CapitalPreferences

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New Ground in Financial Risk Tolerance

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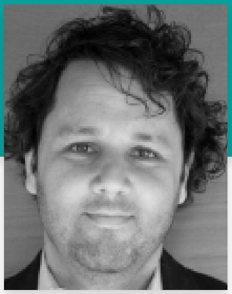

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I. Overview

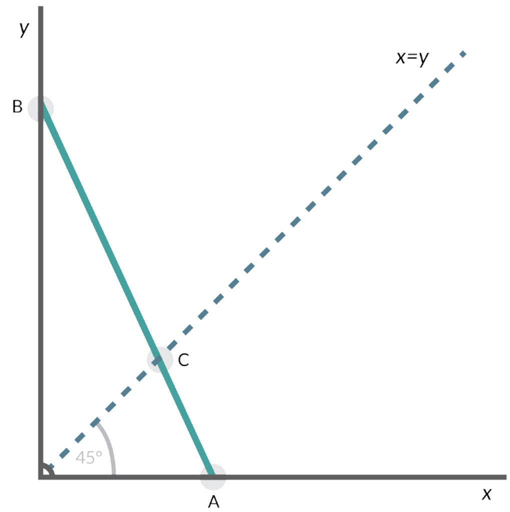
Financial advisors are held to high regulatory standards in the provision of financial advice to clients. Since the market crash brought about by the financial crisis of 2008, the questions of risk-tolerance, capacity for loss and investment suitability have come into focus as regulators seek to ensure investors are protected and the financial system is secure. Capital Preferences offers four scientific tests that consistently and confidently profile clients, addressing those critical questions of risk-tolerance, capacity for loss and investment suitability. These tests are designed using a "game" approach that simplifies the process of information exchange between the advisor and client.

II. Client's decisions under risk

In Decisions under Risk, we ask clients to make decisions under conditions of uncertainty. Specifically, the client is asked to choose between two equally likely states of nature and two associated securities, each of which promises a dollar payoff in one state and nothing in the other. Each decision round starts by having the computer select a budget line. A choice of a portfolio (x,y) from the budget line represents an allocation between securities x and y (corresponding to the usual horizontal and vertical axes). Clients will move the mouse or touch the touchscreen to identify the desired point on the budget line and then select their portfolio by clicking or hitting the enter key. At the end of the round, the computer randomly selects one of the securities x or y and displays the outcome to complete the game then offers feedback on the client's outcome.

Our primary methodological contribution is thus an experimental technique (the game) that enables us to collect richer data about a client's choice under uncertainty than has heretofore been possible. Aside from pure technicalities, our graphical computer interface provides several important innovations over previous work. Most importantly, previous experimental studies have inferred preferences from a small number of individual decisions and hence have been forced to set up relatively extreme choice scenarios. In contrast, we collect many observations per subject. This enables us to analyze preferences at the individual level. This is crucial since individual heterogeneity requires behavior to be examined at an individual level in order to properly examine preferences.

An example of a budget line in our experiment is the line AC drawn in Display 1 below. The point C, which lies on the 45 degree line, corresponds to the safe portfolio with a certain payoff x=y, which is the portfolio consistent with infinite risk aversion. By contrast, point B represents an allocation in which all money is allocated to the cheaper security. This portfolio is consistent with risk neutrality or someone who is completely risk tolerant in this scenario.



Display 1: An example of a budget line

Also note that the point that lies in the middle of the budget line corresponds to the portfolio consistent with maximizing a logarithmic von Neumann-Morgenstern utility function, indicating 'intermediate' attitudes toward risk. Finally, notice that points along BC are risky -- they have a lower payoff in state x and a higher payoff in state y -- but because the slope of the budget line AC is steeper than -1, they have higher expected return than point B. By contrast, points along AB have lower expected return than point B.

