Received 15 September 2014
Revised 15 September 2014
Accepted 10 November 2014

How important are early investment experiences on subsequent investment decisions? A laboratory experiment on asset allocation

Dimitra Papadovasilaki and Federico Guerrero
Department of Economics, University of Nevada, Reno, Nevada, USA
James Sundali
Department of Managerial Sciences, University of Nevada, Reno, Nevada, USA, and
Gregory Stone
Department of Finance, University of Nevada, Reno, Nevada, USA

Abstract

Purpose – The purpose of this paper is to examine the influence of early investment experiences on subsequent portfolio allocation decisions in a laboratory setting.
Design/methodology/approach – In an experiment in which the task consisted of allocating a portfolio between a risky and riskless asset for 20 periods, two groups of subjects were confronted with either a market boom or bust in the initial four periods.
Findings – The findings suggest that after controlling for demographic characteristics, the timing of a boom or bust during the investment lifecycle matters greatly. Subjects that faced a bust early in their investment lifecycle held less of the risky asset in subsequent periods compared to subjects who experienced an early boom.
Originality/value – To the best of the authors knowledge this is the first laboratory study investigating the role of early aggregate shocks on subsequent investment behavior.

Keywords Asset allocations, Behavioural finance, Booms and busts, Laboratory experiments, Portfolio decisions
Paper type Research paper

1. Introduction

Ever since Markowitz (1952) modern portfolio theory has held that an investment should be made based solely upon the expected future risk and return of the investment. In contrast to this normative advice, the premise of this paper is that actual investment decisions are often impacted by past experienced investment returns. The basic idea that salient early life events can impact later behavior is found in many strands of literature. For example, while psychologists have found that normally individuals make decisions with a present or future temporal orientation, a trauma can cause an individual to get "stuck" in the past and cause present decisions to be made with a temporal orientation in the past (Holman and Silver, 1998). Biologists, for their part, have documented that early stressful events may affect complex cognitive and affective procedures, such as decision making (Pechtel and Pizzagalli, 2011).

JEL Classification — C91, G11, D81, G01, G02

Managerial Finance
Vol. 41 No. 6, 2015
pp. 582-590

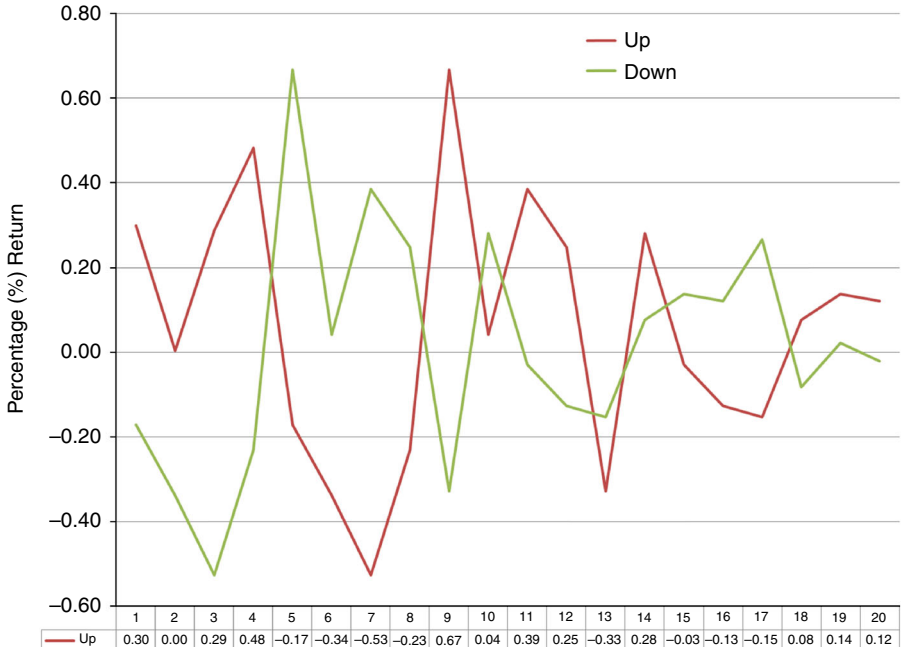
0307-4358
DOI 10.1108/MF-09-2014-0246

In this paper we attempt to complement the few prior studies on early experiences and subsequent investment behavior (Malmendier and Nagel, 2011; Bucciol and Zarri, 2013; Malmendier *et al.*, 2011; Giuliano and Spilimbergo, 2009) by reporting causal results from a laboratory experiment on asset allocation decisions. Two groups of similar subjects had to allocate a small endowment of money between a risky asset (stocks) and a safe asset (cash). The two groups were confronted with opposite market conditions in the beginning periods of the asset allocation task. Subjects who faced a bust early on held reduced stock holdings relative to similar subjects who faced an initial boom. These results hold even though the Down group faced substantially higher returns than the Up group in the remainder of the experiment.

