Pension Guarantees: are they worth the paper on which they are written?

By

Edmund Cannon

University of Bristol

Edmund.Cannon@bristol.ac.uk

and

Ian Tonks

University of Bath,

I.Tonks@bath.ac.uk

January 2014

This policy piece represents on-going research on pensions and annuity markets by Edmund Cannon and Ian Tonks

In October 2012 the UK introduced a new quasi-compulsory defined contribution (DC) national pension scheme (auto-enrolment) under which employers are required to automatically enrol employees into a qualifying pension scheme (though individuals can opt-out). Individuals makes regular contributions into a fund, which accumulates in value up to the retirement date, when the accumulated funds may be accessed to provide a pension in retirement. Importantly in a DC scheme the individual bears the investment risk for the value of the pension fund during the accumulation phase. Having introduced this national DC scheme, the government is waking up to the idea that it might need to protect its citizens from some of these risks (not least because if the realised pension value is low, these citizens may have claims on the state's social security system). DWP (2012) outlines the government's proposals for occupational defined ambition (DA) pensions including some guaranteed elements. DA schemes are a hybrid of traditional DB and DC schemes. DWP (2013) fleshes out more details of these "hard guarantees", after consulting with the pensions industry on the possible structure of such DA schemes. There are a number of problems with market-based "money-safe" guarantees.

1. Guarantees are expensive

A pension guarantees is an example of a long run put option (Cornell (2010)), since just like a put option, the holder of the guarantee can choose to exercise if the value of the pension fund is lower than the value of the guaranteed amount (the exercise price). A number of papers have considered the valuation of pension guarantees (Pennacchi (1999), Biggs, Burdick and Smetters (2009), Munnell, Golub-Sass, Kopcke and Webb (2009), McCarthy (2011)).

To illustrate, consider for an individual on a salary of £25,000 with a single contribution of 8% of salary into a pension scheme: £2,000. This scheme invests the contribution in UK equities, and accumulates a pension fund value in 40 years' time that will be used to generate a pension. Now introduce a "money back" guarantee, meaning that in 40 years, if the accumulated value of the pension fund is less than £2,000, then the fund is guaranteed to be worth £2,000. This guarantee is equivalent to a put option with an exercise price of £2,000, and can be valued using the Black-Scholes model for a similar call option, and then by put-call parity. Long-term UK interest rates in December 2013 were around 3 per cent, and the annual volatility of the UK stock market over the previous 100 years has been 23.6 per cent. The formula for a put-option is

$$P = Xe^{-rt}N(-d_2) - SN(-d_1) \qquad (1)$$

The panel below uses the standard five parameters in the B/S model to obtain the value of such a put as £170.94, which represents 7.87% of the total cost of the contribution plus guarantee. Since DWP (2013) aims to get charges below 1% of funds under management, the cost of these guarantees seem high.

We can see how the cost of the guarantee varies over time, as in each year each additional annual contribution is guaranteed. In successive years the time to maturity of the option reduces by one year. At shorter maturities the value of an option increases the longer is the time to maturity, and this is a well-known property of call options. But this property is not generally true for long-dated put options, as the value of a put option declines to zero as time to maturity increases. This can be seen in the formula for the put-option in equation (1), since the present value of the exercise price will tend to zero at long horizons. Figure 1 below plots the guarantee fee as a percentage of the gross annual contribution (including the guarantee fee) as the number of years to retirement falls.

One can argue about whether the parameters in this model are appropriate. For example, given evidence on long-term mean reversion in stock prices (Bulkley and Tonks (1989)), then the volatility parameter might be lower, reducing the value of the put-option. Further the Black-Scholes model may not be appropriate for valuing such long-run options, since in the above example we have valued each annual contribution separately, whereas the money-back-guarantee is based on the accumulated value of the assets at retirement. An alternative valuation method would be a risk-neutral approach (Cox and Ross (1976)) by simulating paths for future asset values based on the risk free rate and asset volatilities, and randomly sampling these paths many times: calculating the accumulated value of the fund, and hence the value of the guarantee in each simulation. Biggs et al. (2009) suggest that the differences between the Black-Scholes and risk-neutral values are small. There is work by the OECD that suggests the costs of these guarantees are a much smaller percentage than the numbers in our example (Antolin (2009), Antolín, Payet, Whitehouse and Yermo (2011)). OECD (2012) Table 5 (based on Scheuenstuhl, Blome, Karim, Moch and Brandt (2011)) suggests that the cost of a money-back (Capital Guarantee) is only 1.24% of the annual contributions. One possible reason for these different results is that they assume real wage growth is uncorrelated with real equity returns (so the only link between nominal wage growth and nominal equity returns is via inflation). Cannon and Tonks (2013) show that the correlation between these variables is important for pension calculations, but unfortunately the correlation is not well understood and recent evidence suggests that wages (perhaps particularly median rather than mean wages) may be increasingly detached from returns (Pennacchi (2009)).

