Online Appendix to Restoring Rational Choice: The Challenge of Consumer Financial Regulation

John Y. Campbell[1]

March 2016

[1]Department of Economics, Littauer Center, Harvard University, Cambridge MA 02138, USA, and NBER. Email: john_campbell@harvard.edu. This is the online appendix to the Ely Lecture, delivered at the American Economic Association on January 3, 2016. I thank the Sloan Foundation for financial support, and my coauthors Steffen Andersen, Cristian Badarinza, Laurent Calvet, Howell Jackson, Brigitte Madrian, Kasper Meisner Nielsen, Tarun Ramadorai, Benjamin Ranish, Paolo Sodini, and Peter Tufano for joint work that I draw upon here. I also thank Cristian Badarinza for his work with international survey data on household balance sheets, Laurent Bach, Laurent Calvet, and Paolo Sodini for sharing their results on Swedish wealth inequality, Ben Ranish for his analysis of Indian equity data, Annamaria Lusardi for her assistance with financial literacy survey data, Steven Bass, Sean Collins, Emily Gallagher, and Sarah Holden of ICI and Jack VanDerhei of EBRI for their assistance with data on US retirement savings, Eduardo Davila and Paul Rothstein for correspondence and discussions about behavioral welfare economics, and Daniel Fang for able research assistance. I have learned a great deal from my service on the Academic Research Council of the Consumer Financial Protection Bureau, and from conversations with CFPB staff. Finally I gratefully acknowledge insightful comments from participants in the Sixth Miami Behavioral Finance Conference and the Fourth Conference on Household Finance and Consumption at the European Central Bank, and from Alexei Alexandrov, Julianne Begenau, John Beshears, Ron Borzekowski, Chris Carroll, Paulo Costa, Xavier Gabaix, Peter Ganong, Stefano Giglio, Michael Haliassos, Deborah Lucas, Annamaria Lusardi, Vijay Narasiman, Pascal Noel, James Poterba, Tarun Ramadorai, Jon Reuter, Paul Rothstein, Antoinette Schoar, Robert Shiller, Andrei Shleifer, Emil Siriwardane, Jeremy Stein, Cass Sunstein, Richard Thaler, and Jessica Wachter.

I. Stylized Facts of Household Finance

Data for Tables 1 and 2 and Figures 1 and 2 in the lecture come from a research collaboration with Cristian Badarinza. This section of the Appendix describes the underlying surveys, and the way in which data on individual asset types are aggregated into asset classes.

European Household Finance and Consumption Survey (Eurozone)

Deposits and transaction accounts

- Sight accounts: All deposits usually at a bank, savings bank, credit institution, mutual bank, insurance company, against which the account holder is permitted to make daily withdrawals (from the bank counter or ATM machines) and make transfers for the purpose of making payments to third persons or others, or transfers to other accounts. Typical names: (DE) Bankkonto, (DE) Girokonto, (FR) Compte cheques.
- Savings accounts: All money deposits against which the account holder is not permitted to make transfers for the purpose of making payments to third persons or others. Typical names: (DE) Sparkonto, (DE) Sparbuch, (DE) Tagesgeldkonto, (FR) Livret d'épargne.
- Time deposits: Money deposits usually at a bank, savings bank, credit institution, mutual bank, that cannot be withdrawn for a certain "term" or period of time. When the term is over it can be withdrawn or it can be held for another term. Typical names: (BE) bon de caisse, (BE) kasbon, (BE) Termijnrekening, (LU) bon de caisse, (DE) Sparbrief, (DE) Sparkassenbrief.

Mutual funds

- Investments in mutual funds, money market mutual funds or hedge funds.

- Types of mutual funds: Predominantly investing in equity, bonds, money market instruments, or real estate.

Bonds

- Corporate or government bonds, bills or notes.
- All financial assets which are bearer instruments, are usually negotiable and traded on secondary markets and do not grant the holder any ownership rights to the institutional unit issuing them.
- Types of issuer: State or other general government, banks or other financial intermediaries, non-financial corporations.

Directly held stocks

- Publicly traded shares that are listed on a stock exchange or other form of secondary market.
- Excluding mutual fund shares and excluding other equity in private businesses.

Retirement assets and life insurance

- Voluntary pension plans (defined-contribution accounts).
- Access to these plans is not necessarily linked to an employment relationship.
- Whole life insurance policies, which accumulate a cash value that the policyholder can redeem or borrow against.

Other financial assets

- Managed accounts with a bank or investment company, which makes most of the day-to-day decisions or consult more closely with the account owner. Including trust accounts. Excluding pension and insurance accounts.
- Money owed to the household.
- Options, futures, index certificates, precious metals, oil and gas leases, future proceeds from a lawsuit or estate that is being settled, royalties.

Main residence

- Current estimated price of household's main residence (for owner-occupied residential real estate).

Other real estate

- Other properties, including farm land and buildings, industrial real estate, garages, shops, offices, hotels.

Vehicles, valuables and other assets

- Cars, other vehicles, motorbikes, trucks, vans, planes, boats, and works of art, antiques, jewellery.

Private businesses

- Investment in business equity that is not publicly traded.
- Self-employment and non self-employment private businesses.

Mortgage debt for primary residence

- Sum of all mortgage loans with the main residence as collateral.

Other debt secured with real estate

- Outstanding mortgages or loans that use property as collateral, other than the main residence.

Overdrafts and credit lines

- Debit balances on current accounts (overdrafts).
- Credit lines: Granted on the basis of an "umbrella contract" allowing the customer to draw loans on several types of loan accounts up to a certain maximum amount applying to all accounts together.

Credit cards

- Credit/store cards (Visa, Amex, Master Card, Diners).
- Credit instruments for which interest is to be paid on any balance that is not cleared at the end of the month.

Vehicle-, student loans and other debt

- Non-collateralized loans (consumer/personal/installment loans), which have to be repaid in fixed installments over a set period.
- Loans from credit unions.
- Loans from other money lenders (e.g. payday loans and short-term loans for small amounts to be paid back within six months or a year).
- Student loans from a bank and student loans from government.
- Informal loans from relatives and friends.

Survey of Consumer Finances (US)

Deposits and transaction accounts

- Transaction accounts: checking, savings, money market or call accounts.
- Certificates of deposit.

Mutual funds

- Directly held pooled investment funds held by household, including stock mutual funds, tax free bond mutual funds, government bond mutual funds, and combination and other mutual funds, such as hedge funds.

Bonds

- Savings bonds.
- Nontaxable bonds, mortgage bonds, government bonds, and 'other' bonds, such as coporate or foreign bonds.

Directly held stocks

- Publicly traded stock, directly held by household.

Retirement assets and life insurance

- Quasi-liquid retirement assets, including IRAs, Keoghs, thrift-type accounts, and future and current account-type pensions.