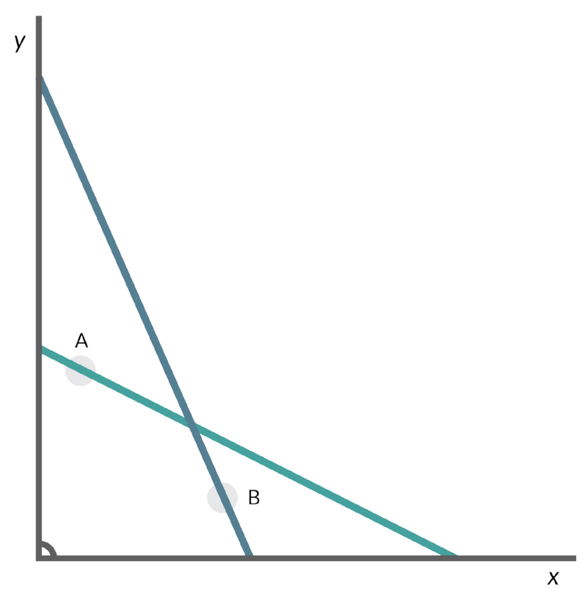
III. The richness of new client profile data

The client data we capture during the profiling process provides a richer understanding of a clients' preferences and allows better advice, segmentation and understanding across an entire client base. The risk mitigation and marketing benefits are substantial. Because our techniques are robust, we can examine and report on a client's sensitivity of portfolio decisions to changes in relative prices in terms of dollars and expenditures respectively. Clearly, this distinction is only relevant in the presence of price changes. We can present the choices made by individual subjects by reporting the portfolio allocations in a number of ways. For each subject, the top panel (A) depicts the portfolio choices (x,y) as points in a scatterplot. The bottom left (B) and right (C) panels show, respectively, the relationship between the log price-ratio (the slope of the budget line), on the one hand, and x/(x+y) and x/x , on the other where x is the endpoint of the budget line at the x-axis.

Overall, a review of many thousands of our research subjects reveals striking regularities within and marked heterogeneity across subjects. An interesting behavioral regularity is captured the decisions of a subject (ID 140600009) who allocated all of his money to x (resp. y) for flat (resp. steep) budget line. This aspect of his behavior would be consistent with risk neutrality. However, for a variety of intermediate budget lines, this subject chose nearly safe portfolios where x=y. This aspect of his choice behavior is consistent with infinite risk aversion. So this subject is apparently switching between behaviors that are individually consistent with Expected Utility Theory, but mutually inconsistent. In fact, as we will see in the econometric analysis, this subject's preferences exhibit loss aversion (where the "safe decision" x=y is taken to be the reference point).

IV. The power of revealed preferences

The idea of revealed preferences is very powerful, yet simple. If one portfolio is chosen when another could have been chosen, we say that the first portfolio is revealed preferred to the second. If a client is always choosing the most preferred portfolio he can afford then the chosen portfolio must be preferred to the portfolios that were affordable but were not chosen. Consider the two budget lines and corresponding choices illustrated in Display 2 below. Could these two portfolios be chosen by a maximizing client? According to the logic of revealed preferences, this client cannot be maximizing because portfolio A is revealed preferred to portfolio B and portfolio B is revealed preferred to portfolio A. That is, the client has apparently chosen A when he could have chosen B (B was affordable) but then he chose B when he could have chosen A – this is clearly inconsistent. Any choices of this sort are not consistent with the essence of economic rationality – utility maximization.



Display 2: A violation of revealed preferences

Our tests are superior in their reliability and accuracy, because the subjects in our experiments make choices in a wide range of budget lines and we provide financial institutions with a stringent test of utility maximization. Hence, in order to decide whether our experimental data are consistent with utility-maximizing behavior we 'only' need to check whether our data satisfies the idea of revealed preferences. To account for the possibility of errors, we assess how closely client's choices comply with revealed preferences by using a continuous Critical Cost Efficiency Index (CCEI), which measures the fraction by which each budget line must be shifted in order to remove all violations. By definition, the CCEI is between 0 and 1: indices closer to 1 mean the data are closer to perfect consistency with the axioms of revealed preferences and hence to perfect consistency with utility maximization.

Evaluating how well the decisions in the controlled experiment comply with the principle of individual utility maximization provides a test decision-making quality. We take the view that if there is no utility function that choices maximize, then those choices cannot be considered purposeful and, in this way, worthy of a high quality. Informed by economic theory, the single experimental task described above delivers measures of both decision-making quality and preferences from a unified realm of decision-making. The revealed preference tests are applicable to, and comparable across, all sorts of economic choice problems. We can thus make domain-specific predictions and provide a unified and theoretically disciplined measure of decision-making quality across domains concerning risk and time (more below).