2. A "money-back" guarantee delivers an insufficient pension

Irrespective of the cost of the guarantee, what likely pension will a money-back guarantee deliver? In fact the answer to this question is, not very much. Diamond (1977) makes the point that if there is a zero rate of return on savings, then an individual who wishes to smooth consumption over forty years of work (with a constant income) and twenty years in retirement, would need to save one third of their annual savings each year while working. This example illustrates the importance of compounded non-zero returns in generating a pension fund value at the end of the accumulation phase. For example, £2,000 invested over 40 years at an expected rate of return of 5% per annum would accumulate to £14,080, which in turn would generate a pension (over an expected 20 years) of £511 per year. On the other hand if the money-back guarantee was exercised, so that the fund value is only equal to the money-back guarantee of £2,000, this sum would generate a pension of only £72.63 per year.

Cannon and Tonks (2013) calculate the distribution of pension fund ratios based on historical data on actual rates of returns on assets for each year for each of 16 countries. We may recalculate these pension fund ratios under the assumption that the rates of return are zero to assess the value of these money-back guarantees in terms of the impact on replacement ratios.

These fund ratios are generated by assuming an individual saves 10 per cent of their actual labour income in that country for forty years, earning net return of zero (no return, no charges). Fund ratios are defined as the size of a simulated pension fund to final labour income. Since the pension from a DC scheme is the value of the pension fund multiplied by the annuity rate at the time of annuitisation, the replacement ratio (the ratio of pension income to final salary) will depend on the pension fund ratio:

$$replacement\ ratio_t = annuity\ rate_t \times fund\ ratio_t \qquad (2)$$

The UK's Pension Commission (2004) suggests a range of benchmark replacement ratios of between 80 and 50 per cent. Since annuity rates for a 65-year old male have historically been in the range of 5-10 per cent, then a target replacement ratio of 80 per cent would suggest an optimal pension fund ratio (fund value to final labour income) of between 8 and 16. At the lower end of this range, if the fund ratio ended up being only 8, then these accumulated funds would only generate a replacement ratio of 80 per cent if annuity rates were as high as 10 per cent. Figure 2 shows the value of the pension fund ratios for each of the 16 countries over the years 1948-2007, assuming a zero rate of return on assets, and the second column in Table 1 reports the median value of such pension fund ratios by country. In this case, the pension fund ratio is dominated by the growth in salaries in the denominator of equation (2), and the growth in fund ratios in the last quarter of the twentieth century reflects the slowdown in wage growth.

Table 1 below reproduces in the first column the results in Cannon and Tonks (2013) on the simulated median fund ratios assuming an all equity strategy during the accumulation phase of the DC scheme, and the actual rate of return on the equity investments in that country in each year. In the second column we report the median fund ratios in each country if there had been a zero rate of return in each year from the investment portfolio, so that the money-back guarantee was exercised. It can be seen that these fund ratios are very low averaging around 1.9. The final column indicates what an annuity rate would need to be to generate a replacement ratio of 80 per cent if the money-back guarantee had been exercised.

3. Mis-selling of structured products

Equity market guarantees can be constructed as a put-option, or alternatively as a bond investment plus an equity call option. As such these guarantees are examples of structured products. However providers of interest rate swaps (a type of structured product) were found to be guilty of mis-selling these products by the UK's regulator in June 2012. The FSA agreed with the banks (who were guilty of this mis-selling) on a package to compensate firms that were mis-sold interest rate hedging products[1] If guarantees are tagged onto pension products what are the likelihood of these products being mis-sold to unsophisticated consumers?