- Cash value of whole life insurance.

Other financial assets

- Managed accounts, including trusts, annuities and managed investment accounts in which the household has equity interest.
- Money owed to the household.
- Future proceed from lawsuits, royalties, futures, non-public stock, deferred compensation, oil, gas, mineral investments.

Main residence

- Primary residence of household, excluding the part of a farm or ranch used in a farming or ranching business.

Other real estate

- Land contracts/notes owed to the household and properties other than the principal residence, including 1-4 family residences, time shares, and vacations homes.

Vehicles, valuables and other assets

- All types of vehicles, cars, trucks, SUVs, motorcycles, boats, airplanes.
- Non-residential investment in time shares and vacation homes net of mortgages and other loans.
- Precious metals, antiques, furniture, art objects, paintings, equipment, musical instruments and other miscellaneous non-financial items owned by household.

Private businesses

- Market value of active businesses calculated as net equity if businesses were sold immediately, including loans from the household to the businesses and the value of personal assets used as collateral for business loans.

Mortgage debt for primary residence

- Mortgages, home equity loans and HELOCs secured by the primary residence.

Other debt secured with real estate

- Land contracts, loans for residential property other than the principal residence, vacation homes, and installment debt reported for cottage or vacation home, excluding debt for nonresidential real estate.

Overdrafts and credit lines

- Lines of credit other than those secured by the primary residence.

Credit cards

- All credit cards and revolving store accounts, excluding purchases made since the last account statement.

Vehicle-, student loans and other debt

- Installment loans for vehicles, education loans and other loans for durables or hospital bills.

- Loans against pensions, loans against life insurance, margin loans.

Survey of Financial Security (Canada)

Deposits and transaction accounts

- Chequing and savings accounts with a nonzero balance and other deposits such as term deposits and Guaranteed Investment Certificates, excluding amounts held in registered pension plans.
- Tax-free savings accounts.

Mutual funds

- Mutual funds and other investment funds, excluding amounts held in registered pension plans.

Bonds

- Federal and provincial savings bonds and other bonds issued by governments and corporations, including investment in foreign bonds and excluding amounts held in registered pension plans.

Directly held stocks

- Publicly traded common and preferred shares, including foreign stock and excluding amounts held in registered pension plans.

Retirement assets and life insurance

- Registered Retirement Savings Plans (RRSPs).
- Registered Retirement Income Funds (RIFs).
- Locked-in Retirement Accounts (LIRAs)
- Employer pension plans registered with Canada Customs and Revenue Agency.
- Other retirement funds.

Other financial assets

- Other non-pension financial assets.

Main residence

- Primary residence, including farm houses and excluding farm land.

Other real estate

- Real estate other than the principal residence, including second homes, vacation homes, timeshares, rental property or vacant lots, located in Canada or outside.

Vehicles, valuables and other assets

- Cars, trucks, vans, sport utility vehicles as well as motorcycles, mobile homes, boats and snowmobiles, excluding vehicles owned by the respondent's business and vehicles that are leased.

Private businesses

- Total amounts the respondent would receive if the private business were sold, after deducting any outstanding debts to be paid.

Mortgage debt for primary residence

- Amount owing on the household's principal residence, including the mortgage owing on the farm house, and excluding the mortgage on the remainder of the farm.

Other debt secured with real estate

- Share of the mortgage owing on second homes, vacation homes, timeshares, rental property or vacant lots.

Overdrafts and credit lines

- Amount owing on home equity lines of credit and regular lines of credit, excluding credit limits.

Credit cards

- Amount owing on the last bill, excluding any new purchases, on all credit card types (VISA, Mastercard, American Express, Diners Club/en Route) and retail store cards, gasoline station cards.
- Deferred payment or instalment plans where the purchased item is to be paid for over a period of time.

Vehicle-, student loans and other debt

- Loans for vehicles

- Loans taken out to attend a post secondary education program, through the Canada Student Loan Program or one of the provincial student loan programs.

Wealth and Assets Survey (UK)

Deposits and transaction accounts

- Current accounts.
- Savings accounts.
- Individual Savings Accounts (ISAs).

Mutual funds

- Unit investment trusts.

Bonds

- Fixed term investment bonds.
- UK and foreign bonds and gilts.

Directly held stocks

- Shares by publicly traded UK companies.
- Overseas shares.
- Employee shares and options.

Retirement assets and life insurance

- Occupational defined contribution pensions.
- Additional Voluntary Contributions (AVCs).
- Personal pensions.
- Pensions from former spouse or partner.

Other financial assets

- Other investments, informal financial assets, children trust funds, children savings accounts, National Savings Products.

Main residence

- Property value of main household residence.

Other real estate

- Other houses, buy-to-let houses, buildings, UK and overseas land and other property.

Vehicles, valuables and other assets

- Household goods and collectables, household contents in main property, second homes, buy-to-let property and overseas property.
- Cars, vans, motorbikes, personalized number plates.

Mortgage debt for primary residence

- Amount owed on all mortgages for primary residence

Other debt secured with real estate

- Mortgages for houses which are not the main residence, buy-to-let houses, UK and overseas land, and other property.

Overdrafts and credit lines

- Current accounts overdrawn.

Credit cards

- Outstanding balances on credit cards.

Vehicle-, student loans and other debt

- Installment loans, student loans from a bank of Company loans.
- Bills arrears.
- Informal loans from family and friends.
- Hire purchase agreements and arrears.
- Mail order accounts and arrears.

Look-through participation rates and asset allocations

Tables 1 and 2 in the lecture report "look-through" participation rates and asset allocations that attribute retirement accounts to underlying asset classes using country-specific averages. Here we explain how this attribution is done. Any assumption is somewhat arbitrary, and fails to capture any variation that may exist in retirement-account asset allocation across households within each country.

USA

The SCF does not allow for a precise attribution of the overall portfolio shares of risky investments and only captures composite ("combined") balances of defined-contribution accounts (see fields X3829-X7785).

To compute the share of risky assets (stocks and bonds) relative to total defined-contribution retirement assets, we use 2010 ICI/EBRI data. The estimated asset allocation for all investors (aggregating across age groups) indicates that 4.4% of assets are invested in money market funds and 10.3% in GICs and other stable value funds. We treat these as non-risky assets and therefore impute an overall share of risky assets in retirement savings equal to 0.85. Since no comparable information is available for mutual fund holdings, we impute a risky share of mutual funds of 1, which is consistent with the other countries in our sample.

To compute equity shares, no such imputation is needed. In the most recent waves of the SCF (including the 2010 wave), indirect holdings of publicly traded stock through mutual funds and retirement accounts are recorded separately.

UK

The Pension Protection Fund[2] reports that 90% of defined-contribution retirement funds in the UK are allocated to stocks and bonds, with very little variation across fund sizes and scheme types. We therefore assume a constant share of stocks and bonds in the portfolio of retirement assets of 0.9 for all UK households. Similarly, we impute a constant share of publicly traded stock in retirement assets equal to 0.45, as reported by the Pension Protection Fund.

