# Life Cycle Asset Allocation – A Suitable Approach for Defined Contribution Pension Plans

## Challenges for defined contribution plans

While Eastern Europe is a prominent example of the importance of defined contribution (DC) plans in pension provision, it certainly isn't the only one. Many emerging economies have introduced DC plans – often as a mandatory pillar with individual accounts – as part of pension system reform. Chile was the first country to do so in 1981. In the industrialised countries, the shift from DB to DC in occupational pensions is particularly pronounced in Anglo-Saxon countries. Given that most investors are not financial market experts, DC pension providers should offer products with appropriate asset allocations to prevent plan members from making suboptimal decisions.

Life cycle models, which are related to life cycle funds but are far from being the same, aim to do just that. The concept has its roots in modern finance theory, and its goal is to achieve optimal asset allocation as a function of investor characteristics. In this way, asset allocation can be tailored to individual needs. To do this, human capital of investors and the (future) income streams derived from it are of fundamental importance.

Based on a life cycle model developed by risklab germany, we will take human capital into account and derive optimal asset allocations as a function of different human capital levels. First, we will present the basic concept of life cycle models and the risklab model that incorporates human capital. We will then show how the optimal asset allocation differs depending on different human capital levels. Lastly, we will analyse these findings by carrying out sensitivity analyses and show how the results change if further investor characteristics such as risk preference, time preference, and bequest motives are taken into account.

## How to invest retirement savings

According to modern finance theory, a diversified investment portfolio is key to an efficient risk-return trade-off in the long run. The long-term portfolio returns strongly depend on strategic asset allocation, i.e. on the risk exposure of the investment portfolio. This is especially true for retirement savings. Due to their long investment horizon, small differences in the average annual return will result in significant changes of the average financial wealth available at retirement. If one considers that a higher annual return is usually accompanied by increasing risk, two questions must be asked: What level of risk can or should the investor accept, and how should age or the current life situation influence the optimal investment strategy?

Investors are generally told that they should shift their portfolio allocation over the life cycle from risky assets like stocks to less risky assets such as bonds. As a rule of thumb, the percentage of wealth invested in bonds should not be greater than the investor's age. Decreasing equity exposure with age is supposedly the „optimal" strategy, regardless of the investor's risk preferences or particular life situation. Two popular arguments support this advice: Time diversification and targeting for large liquidity needs in midlife. Time diversification means that equity risk is

decreased by long holding periods. Over longer periods of time, short-term stock market fluctuations are assumed to be less important. According to this argument, one can "diversify away" the riskiness of stocks simply by extending the holding period. Targeting for liquidity needs is based on the idea that when individuals save towards a specific goal, such as buying a house or paying college tuition fees, having higher equity exposure at the beginning of the savings period will lead to higher average returns. As the target date approaches, investors should decrease risk exposure to minimise the likelihood of missing their target.

While these arguments may seem like common sense, they are not valid according to the restrictive assumptions of Merton's classical asset allocation theory.[1] Merton argued that investing a constant proportion of wealth into stocks was the optimal strategy, irrespective of time horizon. In this model, the capital market and the investor are modelled in a very simplified way. In recent years, academics have focused their efforts on analysing the consequences of more realistic models that are based on more accurate definitions of the capital market and the investor. A realistic modelling of investors is the main goal of life cycle models, which aim to develop „optimal" asset allocation policies.

## An advanced life cycle approach

To derive an optimal asset allocation the economic model should take individual life situations into account. In economic theory, more recent life cycle models do this by including human capital and investor-specific characteristics.

Some of the findings of an enlarged life cycle model developed by risklab germany are presented below. The model builds on current economic research and considers the following parameters:

- The investor's human capital (the status of his career) and financial wealth
- The investor's preferences (risk preference, time preference of consumption and his bequest motive)

### The impact of human capital and financial wealth on asset allocation

Merton's classical asset allocation theory relies on the rather restrictive assumption that the investor's consumption is determined by financial wealth, but not by human capital, meaning future income. The theory argues that under certain assumptions about the capital market a specific allocation to equities is optimal in the long-term (i.e. the equity ratio $\alpha$ within an investor's overall wealth should be constant over time). It equals the ratio of the equity risk premium and the constant relative risk aversion multiplied by the variance of stock returns. The equity risk premium is defined as the average return of stocks minus the return on the risk free asset; the investor is assumed to have constant relative risk aversion.

$$\alpha^{\text{Overall}} = \frac{\text{Equity Risk Premium}}{\text{Risk Aversion} \cdot \text{Variance of Stock Returns}}$$

The optimal overall equity ratio is 16% if we assume an equity risk premium of 4%, a relative risk aversion of 10 and a standard deviation of equity returns of 15.8%. Despite the theoretical rigour of the result, in real life most people finance consumption with earned income, and not with financial wealth alone. Hence, a more realistic model should incorporate current and future labour income.