4. Regulatory capital requirements

As DWP (2013) recognizes, writing pension guarantees involves counter-party risk, which is the basis for prudential regulation of financial institutions (Bailey, Breeden and Stevens (2012)). There are the regulatory capital requirements for such guaranteed products? The case of Equitable Life offers a salutary lesson on offering guaranteed retirement income products (Penrose (2004), Cannon and Tonks (2008)). Equitable Life was once one of the UK's largest life insurers. From the 1950s to the 1980s Equitable Life sold pension products which contained a guaranteed minimum annuity rate, which was much lower than the actual annuity rate. This ceased to be the case as interest rates fell in the late 1980s and early 1990s. In 1993 an Equitable Life actuary raised the issue, but no substantial steps were taken until 1998. Penrose (2004) suggests that financial reserves to deal with

[1] Details of the FSA findings are available here:
http://www.fsa.gov.uk/library/communication/pr/2012/071.shtml

the value of guaranteed annuities should have been put in place in about 1994. Of course, since Equitable Life is a mutual society, doing this would have been a redistribution of funds away from pensioners without the guarantees. Equitable Life's alternative solution was based on manipulating the size of the pension fund of those pensioners who had guaranteed annuities. Equitable Life decided to pay lower terminal bonuses to pensioners who had guaranteed annuities, on the argument that the annuity guarantee was effectively a guarantee of a pension rather than a guaranteed annuity rate. Equitable Life's decision was opposed by some policy holders. Confident that its position was correct, Equitable Life initiated legal action against a sample policy holder (Alan Hyman) resulting in a favourable decision for the life insurer in the High Court in September 1999. However, this was reversed on appeal in January 2000 and the highest court of appeal (the House of Lords) upheld this decision in August 2000, not allowing Equitable Life to discriminate terminal bonus payments between policy holders with or without guarantees, and as a result Equitable Life ceased offering new business. DWP (2013) recognizes that satisfying prudential regulatory requirements make the provision of guarantees, and in particular deferred annuities, "problematic".

5. Conclusions

Pension guarantees in general would appear to be expensive. In relation to money back guarantees, we suggest that the pension income generated by such a guarantee is low, and may result in the individual falling back on the state, because their pension is less than any minimum income guarantee. As recognized in DWP (2013) there are also financial market conduct and prudential regulations, which make pension guarantees even more expensive and problematic. It would appear that market-based pension guarantees are a dead duck. The reason that pension guarantees existed in the past, is because employers writing these guarantees through DB schemes failed to identify their true costs. The demise of DB pension schemes is probably due to employers appreciating the actual liabilities of such schemes.

So given consumer demand for greater certainty of pension income from DC schemes, how can retirement income volatility be reduced? The standard life-cycle model predicts that in order to smooth consumption over the life cycle, consumers need to save during their working lives. If their predicted pension income is below target, they will need to save more: making pension fund values and likely pension income transparent, and allowing for flexible contributions at low cost is the basis of the life-cycle model. DWP (2013) also discusses Collective Defined Benefit schemes with transfers across generations or cohorts, and this approach would appear to offer a more effective self-financed process for risk reduction.

Panel: Calculation of Black-Scholes put option

INPUTS:	
Stock price (P)	2,000
Exercise price (X)	2,000
Interest rate, percent (r)	3
Maturity in years (t)	40
Annual standard deviation, percent (σ)	23.57
INTERMEDIATE CALCULATIONS:	
PV(X)	613.1137
d1 = log[P/PV(X)]/σ√t + σ√t/2	1.5385
d2 = d1 - σ√t	0.0478
N(d1)	0.9380
N(d2)	0.5191
OPTION VALUES:	
Call value = N(d1) x P - N(d2) x PV(X)	1557.83
Use put-call parity	
Put value = Call value + PV(X) - S	170.94
Alternatively use put formula directly	
N(-d1)	0.0620
N(-d2)	0.4809
Put Value = PV(X) x N(-d2) - P x N(-d1)	170.94