Absent reliable information about the allocation of mutual funds, we attribute all such holdings to stocks and bonds and impute an equity share of mutual funds equal to 0.5.

[2]See *Chapter 7: Asset Allocation*, Purple Book, 2014, Pension Protection Fund, London, UK.

Canada

We exploit a recent (April 2015) sample of the *Canadian Financial Monitor* survey and find that the share of stocks and bonds in total retirement assets is equal to 85.1% on average. We use this number to impute the fraction of the retirement savings of Canadian households which are allocated to risky assets. This is very close to the risky share in retirement savings that we impute for the US.

The CFM does not separately record the holdings of stocks and bonds in the overall value of mutual funds. We therefore impute a risky share of mutual funds of 1 and an equity share of 0.5 for both mutual funds and retirement accounts.

Germany and Netherlands

In the *Eurosystem Household Finance and Consumption Survey*, household holdings of money-market mutual funds are recorded for households in Spain, Italy and France. We run a cross-sectional regression where we explain the holdings of money-market funds in these three countries through household characteristics (i.e. the log level of mutual funds holdings, log level of total financial assets, portfolio shares of stocks, bonds and bank deposits, age of household head and highest level of education completed). We use the estimated coefficients to impute funds holdings in Germany and Netherlands.

Germany, Netherlands, Spain, France and Italy

We exploit a recent wave (no. 5/2013) of the *Survey of Health and Retirement in Europe* to impute equity ratios by using the fractions of households which indicate that their mutual fund holdings and retirement assets are invested in publicly traded stock. The results indicate that these shares are equal to 0.49 (Germany), 0.64 (Netherlands), 0.34 (Spain) and 0.51 (France) for mutual funds and 0.213 (Germany), 0.372 (Netherlands), 0.266 (Spain) and 0.278 (France) for defined-contribution plans.

Absent further reliable information, we impute a total share of stocks and bonds in retirement assets equal to 1 in all five countries and a corresponding share of publicly traded stock equal to 0.5 in Italy.

Robustness analysis

The high risky share in continental European defined-contribution retirement assets appears broadly consistent with discussions by European financial market participants. However, one might be concerned that if the risky share is overstated, this would artificially reduce the cross-country differences reported in Table 2 and Figure 1 of the lecture, and might also affect the patterns in Figure 2. As a robustness check, in this appendix we report alternative results assuming a risky share in retirement assets of 0.85 (the same value as in the US and Canada) in Germany, the Netherlands, Spain, France, and Italy, and an equity share in retirement assets of 0.282 in Italy (the average of the European countries for which we have data). Appendix Figures 1 and 2, and Appendix Table 2 (at the back of this appendix) report the results. Some specifics do change, but the overall message of these figures and table is similar to that in the published lecture.

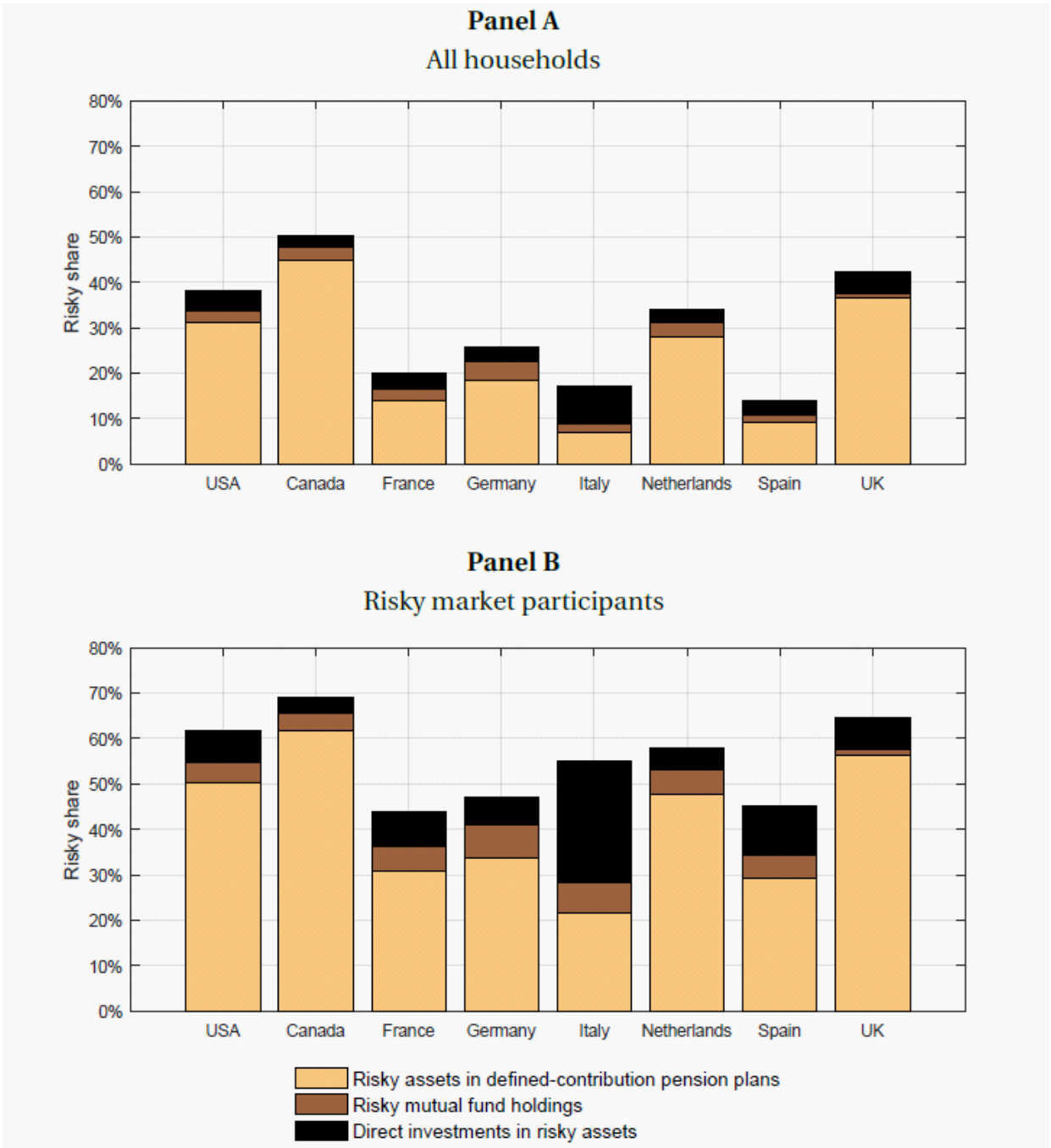

Figure 1: International comparison of average risky shares (alternative assumptions)