V. A reliable measure of risk taking

We can summarize risk taking – combining the individual's attitudes toward risk and loss – with a single statistic: the fraction of dollars a client allocated to the cheaper security. We choose this measure because in each problem that a subject faces, each security is equally likely to be chosen and the budget line is drawn from a symmetric distribution. Thus, the only behavior consistent with infinite risk aversion is always allocating the money equally between the two securities. Conversely, always allocating all the money to the cheaper security is the behavior that would be implied by risk neutrality or complete risk tolerance with the scenario. More generally, subjects who are less averse to risk/loss will allocate a larger fraction of to the cheaper security. Hence, by definition, the measure is between 0.5 and 1: indices closer to 1 mean more risk taking. The advantage of this measure is that it is simple and nonparametric. It measures attitudes toward risk/loss without making assumptions about the parametric form of the underlying utility function. Note the considerable heterogeneity in risk taking across subjects – subject (ID 140700412) took no risks (0. 5179) and subject (ID 140700411) is almost neutral to risk – and the small standard error of the measure.

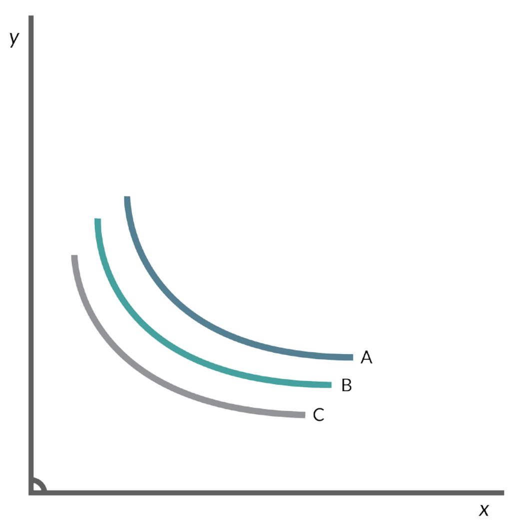
Subject	Risk	Std. Err.
140600008	0.7386	0.0347
140600009	0.7203	0.0498
140700002	0.7203	0.0317
140700411	0.9380	0.0120
140700412	0.5179	0.0182

VI. Separating risk aversion from loss aversion

People differ in their willingness to bear risk. An individual who is risk averse prefers certain income to a risky income with the same expected value, where as a risk neutral individual is indifferent between certain income and a risky income with the same expected value. Because risk is endemic in a wide variety of economic circumstances, models of decision making under risk play a key role in every field of economics. The standard model of decisions under risk is based on von Neumann and Morgenstern (the founding fathers of game theory) celebrated Expected Utility Theory. The curvature of the expected utility function describes the individual attitudes toward risk: the individual is more risk averter the more concave is utility function is. Very few researchers have estimated parametric utility functions for individual subjects. The large amount of data generated by our design allows us to apply statistical models to individual data rather than pooling data or assuming homogeneity across individuals. Hence, we can generate better individual-level estimates of risk aversion than has heretofore been possible.

Loss aversion is the tendency for individuals to prefer avoiding losses over acquiring gains. For example, for people who are averse to losses take the price paid for a stock as a "reference point" and will thus be reluctant to sell the stock at a loss relative to the original price paid and invest the proceeds in other stocks that they think are better investments. Put simply, loss aversion implies that individuals feel the 'pain' of a loss more acutely than they feel the 'pleasure' of a similar size gain, or losses "loom larger" than gains. Loss aversion was first demonstrated by and Daniel Kahnemann (the 2002 Economics Nobel laureate) and Amos Tversky and developed by their Prospect Theory. More technically, loss aversion means that the expected utility function describing the individual attitudes toward risk is more “curved” over losses than it is over similar gains. In addition to identifying the existence of loss aversion and the type of model that is capable of explaining it, we can simultaneously estimate measures of risk and loss aversion at the individual level.