Figure 1: Put fee as a percentage of annual contributions

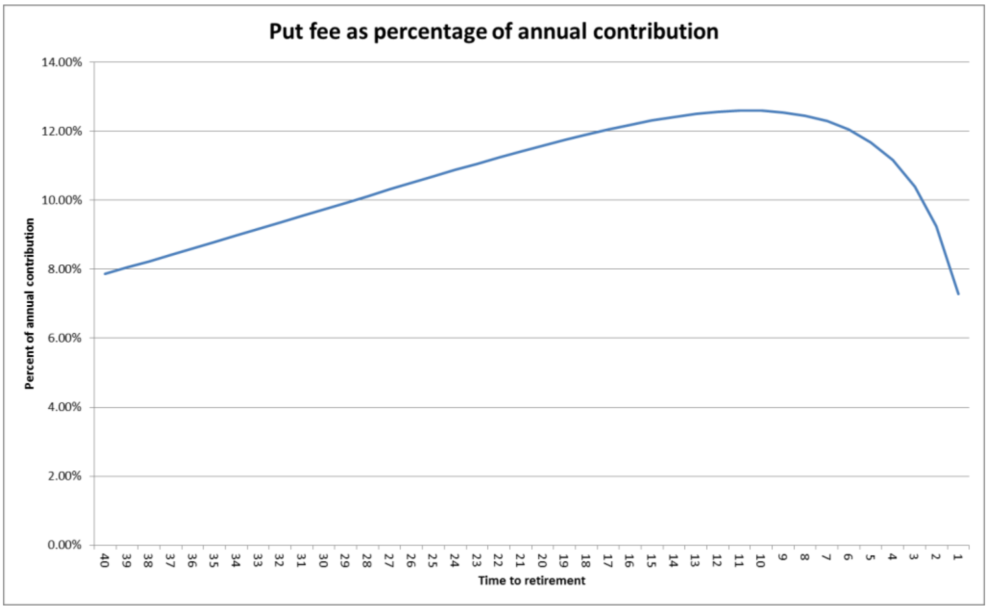

Figure 2: Hypothetical pension fund ratios assuming a zero rate of return on pension fund assets