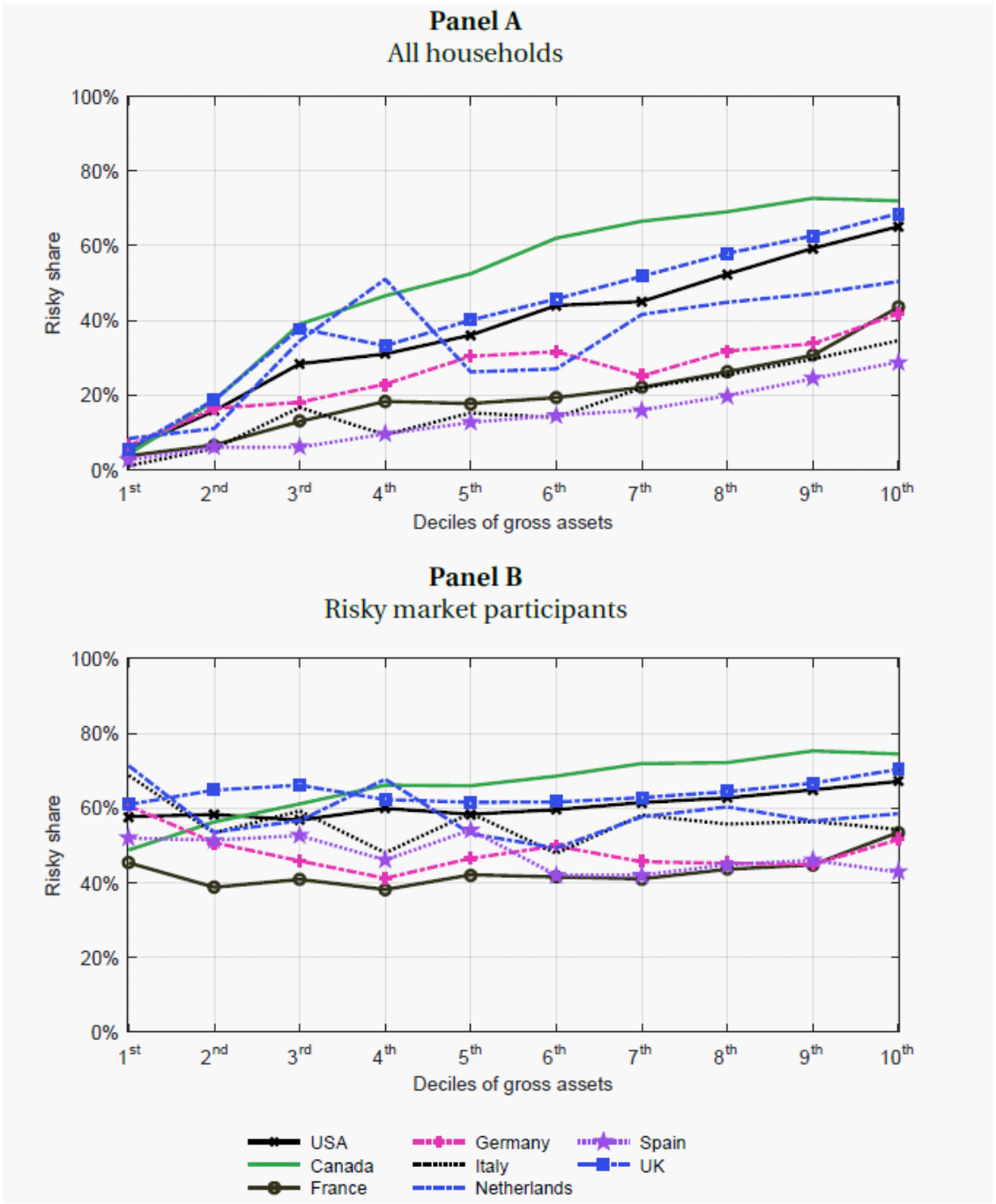

Figure 2: Average risky shares across deciles of gross assets (alternative assumptions)

IA. Investment Strategies and Wealth Inequality

This section of the online appendix presents a more detailed analysis of the components of growth in wealth inequality.

Notation

I will consider a set of households with different investment strategies. I will use the notation Var^* to denote a cross-sectional variance at a point in time. That is, for N cross-sectional units indexed by i,

$$\text{Var}^*\left(X_{it}\right) = \frac{1}{N}\sum_{i=1}^{N}\left(X_{it} - \frac{1}{N}\sum_{i=1}^{N}X_{it}\right)^2. \tag{1}$$

Similarly, I will use Cov^* to denote a cross-sectional covariance:

$$\text{Cov}^*\left(X_{it}, Y_{it}\right) = \frac{1}{N}\sum_{i=1}^{N}\left(X_{it} - \frac{1}{N}\sum_{i=1}^{N}X_{it}\right)\left(Y_{it} - \frac{1}{N}\sum_{i=1}^{N}Y_{it}\right). \tag{2}$$

Simple model without saving

In the absence of income and consumption (and hence in the absence of saving), the evolution of household i's wealth is given by

$$W_{i,t+1} = W_{it}(1 + R_{i,t+1}), \tag{3}$$

where $(1 + R_{i,t+1})$ is the gross return on household i's portfolio. Taking logs,

$$\begin{aligned} w_{i,t+1} &= w_{it} + r_{i,t+1} \\ &= w_{it} + \text{E}_t r_{i,t+1} + \widetilde{r}_{i,t+1}, \end{aligned} \tag{4}$$

where $\text{E}_t r_{i,t+1}$ is the rational (econometrician's) expectation of the log portfolio return for household i, and $\widetilde{r}_{i,t+1} = r_{i,t+1} - \text{E}_t r_{i,t+1}$ is the unexpected component of the log portfolio

return.

It follows from equation (4) that we can decompose the change in the cross-sectional variance of log wealth from time t to time $t+1$ into five terms:

$$\begin{aligned}\mathrm{Var}^*\left(w_{i,t+1}\right)-\mathrm{Var}^*\left(w_{it}\right) &= \mathrm{Var}^*\left(\mathrm{E}_t r_{i,t+1}\right)+\mathrm{Var}^*\left(\widetilde{r}_{i,t+1}\right)+2\mathrm{Cov}^*\left(w_{it},\mathrm{E}_t r_{i,t+1}\right)\\ &\quad +2\mathrm{Cov}^*\left(w_{it},\widetilde{r}_{i,t+1}\right)+2\mathrm{Cov}^*\left(\mathrm{E}_t r_{i,t+1},\widetilde{r}_{i,t+1}\right). \qquad (5)\end{aligned}$$

The first term on the right hand side of equation (5) is the cross-sectional variance in expected log returns, caused by differences across households in their willingness to take compensated risk or their investment skill. The second is the cross-sectional variance in unexpected log returns, the result of either differences in exposures to common shocks or imperfect diversification that allows idiosyncratic shocks to affect individuals' portfolio returns.