An indifference map is a set of indifference curves that describes the client’s risk preferences. As illustrated in Display 3, any portfolio on indifference curve 3, such as portfolio A, is preferred to any portfolio on indifference curve 2, such as B, which in turn is preferred to any portfolio on indifference curve 1, such as C. If indifference curves intersect, the axiom of revealed preferences is violated. The optimal (affordable) portfolio is where the highest indifference curve tangent to the budget line. As Illustrated in Display 4, the shape of the indifference curves on either side of the 45-degree line is determined by the client’s risk aversion, and the nature of the “kink” 45-degree line is determined by the client’s loss aversion/seeking. The left hand diagram depicts a typical indifference curve for a loss averse individual. The right hand diagram depicts the indifference curve for a loss seeking individual. For a loss neutral client, in contrast, the indifference curves are “smooth” everywhere.



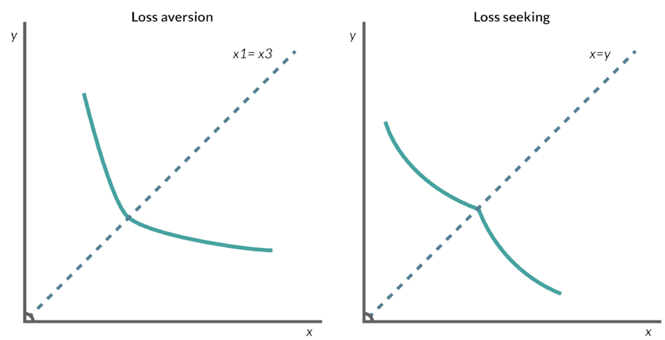
Display 3: Indifference map

In our main specification, we estimate a two-parameter model. These parameters are used to classify the population of subjects. The model does a good job of fitting the data and allowing us to classify different types of behavior. The utility function we estimate is given by,

$$\alpha u(x)+(1-\alpha)u(y)$$

where u(·) is a constant relative risk aversion utility (CRRA) function

$$u(x) = \frac{x^{1-\rho}}{1-\rho}$$



Display 4: The indifference curve for a loss averse (left panel) and loss seeking (right panel)

ρ is the Arrow-Pratt-De Finetti measure of (relative) risk aversion and $0\leq\alpha\leq1$ is a parameter measuring loss aversion/ seeking. We estimated the parameter α which tells us whether the subject is loss averse/seeking: If $\alpha>1/2$ there is loss aversion (indifference curves in the left diagram of Display 4), if $\alpha<1/2$ there is loss seeking (indifference curves in the right diagram of Display 4), and if $\alpha=1/2$ we have loss neutrality (smooth indifference curves).

The estimation technique is simple non-linear least squares (NLLS), but we can also employ a structural model using maximum likelihood (ML) methods. The estimation results are attached below. The parameter estimates reported below vary dramatically across subjects. We emphasize again that our estimations are done for each subject separately. Other experimental methods infer preferences from a small number of individual decisions and hence are forced to set up relatively extreme choice scenarios. Our method enables us to confront clients with a wide range of prices, so that the specification of choice sets is less likely to influence clients’ decisions.

ID	α	se(α)	ρ	se(ρ)
140600008	0.5271	0.0321	0.5360	0.1108
140600009	0.7999	0.0362	0.0643	0.0498
140700002	0.5041	0.0837	0.6623	0.2472
140700411	0.4042	0.0812	0.5289	0.1526
140700412	0.9215	0.0319	0.0594	0.0368

Note: α = loss aversion; ρ = risk aversion; se = standard error

VII. Measuring ambiguity aversion

An important advantage of our methods and analyses is that they can be transported, with relative ease, to different decision domains so we can generate analogous individual-level data which will similarly allow for a rigorous test of individual-level decision-making under ambiguity in addition to risk. Daniel Ellsberg famously proposed an experiment the results of which have become known as the "Ellsberg paradox" because they are in odds with the predictions of Expected Utility Theory. Ellsberg (as well as others before and after him) observation is that people's choices show an aversion to ambiguity not just for risk. In fact there is an important distinction between situations involving 'pure' risk (the odds of uncertain outcomes are objectively known like tossing an unbiased coin) and situations also involving ambiguity (the odds of uncertain outcomes are not objectively known). A large and growing body of empirical work shows that people dislike the possibility that they may have the odds wrong and so make a wrong decision.