Future labour income can be considered an implicit asset. It can be equated with a person's „human capital", which delivers stochastic cash flows over the lifetime. These stochastic cash flows cannot usually be traded in financial markets. Especially for young investors with little financial capital, „human capital" and the income streams derived from it represent the main

[1] Merton, R.C. (1969), Lifetime Portfolio Selection Under Uncertainty: The Continuous-Time Case, Review of Economics and Statistics, Vol. 51, 247-257.

part of their total wealth, which is the sum of financial wealth and human capital.

To clarify the impact of non-tradable labour income, consider a stylised example with deterministic and thus risk-free salary streams. In this way, Merton's outlined solution can be transformed rather simply. The share of total wealth invested in stocks should be constant over time, but not the share of financial wealth. This fraction depends on the evolution of financial wealth and total wealth, i.e. the sum of financial wealth and human capital, as stated in the following equation:

$$\alpha^{\text{Overall}} = \frac{\text{Investment in Stocks}}{\text{Total Wealth}} = \frac{\alpha^{\text{Financial Wealth}} \cdot \text{Financial Wealth}}{\text{Financial Wealth} + \text{Human Capital}}$$

Whenever the ratio of financial wealth to total wealth increases, the fraction of financial wealth invested in stocks decreases to obtain a constant overall equity ratio. If we assume that the investor's overall optimal equity ratio is 16%, he is fully invested in equity as long as the value of his human capital is more than five times his financial wealth. In general, financial wealth increases throughout the investor's working lifetime, whereas human capital decreases as people age. Under this assumption, decreasing the equity ratio of financial wealth over time is optimal, as it allows to keep a constant overall equity ratio.

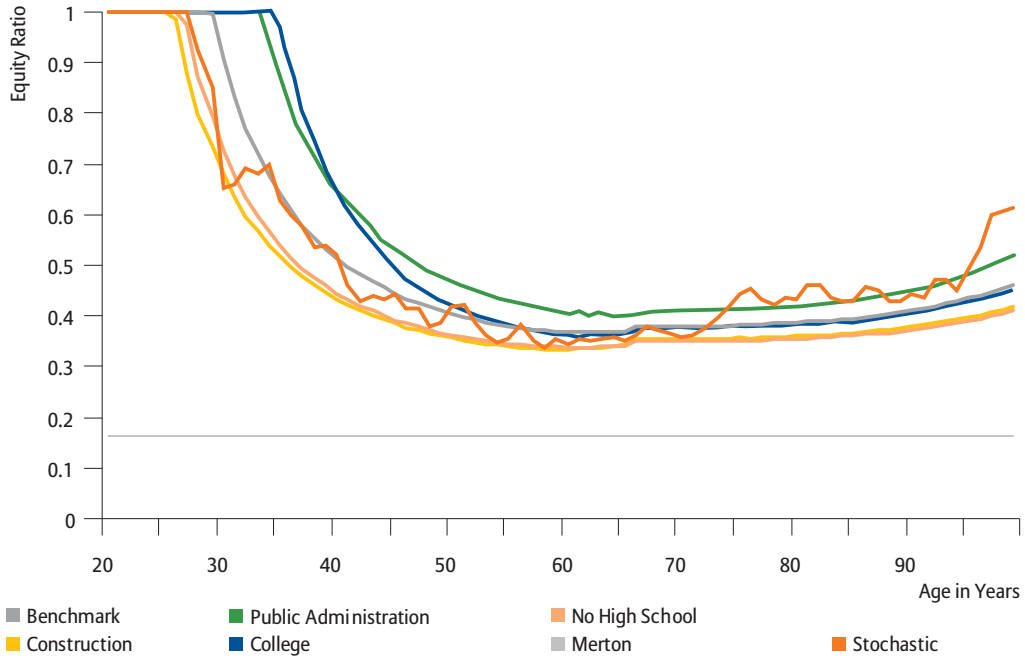
Deterministic labour income is obviously a substitute for risk-free bond holdings, as deterministic human capital is equivalent to a non-tradable bond. But is this still true if income is modelled in a more realistic, stochastic manner? risklab germany's lifecycle model defines labour income as a stochastic process with permanent and transitory shocks as well as a deterministic growth term. The process parameters are estimated for different groups of employees, as level of education and sector of employment imply different risk and growth characteristics for labour income. While, for example, the construction sector is characterised by volatile income streams with low deterministic growth rates, salaries in public administration are less risky. Investors with a college education on the other hand can anticipate higher growth rates of labour income and a relatively low risk of unemployment.