The remaining three terms are cross-sectional covariances. The cross-sectional covariance between log wealth and expected log return captures any tendency for wealthier households to earn higher expected log returns through greater willingness to take risk or greater investment skill. This is the covariance emphasized by Piketty (2014). The cross-sectional covariance between log wealth and unexpected return is positive in periods where the investment strategies favored by wealthier people do unexpectedly well. For example, if wealthier people hold portfolios with higher betas, this cross-sectional covariance is positive when the aggregate stock market does better than average. The final covariance, between the expected log return and the unexpected return, has a similar interpretation.

If we take the unconditional time-series average of equation (5), the last two covariances drop out because they have a zero unconditional expectation in the time series. We can write a simpler three-way variance decomposition

$$\begin{aligned}\mathrm{E}\left[\mathrm{Var}^* w_{i,t+1}-\mathrm{Var}^*\left(w_{it}\right)\right] &= \mathrm{E}\left[\mathrm{Var}^*\left(\mathrm{E}_t r_{i,t+1}\right)\right]+\mathrm{E}\left[\mathrm{Var}^*\left(\widetilde{r}_{i,t+1}\right)\right]\\ &\quad +2\mathrm{E}\left[\mathrm{Cov}^*\left(w_{it},\mathrm{E}_t r_{i,t+1}\right)\right]. \qquad (6)\end{aligned}$$

Imposing a factor structure

It is possible to be more explicit about the determinants of these cross-sectional variances and covariances if we consider a simple factor structure. For example, we might use the market model, define $er_{m,t+1} = \mathrm{E}_t r_{m,t+1} - r_{f,t+1}$, and write

$$\mathrm{E}_t r_{i,t+1} = r_{f,t+1} + \alpha_{it} + \beta_{it}\mathrm{E}_t er_{m,t+1} \tag{7}$$

and

$$\widetilde{r}_{i,t+1} = \beta_{it}\widetilde{er}_{m,t+1} + \varepsilon_{i,t+1}. \tag{8}$$

Then we have

$$\mathrm{Var}^*\left(\mathrm{E}_t r_{i,t+1}\right) = \mathrm{Var}^*\left(\alpha_{it}\right) + \mathrm{Var}^*\left(\beta_{it}\right)\left(\mathrm{E}_t er_{m,t+1}\right)^2 + 2\mathrm{Cov}^*(\alpha_{it}, \beta_{it})(\mathrm{E}_t er_{m,t+1}). \tag{9}$$

Here the first term captures cross-sectional variance in alpha (investment skill, or ability to exploit deviations of expected returns from predictions of the CAPM). The second term captures cross-sectional variance in beta, which matters more when the expected excess market return is far from zero. The third term captures the cross-sectional covariance between alpha and beta, which has a positive effect on the dispersion of expected returns when the expected excess market return is positive. A positive cross-sectional covariance between alpha and beta occurs when more skilled investors are also willing to take more market risk exposure.

Similarly, we have

$$\begin{aligned}\mathrm{Var}^*\left(\widetilde{r}_{i,t+1}\right) &= \mathrm{Var}^*\left(\beta_{it}\right)\widetilde{er}^2_{m,t+1} + \mathrm{Var}^*\left(\varepsilon_{i,t+1}\right) \\ &\quad +2\mathrm{Cov}^*(\beta_{it}, \varepsilon_{i,t+1})\widetilde{er}_{m,t+1}.\end{aligned} \tag{10}$$

The first term captures cross-sectional variance in beta, which matters more when the unexpected excess market return is far from zero. The second term captures cross-sectional

variance in the idiosyncratic return $\varepsilon_{i,t+1}$. This cross-sectional variance is high when investors are poorly diversified. The third term captures the effect of covariance between beta and idiosyncratic return. The unconditional time-series expectation of this term is zero, so we have

$$\mathrm{E}\left[\mathrm{Var}^*\left(\widetilde{r}_{i,t+1}\right)\right] = \mathrm{E}\left[\mathrm{Var}^*\left(\beta_{it}\right)\widetilde{er}^2_{m,t+1}\right] + \mathrm{E}\left[\mathrm{Var}^*\left(\varepsilon_{i,t+1}\right)\right]. \tag{11}$$

When $\mathrm{Var}^*\left(\beta_{it}\right)$ is constant over time (as would be the case if households have fixed betas over time), then this simplifies further to

$$\mathrm{E}\left[\mathrm{Var}^*\left(\widetilde{r}_{i,t+1}\right)\right] = \mathrm{Var}^*\left(\beta_{it}\right)\,\mathrm{E}\left[\widetilde{er}^2_{m,t+1}\right] + \mathrm{E}\left[\mathrm{Var}^*\left(\varepsilon_{i,t+1}\right)\right]. \tag{12}$$

Finally, we have

$$\mathrm{Cov}^*\left(w_{it}, \mathrm{E}_t r_{i,t+1}\right) = \mathrm{Cov}^*\left(w_{it}, \alpha_{it}\right) + \mathrm{Cov}^*\left(w_{it}, \beta_{it}\right)\mathrm{E}_t er_{m,t+1}. \tag{13}$$

The covariance between wealth and expected return emphasized by Piketty (2014) is determined by the covariance between wealth and alpha, and the covariance between wealth and compensated risk exposure.

Taking account of saving

In the presence of income and consumption (equivalently, in the presence of saving), the evolution of household i's wealth is given by

$$W_{i,t+1} = W_{it}\left(1 + \frac{Y_t - C_t}{W_{it}}\right)\left(1 + R_{i,t+1}\right) = W_{it}\left(1 + S_{it}\right)\left(1 + R_{i,t+1}\right), \tag{14}$$

where $(1 + S_{it})$ is the household's gross savings rate as a fraction of wealth. Taking logs,

$$\begin{aligned} w_{i,t+1} &= w_{it} + s_{it} + r_{i,t+1} \\ &= w_{it} + s_{it} + \mathrm{E}_t r_{i,t+1} + \widetilde{r}_{i,t+1}. \end{aligned} \tag{15}$$

The previous three-way decomposition of the unconditional time-series average growth in wealth inequality now becomes a six-way decomposition:

$$\begin{aligned}\mathrm{E}\left[\mathrm{Var}^{*} w_{i,t+1} - \mathrm{Var}^{*}\left(w_{it}\right)\right] &= \mathrm{E}\left[\mathrm{Var}^{*}\left(s_{i,t+1}\right)\right] + \mathrm{E}\left[\mathrm{Var}^{*}\left(\mathrm{E}_t r_{i,t+1}\right)\right] + \mathrm{E}\left[\mathrm{Var}^{*}\left(\widetilde{r}_{i,t+1}\right)\right] \\ &\quad + 2\mathrm{E}\left[\mathrm{Cov}^{*}\left(w_{it}, s_{it}\right)\right] + 2\mathrm{E}\left[\mathrm{Cov}^{*}\left(w_{it}, \mathrm{E}_t r_{i,t+1}\right)\right] \\ &\quad + 2\mathrm{E}\left[\mathrm{Cov}^{*}\left(s_{it}, \mathrm{E}_t r_{i,t+1}\right)\right]. \end{aligned} \tag{16}$$

Relative to the previous analysis that neglected savings, the new terms tell us that wealth inequality grows faster when there is cross-sectional dispersion of savings rates, when wealthier people save more, and when high savings rates are correlated with high expected investment returns.