Like in the experiment of decision-making under risk described above, we ask clients to choose between two states of nature and two associated securities, each of which promises a dollar payoff in one state and nothing in the other. But unlike in the experiment of decision-making under risk where the clients are informed that the two states are equally likely, in the experiment of decision-making under ambiguity the two states have ambiguous (unknown) probabilities. The (only) difference between the experiments of decision-making under risk and ambiguity is whether the probabilities of x or y are revealed to the clients. As they are not, the decision problem involves ambiguity rather than only risk. Put differently, ambiguity aversion is an aversion to portfolios where the probabilities involved are less known. It is, therefore, a preference for known financial risks over unknown financial risks.

The equity premium – the difference between the average return of stocks and bonds – has been noted to be very large – a phenomenon so-called the "equity premium puzzle." Ambiguity aversion has been repeatedly suggested as the explanation for the equity premium puzzle in recent theoretical models and a large body of empirical work has largely confirmed the prediction of the theory. The argument is that attitudes toward ambiguity are heterogeneous across clients, just as attitudes toward risk are heterogeneous across clients, but that heterogeneity of attitudes toward ambiguity has different implications than heterogeneity of attitudes toward risk. In particular, clients who are sufficiently ambiguity averse will refuse to hold an ambiguous portfolio. This suggests a different cross-section of portfolio choices than if probabilities were known.

VIII. Decoding time preferences

Intertemporal choice is individual decisions Involving tradeoffs among costs and benefits occurring at different times. Revealed preferences can also be used to make judgments involving time instead of risk tradeoffs, and all our comparative static results derived earlier for choice problems involving risk can be applied to intertemporal consumption as well. Time discounting is the present value for an individual of a dollar to be delivered in the "next period," which can be higher or lower than the present value of the market 1/(1+r) where r is the real interest rate.

The experiment of intertemporal choice replaces the state-contingent assets in the experiments of decision-making under risk and ambiguity with time-dated assets. In this experiment, clients choose, from a budget line, bundles consisting of some income sooner and some income later. As in the experiments described above, the budget lines vary randomly and cross often, now reflecting different interest rates as well as endowments. Clearly, to the extent that people have different estimates of about the rate of inflation, they will also have different time discounting. We can use our experimental data to estimate models of time discounting to provide the most precise estimates of time discounting.

The long-standing interest in intertemporal choice has, in recent years, been further fueled by evidence of non-constant time discounting and a better understanding of its consequences to financial decision-making. A large body of empirical work can be interpreted to show that time discount rates decline as tradeoffs are pushed into the temporal distance. In particular, individuals often choose the larger and later of two rewards when both are distant in time, but prefer the smaller and earlier one as both rewards draw nearer to the present. Interpreted as present bias, these preference reversals have important implications: non-constant time discounting implies time-inconsistency -- the choices that a person makes now about consumption at later date are different from the choices he would make when that date arrives. Self-control problems and a demand for commitment thus emerge. We provide a new and rich set of individual-specific estimates of time preferences, including time discount rates and present bias.

IX. Portfolio optimization based on preferences

In constructing portfolios, we first identify the investable universe and develop a set of statistics that characterize the return and yield streams for each individual investment as well as structural relationships between the investments. We identify the statistics that characterize each return and yield series by fitting a probability distribution using a maximum likelihood (ML) approach. Typically, returns and yields are characterized by extreme value, normal or t-location scale probability distributions. We identify the structural statistical relationships between investments by estimating a copula that characterizes the joint dependency between both the returns and yields. This approach is more robust than traditional approaches to portfolio construction because it captures correlations of ranked returns, incorporates considerations of conditional relationships and captures tail dependencies that characterize outcomes at the extremes. The portfolio optimization process relies on the copula and return distributions in determining the distribution of portfolio returns.

Having identified parameters for each individual's utility curve, using the relevant specification for utility, we are able to determine the optimal portfolio. This optimal portfolio identifies the optimal mix of assets given an individual's revealed preferences. This approach is very flexible and allows us to incorporate traditional constraints such as limits on asset concentration and/or risk concentration, target return, etc.

