse mortgage pricing and risk analysis allowing for idiosyncratic home price risk and longevity risk. Insurance: mathematics and Economics, 63 pp.76-90, (2015)

Shao A.W., Chen H., Sherris M.: To Borrow or Insure? Long Term Care Costs and the Impact of Housing, SSRN https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2707350, (2018)

Valente A., Gilardi C.: Soluzioni finanziarie per la terza età. Cacucci Editore, Bari (2013)

Wang L., Valdez E. A., Piggot J.: Securitization of Longevity Risk in Reverse Mortgage. North American Actuarial Journal, 12 pp. 345-371, (2008)

Website list

Equity Release Council UK - http://www.equityreleasecouncil.com

www.aviva.co.uk

www.globalpropertyguide.com/home

www.reversemortage.org

United States Census Bureau - https://www.census.gov/programs-surveys/ahs.html

NMRLA, 2018 https://libertyreversemortgage.com/national-reverse-mortgage-lenders-association/

https://wwwt.agenziaentrate.gov.it/servizi/UfficiProvinciali/index.php

HMD https://www.mortality.org