Empirical results using Indian data

The lecture implements this decomposition using data from Campbell, Ramadorai, and Ranish (2015). The dataset is a universe of directly held equities from National Securities Depository Limited (NSDL), one of two main electronic securities depositories in India, over the period 2002–2012 at a monthly frequency. All directly held, publicly traded Indian equities are included, and this captures the great majority of risky financial assets for Indian investors, since directly held foreign stocks and mutual funds both have a very low market share in India. Wealth is proxied here by the size of the NSDL equity account.

In this dataset, average log returns increase strongly with account size, from 75-90 basis points per month among the smallest accounts to almost 140 basis points per month in the top decile of accounts. This pattern reflects generally increasing diversification among larger accounts, which increases average log returns while leaving average simple returns almost flat across the account size distribution. There are minor exceptions at the two extremes of the wealth distribution. The very smallest accounts are tiny and tend to hold micro-cap stocks that have delivered high average returns in this period. The largest 0.1% of accounts are somewhat less diversified than smaller accounts, possibly because they belong to corporate

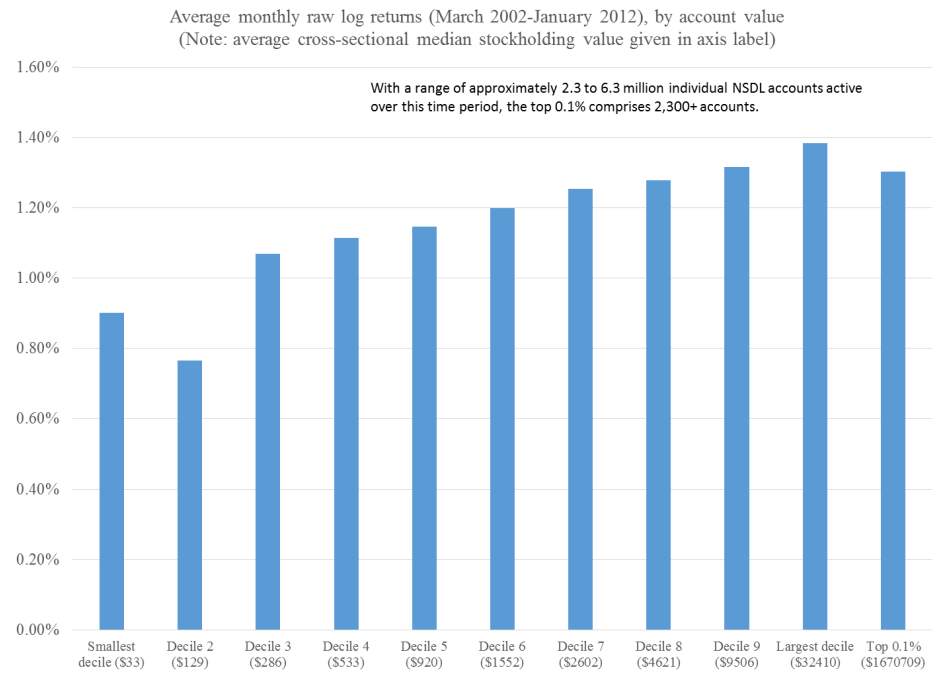

Figure 3: Average log returns in Indian equity accounts, by size decile

executives who are encouraged or required to hold their employer's stock.

These results are illustrated in Appendix Figure 3. The results are robust to alternative empirical procedures, as illustrated in Appendix Figure 4. This figure compares the patterns in the first figure with those obtained if one sorts accounts by lagged equity value or by the value of all assets in the NSDL data (including non-equity assets). It also reports results controlling for account age, excluding accounts for which 10% or more of stockholdings lack return data, and finally excluding micro-cap stocks below 500 million rupees in capitalization. The last of these adjustments reduces the average log returns on the smallest accounts, which tend to hold micro-cap stocks that performed unusually well during the sample period.

The same data can be used to calculate the three terms on the right hand side of equation (6). The sum of the three terms is 0.015 per month, of which a negligible share (less than 0.05%) comes from the cross-sectional variance of expected returns, 57% comes from the cross-sectional variance of unexpected returns, and 43% comes from the cross-sectional covariance between log wealth and expected log returns. The average level of the cross-

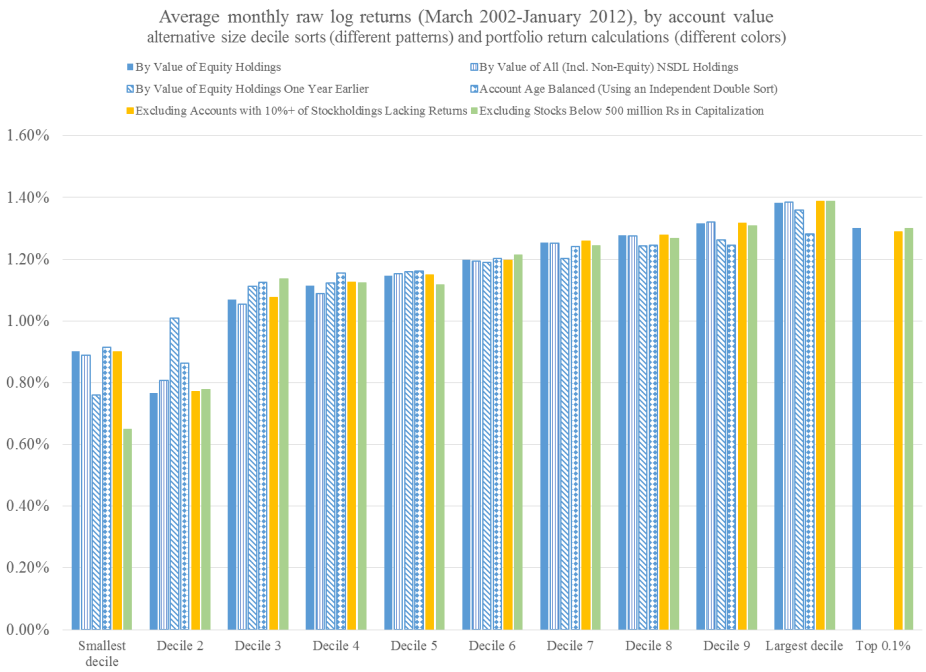

Figure 4: Alternative measures of average log returns

sectional variance of log account size is 4.55, and the average monthly change in this cross-sectional variance over the sample period is 0.021 per month, almost 40% larger than the sum of the three terms on the right hand side of equation (6). This implies that inflows to Indian equity accounts, which are not modeled in (6), have increased inequality in equity account size over this period. Nonetheless a substantial fraction of the overall increase in inequality is accounted for by investment returns.

