**Asset Allocations in Pension Plans**

1. Asset Allocations in Pension Plans: One Size Does Not Fit All Based on joint research with Ofer Setty and Roine Vestman. Magnus Dahlquist AQR Asset Management Institute London Business School November 2, 2016

2. What we do and what we find • we consider about 300,000 individuals’ financial portfolios inside and outside the pension system from 2000 to 2007. • We find a strong relationship between default investing inside the pension system and limited stock market participation outside the pension system. • We document substantial heterogeneity among default investors in terms of labor income, financial wealth, and stock market participation, suggesting that a “one-size-fits- all” design of the default fund is not optimal. 2

3. What we do and what we find (cont’d) • Following the empirical analysis, we build a life-cycle portfolio choice model, incorporating pension accounts and investor heterogeneity. • We characterize default investors’ fully customized asset allocations and compare them with pure age-based investing like “100-minus-age.” • We find that the fully customized asset allocations exhibit substantial dispersion in the equity exposure (not only over age but also over other observable investor characteristics). 3

4. Pension savings components 4 Private pension Private pension scheme – Income pension (notional DC plan; 16% contribution; return like wage growth) – Premium pension (fully funded DC plan; 2.5% contribution; return depends on choice) – Guaranteed pension Adapted from the Swedish Pensions Agency Public pension system: (DC plan; 4.5% contribution; return depends on choice) Occupational pension

5. Data and investors • New pension system launched in 2000. • We have detailed data from 2000 to 2007 on: – Individuals’ socio-demographics. – Fund holdings in the premium pension plan. – Fund and asset holdings outside the pension system. • Investor types: – Passive (60%). – Active (40%). 5

6. Averages of key variables 6 Passive Active Age 47 47 Labor income (SEK 1000s) 225 285 Financial wealth (SEK 1000s) 218 294 Participation 0.46 0.62 Equity share (u) 0.20 0.29 Equity share (c) 0.43 0.47 Elementary school 0.18 0.12 High school 0.54 0.55 College 0.27 0.32 PhD 0.01 0.01 Based on Table 1 in the paper. The table presents averages of variables for all investors and investor categories in 2007. ``Passive'' refers to investors who are invested in the default fund or who opted out of the default fund when entering the pension system but have since never changed their allocation. Out of the passive investors, 51.8% are default investors. ``Active'' refers to investors who, after entering the pension system, made at least one change to their allocation. There are 182,487 passive investors and 119,145 active investors. Labor income and financial wealth are in SEK 1000s. Equity share (u) refers to the unconditional equity share and Equity share (c) refers to the equity share conditional on stock market participation.

7. Activity and stock market participation 7 I II III IV Age 0.04 0.22 Labor income 0.22 0.17 Financial wealth 0.05 0.28 D (real estate) 0.12 0.07 0.17 0.07 D (education) Yes Yes Yes Yes D (geography) Yes Yes Yes Yes Splines (age/income/fw) No Yes No Yes R-squared 0.04 0.07 0.15 0.29 D (Activity) 0.10 0.06 R-squared 0.01 0.01 Based on Table 2 in the paper. All reported estimates are significant at 1% or 5% level (using standard errors that account for conditional heteroskedasticity). Age is scaled down by 100; and labor income and financial wealth are scaled down by 1,000,000. The number of observations is 301,632. Specifications II and IV replace the linear specifications in age, labor income, and financial wealth with piecewise linear splines. Activity Participation

8. Heterogeneity among passive investors 8 10% 25% 50% 75% 90% A. All passive investors … … … … … B. Participants Age 32 39 48 58 65 Labor income (SEK 1000s) 0 137 250 336 461 Financial wealth (SEK 1000s) 26 68 176 433 935 Equity share 0.09 0.23 0.44 0.61 0.76 C. Non-participants Age 30 36 44 54 62 Labor income (SEK 1000s) 0 73 206 278 351 Financial wealth (SEK 1000s) 7 7 27 84 207 Equity share 0 0 0 0 0 Based on Table 3 in the paper. The table presents the variables for passive investors by percentiles in 2007. Panel B refers to passive investors who participate in the stock market. Panel C refers to passive investors who do not participate in the stock market. A total of 182,487 investors are represented (83,053 in Panel B and 99,434 in Panel C). The equity share in Panel B is the equity share of investors who participate in the stock market; the equity share in Panel C is that of investors who do not participate in the stock market and by definition equals zero.