The results presented herein focus on investors who work in the construction and public administration sectors. We will also show the results for a sub-sample of investors with a college education. Overall estimates for all sub-groups are indicated by „Benchmark".

The results are based on the assumption that the investor receives deterministic pension income equivalent to 68% of the last labour income. The risk aversion coefficient and the equity risk premium have been chosen in such a way that the optimal equity ratio without human capital equals 16%. We assume a medium time preference and no bequest motive. The sensitivity of the results in light of these assumptions is analysed in the next section. Figure 1 shows that the resulting equity ratios are well above this level throughout the entire lifetime and for all sub-samples. Investors would even prefer to borrow money in their twenties to buy more stocks, because the present value of their labour income outweighs their financial wealth by far. Over time, the present value of human capital decreases and financial wealth increases since the investors start to save for retirement, meaning that equity ratios of financial wealth decrease.

At retirement age (65), the equity ratio invested in financial wealth should still be roughly 40% for all sub-groups, which may seem surprising at first glance. Again, the reason lies in the implicit asset human capital, which now comes in the form of pension annuity payments. Once this has been taken into account, the overall equity ratio is 16%, as implied by the assumed risk aversion and equity risk premium. After retirement, the equity ratio should even slightly increase because of the relative evolution of financial wealth and human capital. Due to the increasing risk of mortality, the investor increases his utility by consuming more of his financial wealth.

Figure 1: The impact of human capital and financial wealth on asset allocation




Optimal equity ratios throughout the lifecycle for different labour income groups. The graphs show the median of the optimal equity ratios for 10,000 simulation paths. A single stochastic path is also shown to illustrate the volatility of the solution.

As a consequence of this reduction of financial wealth, the investor has to increase his relative equity exposure of his financial wealth in order to keep up a stable overall equity ratio.

In addition to these general results, we found that investors with riskier labour income streams (e.g. the construction sub-group) should invest less of their financial wealth in equity. This is due to higher buffer stock savings to compensate for reductions in labour income. Investors with stable labour income (e.g. the public administration sub-group) have a smaller need to save financial wealth for this purpose, and should therefore have a lower ratio of financial wealth to total wealth, resulting in higher equity ratios. Investors with college degrees also have a higher amount of implicit human capital, and thus a higher equity ratio within their financial wealth.

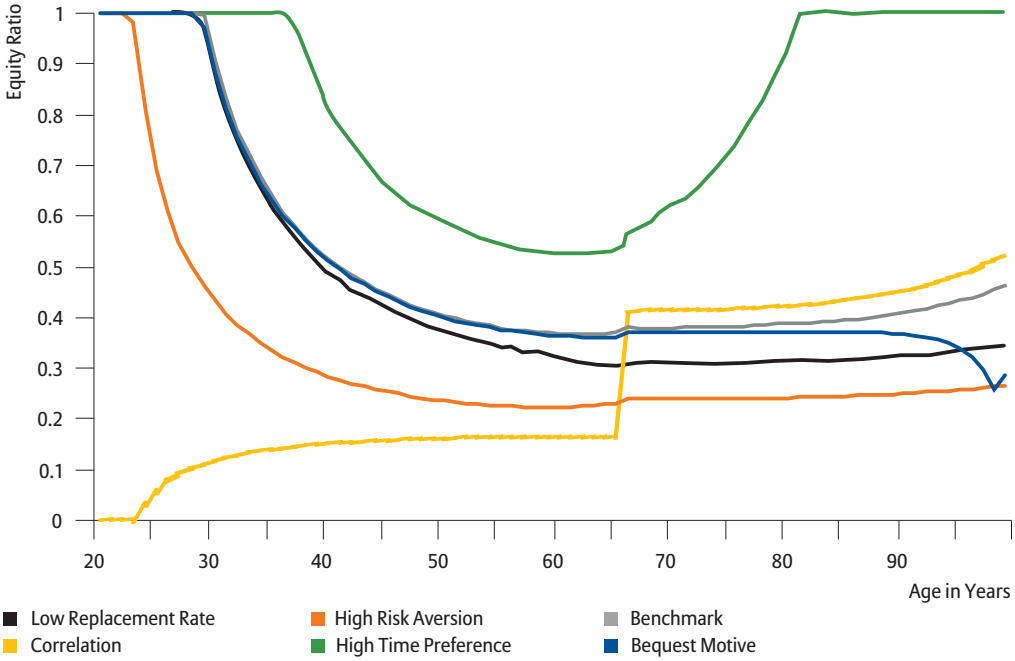
In conclusion, this shows that realistically calibrated labour income processes still mimic the risk-free asset. For this reason, it is indeed reasonable for investors to decrease equity exposure as they approach retirement. During retirement, however, the optimal equity ratio is slightly increasing, depending on the specific modelling.