The above results are robust to an alternative treatment in which the average log returns are calculated for accounts in each account size decile, while maintaining an independent 3 x 3 x 3 sort on portfolio weighted average size, book-market, and prior $(t-12:t-2)$ return dollar-weighted percentiles.

II. What Goes Wrong in Household Finance?

Data for Figure 3 in the lecture were kindly provided by Annamaria Lusardi. The 2012 National Financial Capability Study can be downloaded from the data website at http://www.usfinancialcapability.org/. A detailed description of the data and the financial literacy questions is provided in Lusardi, "Americans' Financial Capability", NBER Working Paper No. 17103, 2011.

III. The Behavioral Welfare Economics of Consumer Financial Regulation

This section of the online appendix discusses a variant of the behavioral welfare economics model presented in the lecture.

Setup of the model

Two financial products are available to consumers, A and B. Product A, the "plain-vanilla" product, delivers utility normalized to zero for all consumers: $U_A = 0$. Product B, the "problematic" product, is correctly preferred by some consumers but mistakenly chosen by others. As motivating examples, product A could be a bank account without overdraft protection while product B could be the same account with overdraft protection; or product A could be informal lending within the family while product B could be a payday loan.

A continuum of agents, with mass normalized to one, believe that they receive non-negative utility $U_B = u$ from product B.[3] u varies across agents with probability density function $f(u)$, CDF $F(u)$, and upper bound h, but each agent knows her own value of u. At each level of u, a fraction b of the agents are behavioral agents who receive lower utility from the product, $U_B = u - 1$. In other words these agents overstate the utility they receive from product B by a fixed amount normalized to unity. The overstatement might be due

[3]There can also be agents who prefer product A in the absence of regulation, but these agents are unaffected by regulation and can be dropped from further consideration.

to a mistake in assessing the suitability of the product ex ante, or a mistake in managing it ex post. The remaining fraction $(1 - b)$ of the agents are rational and receive utility u as they expect. Behavioral and rational agents are identical in all other respects, and this rules out the possibility of nudging behavioral agents without impacting rational agents, or of imposing "qualified investor" rules to exclude only behavioral agents from the product-B market.

For a simple parametric example, assume a uniform distribution for u between 0 (the lower bound consistent with choosing product B) and h (the upper bound). The parameter h captures the heterogeneity of agents, both within the B-choosing group and between the average of that group and the unmodeled A-choosing group. With this specification, $f(u) = 1/h$ and $F(u) = u/h$. This example is illustrated in Figure 4 of the lecture. Self-perceived utility on the horizontal axis runs from zero to h for all agents. True utility runs from 0 to h for rational agents, and from -1 to $h - 1$ for behavioral agents. Averaging across the two groups, true social utility runs from $-b$ to $h - b$. Figure 4 shows a case where $h < 1$ (which implies that all behavioral agents would be better off switching to product A), and $b < h$. However the parametric model also allows $h \geq 1$ and $b \geq h$.

An advertising or financial education campaign

Consider an advertising or financial education campaign that reaches all behavioral agents with equal probability, regardless of their self-perceived or true utility of product B. Such an intervention may either persuade the affected behavioral agents that they are better off with product A, or may educate them to make a fully rational choice understanding their own true utility. These are equivalent if $h \leq 1$ but not in the case where $h > 1$, because in that case some behavioral agents are actually better off with product B.

If the regulator has the technology to reach a fraction λ of behavioral agents and persuade them to switch to product A, at a total cost $g(\lambda)$, then the total population of B-choosing

agents shrinks to $1 - \lambda b$ and social welfare is

$$W(\lambda) = \int_0^h \left[(1 - \lambda b)u - (1 - \lambda)b\right] f(u)du - g(\lambda). \tag{17}$$

In the simple parametric example, with the additional assumption of a quadratic advertising cost function $g(\lambda) = k\lambda^2/2$, the social welfare function is

$$\begin{aligned} W(\lambda) &= (1 - \lambda b)\left(\frac{h}{2}\right) - (1 - \lambda)b - \frac{k}{2}\lambda^2 \\ &= \left(\frac{h}{2} - b\right) + b(1 - \frac{h}{2})\lambda - \frac{k}{2}\lambda^2, \end{aligned} \tag{18}$$

and the derivative of social welfare with respect to λ is

$$\frac{dW}{d\lambda} = b\left(1 - \frac{h}{2}\right) - k\lambda. \tag{19}$$

The optimal policy equates the fixed marginal benefit of persuading more behavioral agents to switch to product A with the increasing marginal cost of doing so. The solution is

$$\lambda^* = \frac{b(1 - h/2)}{k}, \tag{20}$$

provided that $0 \leq \lambda^* \leq 1$. Unsurprisingly, the scale of the optimal advertising campaign increases in the fraction of behavioral agents, and decreases in the heterogeneity parameter (which captures benefits that product B offers even to behavioral agents) and the cost of reaching and persuading behavioral agents.

A financial education campaign that educates behavioral agents to be fully rational is equivalent to the above advertising campaign when $h \leq 1$. However, if $h > 1$ a fraction $(h - 1)/h$ of newly educated agents rationally choose to remain with product B. This adds a term $\lambda b(h - 1)/h$ to the social welfare function. The derivative of social welfare with

respect to λ is increased by $b(h-1)/h$, so the optimal solution is now

$$\lambda^* = \frac{b(1-h/2+(h-1)/h)}{k}, \tag{21}$$

provided that $0 \leq \lambda^* \leq 1$. If a financial education campaign and an advertising campaign on behalf of product A are equally expensive, when $h > 1$ the optimal scale of the financial education campaign is larger because it offers greater benefits than the advertising campaign.

Transfers and an advertising or financial education campaign

Some mistakes by behavioral agents are product management failures that generate fees to product providers. Examples might include credit card late payment fees, or bank overdraft fees. Gabaix and Laibson (2006) emphasize that in a competitive financial market, fees from behavioral agents are passed on to all purchasers of the product in the form of lower product prices. Thus, in equilibrium rational agents benefit at the expense of behavioral agents. Such a mechanism potentially affects the welfare analysis of consumer financial regulation because losses to behavioral agents are transfers to rational agents, not social losses.