9. Summary of the empirical results • Passive investors (relative to active investors): – Less educated. – Lower income. – Less wealth (more reliant on their pension savings). [They may be characterized as less sophisticated.] • Passive investors participate less in the stock market. • Passive investors display substantial heterogeneity in terms of labor income, financial wealth, and participation. 9

10. A life-cycle portfolio choice model • we build a life-cycle portfolio choice model for default investors to evaluate various default fund designs. • We extend the standard model to include: – Pension accounts. – Choice to opt out the default fund. – Choice to participate in the stock market. • The model generates endogenously heterogeneity in labor income and financial wealth, as well as stock market participation/non-participation outside the pension system and default/opt-out investment inside the pension system. 10

11. In a nutshell, investors… • Live from age 25 up to at most age 100 (retire at age 65). • Have risky labor income during working age and receive at retirement actuarially fair annuities from the pension system. • Save outside the pension system in: – A risk-free bond and stocks. • Save inside the pension system in: – A notional pension account (income based and evolves at the risk-free bond return). – A unified DC account (income based but with a choice on the mix of the risk-free bond and stocks). 11

12. Asset allocations in the default fund • We calibrate the model to passive and active investors. • We consider different asset allocations for the default fund: – Full individual customization (fully optimal). – Age-based profiles (like “100-minus-age”). – Rule-of-thumb (based on regressions using observable individual characteristics beyond age). • In particular, we compare and contrast an age-based profile (“100-minus-age”) with a full individual customization. 12

13. 0 100 200 300 400 20 30 40 50 60 70 80 90 100 Laborincome(SEK1000s) Age Model, opt out Model, default Data, opt out Data, default Based on Figure 2 in the paper. Model fit – labor income 13

14. 0 200 400 600 800 20 30 40 50 60 70 80 90 100 Financialwealth(SEK1000s) Age Model, opt out Model, default Data, opt out Data, default Based on Figure 2 in the paper. Model fit – financial wealth 14

15. 0 400 800 1200 1600 20 30 40 50 60 70 80 90 100 Pensionaccountsandfinancialwealth(SEK1000s) Age Notional account DC account Financial wealth Based on Figure 3 in the paper. Importance of DC account 15

16. Optimal DC equity share • consider the two main sources of risk: – Aggregate equity risk (correlates with labor income). – Idiosyncratic uninsurable labor income shocks. • We study the life-cycle profile of the optimal DC equity share for these two sources of risk: – Over different economies (equity risk). – Over different individuals (inequality). • We also consider regressions of the optimal DC equity share on state variables (excluding participation costs). 16

17. DC equity share – equity risk 17 0 0.2 0.4 0.6 0.8 1 20 30 40 50 60 70 80 90 100 DCequityshare Age 2nd decile Mean 9th decile Based on Figure 4 in the paper.

18. DC equity share – inequality 18 0 0.2 0.4 0.6 0.8 1 20 30 40 50 60 70 80 90 100 DCequityshare Age 2nd decile Mean 9th decile Based on Figure 4 in the paper.

19. Regression-based approximation • Customize the DC equity share (based on observables). • Regression of optimal DC equity share on: – Age. – Labor income. – Financial wealth. – Participation status. – DC account balance. • Depart from pure age-based investing. 19

20. DC equity share in model simulated data 20 I II III IV V VI VII Constant 1.746 1.873 1.585 1.738 1.313 1.347 1.266 Age –0.024 –0.023 –0.018 –0.022 –0.009 –0.008 –0.007 Labor income –0.760 0.262 Financial wealth –0.565 –0.096 D (participation) –0.233 –0.196 –0.198 DC account –0.666 –0.603 –0.618 R-squared 0.630 0.687 0.740 0.730 0.786 0.855 0.859 Based on Table 6 in the paper. All estimates are significant at 1% (using standard errors that account for conditional heteroscedasticity and clustered over economy and individual). Labor income, financial wealth, and DC account balances are scaled down by 1,000,000. The simulated data are based on 50 economies, each of which has 11,500 investors (500 individuals with 23 different costs) who each work for 40 years. The number of default investors is endogenous.

21. Welfare and robustness analysis • Welfare in terms of consumption equivalent: – Average gain of 1.5% during retirement phase. – Lower dispersion in pension income. – Not sensitive to alternative age-based rules. • Robustness analysis: – Return disaster. – Low equity premium. – Share of default investors. – Sub-optimal portfolio choice in financial wealth. 21

22. Brief comments on regulation • focus: – More on aggregated pension plans (size, investment, expected returns and volatility) during working phase. – Less on the individual during the retirement phase. • Engaged/non-engaged individuals: – Customized default option. – Meaningful and cost efficient opt-out choices. • Discouraging research evidence on financial advisors. 22

23. Concluding comments • we examine the effects of different equity exposures in a DC plan’s default fund with heterogeneous participants. • Using detailed data on individuals and their holdings inside and outside the pension system, we find: – Heterogeneity across default and active investors. – Heterogeneity among default investors. • We set up a life-cycle model that captures the economic situation of default investors; allowing for investor heterogeneity, we evaluate different designs of the default fund and relate to common age-based investment rules. 23

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