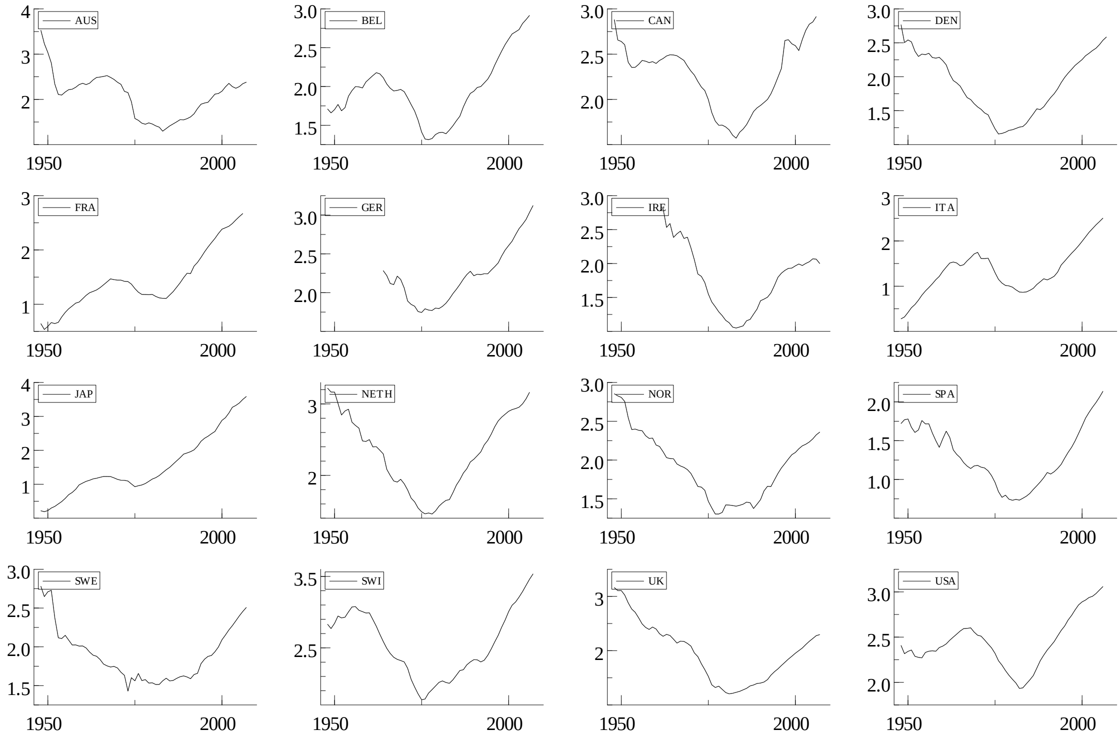

Table 1: Median fund ratios across countries

	Median fund ratio: All Equity strategy using actual historical returns and wages	Median fund ratio: zero-returns using actual historical wages	Annuity rate necessary to generate 80% replacement ratio
Australia	13.36	2.17	37%
Belgium	6.28	1.95	41%
Canada	11.4	2.37	34%
Denmark	6.73	1.91	42%
France	5.07	1.31	61%
Germany	9.16	2.22	36%
Ireland	12.11	1.85	43%
Italy	5.23	1.30	62%
Japan	6.69	1.20	67%
Netherlands	11.86	2.35	34%
Norway	6.26	1.94	41%
Spain	4.81	1.27	63%
Sweden	9.62	1.84	44%
Switzerland	8.42	2.49	32%
UK	11.88	1.98	40%
USA	14.96	2.40	33%
Average	8.99	1.91	42%

References

Antolin, P. (2009). "Private pensions and the financial crisis: How to ensure adequate retirement income from DC pension plans." *OECD Journal: Financial Market Trends*, **2009**(2): 153-179.

Antolín, P., S. Payet, E. Whitehouse and J. Yermo (2011). The role of guarantees in defined contribution pensions, OECD Publishing.

Bailey, A., S. Breeden and G. Stevens (2012). "The Prudential Regulation Authority." *Bank of England Quarterly Bulletin*: Q4.

Biggs, A., C. Burdick and K. Smetters (2009). Pricing personal account benefit guarantees: A simplified approach. *Social security policy in a changing environment*, University of Chicago Press**:** 229-249.

Bulkley, G. and I. Tonks (1989). "Are UK stock prices excessively volatile? Trading rules and variance bound tests." *Economic Journal*, **99**(398): 1083-1098.

Cannon, E. and I. Tonks (2013). "The Value and Risk of Defined Contribution Pension Schemes: International Evidence." *Journal of Risk and Insurance*, **80**(1): 95-119.

Cannon, E. S. and I. Tonks (2008). *Annuity markets*, Oxford University Press, USA.

Cornell, B. (2010). "Warren Buffett, Black–Scholes, and the Valuation of Long-Dated Options." *Journal of Portfolio Management*, **36**(4): 107-111.

Cox, J. C. and S. A. Ross (1976). "The valuation of options for alternative stochastic processes." *Journal of financial economics*, **3**(1): 145-166.

Diamond, P. A. (1977). "A framework for social security analysis." *Journal of Public Economics*, **8**(3): 275-298.

DWP (2012). Reinvigorating workplace pensions. London, Stationery Office. **Cm 8478**.

DWP (2013). Better Workplace Pensions: A Consultation on Charging. London, Stationery Office.

DWP (2013). Reshaping workplace pensions for future generations: consultation. London Stationery Office.

McCarthy, D. (2011). Are investment guarantees a cost-effective way to management retirement investment risk?, Imperial College.

Munnell, A. H., A. Golub-Sass, R. W. Kopcke and A. Webb (2009). "What does it cost to guarantee returns." *Center for Retirement Research at Boston College*(9-4): 1-14.

OECD (2012). The Role of Guarantees in Retirement Savings Plans. *OECD Pensions Outlook 2012*.

Pennacchi, G. G. (1999). "The value of guarantees on pension fund returns." *Journal of Risk and Insurance*: 219-237.

Pennacchi, G. G. (2009). Comment on" Pricing Personal Account Benefit Guarantees: A Simplified Approach". *Social Security Policy in a Changing Environment*, University of Chicago Press**:** 249-254.

Penrose, L. G. W. (2004). Report of the Equitable Life inquiry.

Scheuenstuhl, G., S. Blome, D. Karim, M. Moch and S. Brandt (2011). Assessing the Nature of Investment Guarantees in Defined Contribution Pension Plans. *Financial Study*. Munich, Risklab.