To understand the issue, I now alter the simple product choice model so that each behavioral agent generates a unit fee that is passed on to all purchasers of product B. This is the extreme case where the misperceptions of behavioral agents are entirely about transfers that they make to rational agents. The subsidy per purchaser is b, and if the subsidy is removed the price of product B increases by b so rational agents' net-of-cost utility declines by this amount.

Interventions against products, of the sort discussed in section III.B of the lecture, have the same social benefits in this case as they did before, and accordingly the optimal scale of these interventions is unchanged. The reason is that interventions against products affect rational and behavioral agents in the same proportion that they exist in the population. In effect the social planner uses the preferences of a weighted average of rational and behavioral agents, and transfers net out from this weighted average.

Interventions against mistakes, of the sort discussed in section III.C of the lecture and in this online appendix, have lower benefits and a smaller optimal scale in the presence of transfers. Eliminating mistakes benefits behavioral agents but, if there are transfers, it hurts rational agents and the social planner must take this into account.

To illustrate this point, assume that $b < h$ and $h \leq 1$, and consider a financial education campaign that educates all behavioral agents to become rational. After the campaign, product B is now less attractively priced for rational agents and has utility running from $-b$ to $h - b$. A fraction b/h of agents now have negative utility from product B and switch to product A. Social welfare is the remaining market size, $(1 - b/h)$, times the average utility of remaining agents $(h - b)/2$, less the cost of the financial education campaign:

$$\begin{aligned} W(1) &= \left(1 - \frac{b}{h}\right)\left(\frac{h-b}{2}\right) - \frac{k}{2} \\ &= \frac{h}{2} - b + \frac{b^2}{2h} - \frac{k}{2}. \end{aligned} \tag{22}$$

Relative to social welfare before the intervention, $W(0) = h/2 - b$, the gain in welfare is $b^2/2h - k/2$. The first term is the area of the triangle in the lecture's Figure 4 between the origin and the points $(0, -b)$ and $(b, 0)$, divided by h to correct for the effect of h on the density of agents in any region of the state space.

Since the marginal benefit of financial education is constant in this model, while the marginal cost is linear, a financial education campaign that reaches only a fraction λ of behavioral agents generates social welfare

$$W(\lambda) = \left(\frac{h}{2} - b\right) + \left(\frac{b^2}{2h}\right)\lambda - \left(\frac{k}{2}\right)\lambda^2. \tag{23}$$

The optimal scale of intervention is

$$\lambda^* = \frac{b^2}{2hk}. \tag{24}$$

These results can be compared with the social welfare created by financial education in

the previous analysis without transfers. For any level of λ, the social welfare implied by equation (18) in the case without transfers is greater than that in (23) by $b(1-h/2-b/2h)$, which is positive when $b < h$ and $h < 1$ because $1 - h/2 > 1/2 > b/2h$. Thus the presence of transfers reduces the welfare gain from a financial education campaign of any given size. Similarly, the optimal scale of intervention in the case without transfers given in equation (20), less the optimal scale in the case with transfers given in (24), is $b(1-h/2-b/2h)/k > 0$. The presence of transfers implies that the optimal financial education campaign should be smaller because it offers smaller benefits.

Results are similar if we consider an advertising campaign that persuades all behavioral agents to switch to product A. This removes a fraction b of the initial market for the product. But there is a further effect because, in the absence of a subsidy from behavioral agents, a fraction b/h of rational agents also switch to product A. The size of the remaining market for product B is only $(1-b)(1-b/h)$, which is even smaller than in the case where all behavioral agents are educated to become rational. Social welfare in this case is $(1-b)$ times the value in equation (22). The reduction in social welfare relative to the situation where all agents become educated is the area of the triangle in the lecture's Figure 4 between the points $(b, 0)$, $(h, 0)$, and $(h, h-b)$, multiplied by the initial fraction of behavioral agents b and divided by h to correct for the effect of h on the density of agents. This represents the loss to behavioral agents who are persuaded to switch to product A when they would in fact be better off remaining with product B once they are educated to avoid the product management mistake. The same logic used in the case of a financial education campaign implies that the benefit of any partial advertising campaign is smaller, and the optimal scale of the campaign is smaller, when behavioral agents are creating transfers to rational agents.

IV. Recent Developments in Consumer Financial Markets

Section IV.A of the lecture analyzes data provided to me by the Employee Benefits Research Institute (EBRI) and the Investment Company Institute (ICI). Here I explain more about how we processed these data.

The numbers discussed in Section IV.A and plotted in Figure 5 of the lecture can be found in the spreadsheet "EBRI-ICI.xlsx". The tab "Asset Allocation" provides statistics for the shares of target date funds (TDFs), concentrated equity (company stock), and diversified equity (all other types of equity) for different cohorts and the aggregate population from 1996 to 2013. The tab "Diversified Equity Distribution" reports the cross-sectional distribution of the diversified equity share from 1999 to 2013, for the aggregate population without a cohort breakdown. The fraction of plan participants with less than a 20% share of diversified equity is calculated by summing the columns headed "zero" and "1 to 20 percent". The tab "Equity Distribution" reports the cross-sectional distribution of the total equity share, including concentrated equity (company stock), and does contain cohort-specific information.

Figure 5 in the lecture plots the difference between participants in their 20s and participants in their 60s in the diversified equity share and the TDF share (from the "Asset Allocation" tab), and the difference between the fraction of participants in their 20s and the fraction of participants in their 60s with less than 20% equities (including both diversified and concentrated equity holdings, from the "Equity Distribution" tab).

Estimated values are plotted in dots in Figure 5. Estimation is required because prior to 2006, the share of TDFs is not recorded by EBRI/ICI. In this period, EBRI/ICI provides a single statistic "balanced funds" which includes both TDFs and non-TDF balanced funds. To distinguish between these two types of funds, we assume a linear depreciation schedule for the fraction of TDFs in balanced funds from 2005 to 2001. Specifically, for each year prior to 2006 and in each cohort, the fraction of TDFs in balanced funds decreases by one-fifth of the reported value for the same cohort in 2006, until it reaches zero in 2001 and earlier.

These estimated fractions are italicized in the spreadsheet for 2002-2005.

Diversified equity is the sum of equity funds and the equity portion of TDFs and non-TDF balanced funds. For 2006-2013, we first recover the equity share of TDFs from the other known variables. The equity share of TDFs for 2002-2005 is imputed using the historical average values from 2006-2013. These estimates are recorded in italics in the column "Equity share of TDF". We then use the imputed equity share of TDFs to calculate the diversified equity share for 2002-2005.

Many of the numbers in the spreadsheet can be found online in "401(k) Plan Asset Allocation, Account Balances, and Loan Activity", annual reports available at https://www.ici.org/research/investors/ebri. The numbers for TDFs in 2006 and the cross-sectional distribution of diversified equity holdings were specially provided by EBRI/ICI and are not available online.