## The impact of further investor-specific characteristics

Besides the different labour income characteristics, various other factors influence optimal lifecycle asset allocation. The results shown here are based on the following assumptions: the retirement income replacement ratio is approximately 68%, the correlation between labour income and equity returns is zero, the investor has an optimal overall equity ratio of 16 percent, a medium time preference for consumption and no bequest motive. The sensitivities of the results in light of these assumptions are shown in figure 2.

Lower retirement income replacement rates result in higher retirement savings. In addition, the present value of future labour income decreases. Both effects imply lower equity ratios. If the retirement income is stochastic and not deterministic, the investor accumulates higher savings and has lower equity ratios (not depicted).

Figure 2: The impact of further investor-specific characteristics




Optimal lifetime equity ratios for different investor-specific characteristics. The results are the median over 10,000 simulation paths.

A correlation between labour income shocks and equity returns can result in much lower equity ratios, as the investor tries to hedge his labour income risk with reduced equity holdings. This can even result in equity ratios below the Merton solution as shown in Figure 2, where we assume a correlation coefficient of 0.3. As soon as the investor enters the retirement phase, the (correlated) labour income risk is no longer relevant and the investor strongly increases his equity ratio.

A higher risk aversion has two effects. First, it reduces the optimal overall equity ratio. Second, the investor accumulates more financial wealth due to buffer stock savings. Both effects result in lower equity ratios.

An increased time preference for consumption results in decreased savings and higher equity ratios. If the investor wants to pass his wealth on to his heirs, he is less likely to be hasty in consuming his retirement savings, which results in a constant equity ratio throughout retirement. The equity ratio begins to decrease when the investor fears that he has to consume the savings he would otherwise pass on.

## Conclusion

With the advent of DC plans in many parts of the world, including Central and Eastern Europe, individual choice in retirement savings has become much more important than it used to be. A new line of research, namely behavioural economics and finance, directly addresses the issue of how people can handle their new-found freedom of choice when it comes to retirement saving instruments. Contrary to traditional economics, which sees people as fully rational agents who use their complete information to maximise self-interest, behavioural finance and economics focuses on how „real" people make decisions, incorporating insights from psychology into economics. While behavioural approaches also acknowledge that people try to maximise their self-interest, they consider rationality to have its limits, leaving people in a quandary when they are faced with solving complex problems and processing information. Put differently, people are only boundedly rational and often achieve suboptimal outcomes.

Behavioural finance and economics has come up with findings that are vital in the realm of asset allocation for retirement plans. People usually tend to stick to the choices they have made and very rarely make active changes to their contribution rates or asset allocation. To a high degree, the initial choice is to a very high degree influenced by what is given as the default choice. Moreover, people tend to rely on past performance much too strongly and fail to properly consider expected risks and returns. They also have a tendency to be overconfident in their own skills and excessively optimistic.

The lifecycle investment approach is able to protect retirement investors from many of the common problems that can have a negative impact on their retirement income. Since asset allocation changes dynamically and automatically depending on age or on other characteristics that are part of the presented model, investors can ensure that their asset allocation suits their needs. The danger of investing in assets that are too risky or conservative is therefore limited, as is the likelihood of making ill-informed decisions.

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