X. Selected References

(Most closely related academic publications)

- Revealing Preferences Graphically: An Old Method Gets a New Tool Kit (with Syngjoo Choi, UCL, Ray Fisman, Columbia B-School, and Douglas Gale, NYU). American Economic Review, Papers & Proceedings, May 2007, 97(2), pp. 153-158.

- Consistency and Heterogeneity of Individual Behavior under Uncertainty (with Syngjoo Choi, UCL, Ray Fisman, Columbia B-School, and Douglas Gale, NYU). American Economic Review, December 2007, 97(5), pp. 1921-1938.

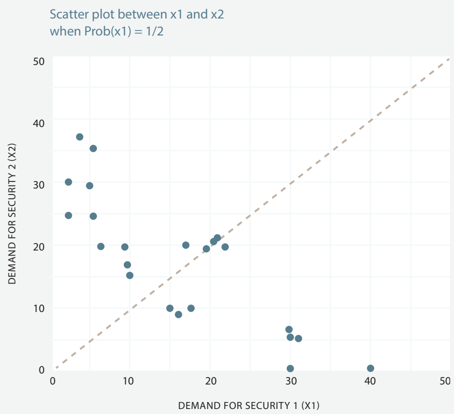
- An Old Measurement of Decision-making Quality Sheds New Light on Paternalism (with Dan Silverman, Arizona State University). Journal of Institutional and Theoretical Economics, February 2013, 169(1), pp. 29-44.

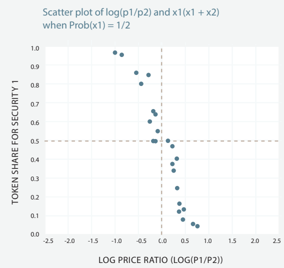
- Who is (More) Rational? (with Syngjoo Choi, UCL, Wieland Müller, Tilburg University, and Dan Silverman, Arizona State University). American Economic Review, June 2014, 104(6), pp. 1518–1550.

- Estimating Ambiguity Aversion in a Portfolio Choice Experiment (with David Ahn, Berkeley, Syngjoo Choi, UCL, and Douglas Gale, NYU). Quantitative Economics, July 2014, 5(2), pp. 195–223.

Appendix A

Participant
140600008





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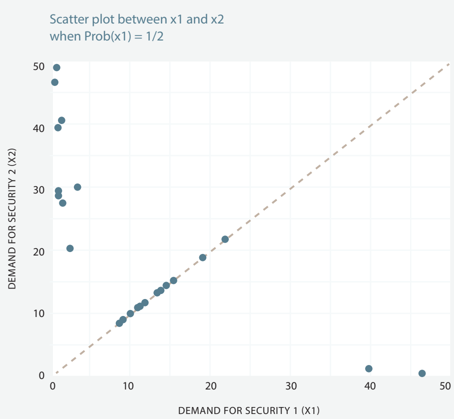

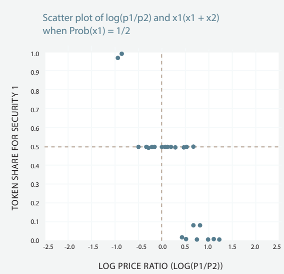

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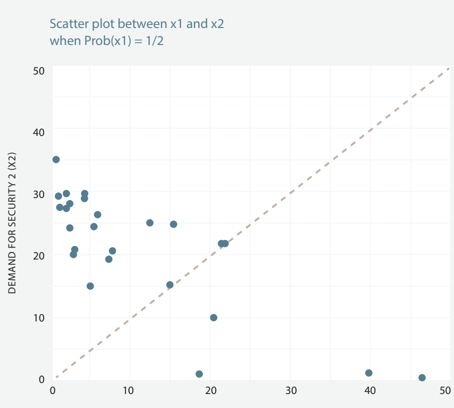

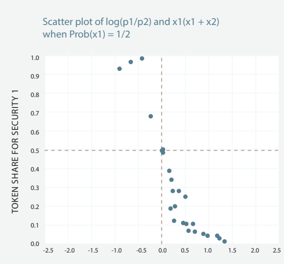

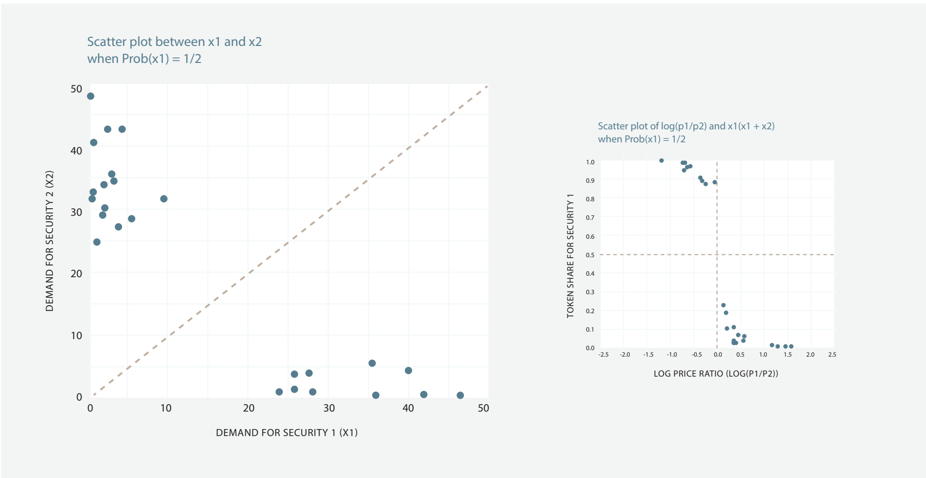

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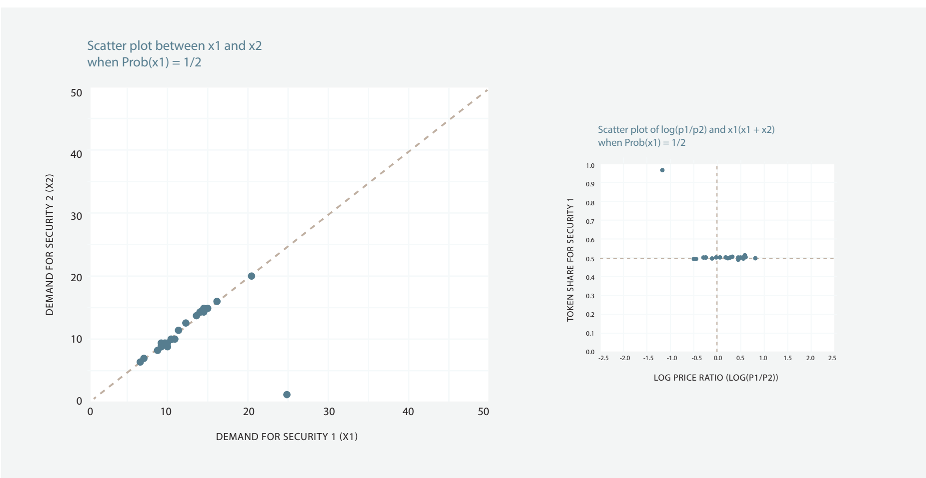

Participant
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Biography

Shachar, Professor and Chair of the Economics Department and former Faculty Director of Experimental Social Science Laboratory at UC Berkeley, offers clients insights gleaned from his research in behavioral and experimental economics; in particular, his research provides clients with novel tools for understanding individual preferences and attitudes towards risk and time, which inform nearly all aspects of financial decision-making. More specifically, his research has uncovered valuable new insights—which are not accessible with existing survey methods—about individual saving, investment and insurance choices; these insights enable clients to make better decisions about how to design and market their products and services, and improve client acquisition, relationship, and retention.

His extensive academic experience includes visiting professorship positions at Stanford University, Princeton University, University of Oxford, University of Cambridge, and the European University Institute, among others.

Among his many awards, Shachar was awarded a Sloan Fellowship and received special recognition for his distinguished excellence in teaching from the UC Berkeley Haas School of Business and the UC Berkeley Division of Social Sciences.

Shachar and his wife Hilla have three children – Danya, Omri, and Yotam – and live in Piedmont, CA. Shachar is fully convinced he could have been a professional soccer player if he had received even a modicum of support from his parents, whom he has forgiven.