2. Experimental design and procedures

An experiment was designed in which the subjects made repeated asset allocation decisions choosing between a risk free asset and a risky asset. The risk free asset had constant return of 4 percent while the risky asset returns were those of the Dow Jones Industrial Average (DJIA). To explain the risky asset to subjects, they were told that the realized returns in the experiment would be similar to what the DJIA produced from 1921 to 2009 and were also given return statistics including the mean (7 percent), SD (20 percent), high return (67 percent), and low return (−53 percent)) for the DJIA for this time period.

Subjects were split into two groups and faced two different DJIA return streams. The Up group experienced returns on the DJIA from 1925 to 1944, while the Down group experienced the returns of the DJIA from 1929 to 1948 (Figure 1). The Up group



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Up	0.30	0.00	0.29	0.48	−0.17	−0.34	−0.53	−0.23	0.67	0.04	0.39	0.25	−0.33	0.28	−0.03	−0.13	−0.15	0.08	0.14	0.12
Down	−0.17	−0.34	−0.53	−0.23	0.67	0.04	0.39	0.25	−0.33	0.28	−0.03	−0.13	−0.15	0.08	0.14	0.12	0.27	−0.08	0.02	−0.02

Figure 1.
Risky asset returns experienced by the two groups

experiences mostly positive returns for the first four periods while the Down group experiences four periods of large negative returns. As seen in Figure 1, in the Up condition the initial returns on Stocks for Years 1-4 are 30, 0.3, 29, and 48 percent; in the Down condition the initial returns on Stocks for Years 1-4 are −17, −34, −53, and −23 percent. The annual returns on the stock investment from Years 5-20 in the Up condition are identical to the returns in the Down condition from Years 1-16. Figure 1 summarizes the information on the stream returns each group faced.

Subjects made allocation decisions using a spreadsheet interface which is shown in Figure 2. Each subject was given a $5.00 endowment to begin the experiment. Each "Year," the subject chose how to invest their endowment. The subjects had two investment choices: US Stocks (S), Cash (C). To make an asset allocation decision a subject would enter a number in the appropriate cell for a chosen investment. For example, if a subject chose to invest 50 percent of his funds in US Stocks for that year, he would enter 50 in the Asset Allocation Column for US Stocks. Given this decision, the rest of their funds that is the 50 percent, would have to be invested in cash. The spreadsheet was built with checks and controls to insure accuracy in decision entry. Once a subject was satisfied with his or her asset allocation decisions for a particular year, he or she would then click a "Final Decision" button on the spreadsheet and the investment returns for that year would be displayed. After a subject had finished reviewing the results, he or she would then click a button to begin making decisions for the next year (Figure 2).

Subjects were recruited through an advertisement in the campus mail sent to all University of Nevada, Reno staff employees, approximately 1,400 employees. The flyer stated that a subject could earn between $5.00 and $50.00 depending upon performance for participation in a one hour experiment on investment decision making. In all, 59 subjects signed up to participate in the experiment.

The experiment was conducted in a computer lab in the College of Business at the University of Nevada, Reno. Upon arrival, each subject received a copy of the human subject consent form and condition instructions. The experiment began with the reading aloud of the consent form and instructions. After consent was obtained, each

FINAL DECISION
Click here after you have made your asset allocation decisions.

Year	Beginning Account Balance ($)	% Asset Allocation to: Cash	U.S. Stock Index Fund	Total Allocation (Must Sum to 100%)	Portfolio Expected Return %	Portfolio Standard Deviation %
Practice 1	5.00	25	75	100%	6.8%	15.0%
Practice 2	5.80	10	90	100%	7.3%	18.0%
1	5.00	0	100	100%	7.7%	20.0%
2	6.50	0	100	100%	7.7%	20.0%
3	6.52	0	100	100%	7.7%	20.0%
4	8.40	0	100	100%	7.7%	20.0%
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
18	4.60	0	100	100%	7.7%	20.0%
19	4.95	0	100	100%	7.7%	20.0%
20	5.64	0	100	100%	7.7%	20.0%

Figure 2.
Subject user interface

subject received a $5.00 show-up fee. Since the recruitment flyer stated that subjects would receive a minimum compensation of $5.00, the show-up fee was given to fulfill this promise. Subjects were then told that any further compensation in the experiment was contingent on their performance in an asset allocation task.

After all the instructions were read and questions answered, the subjects then made two practice decisions for which they were not paid. After their practice decisions, the subjects had a final opportunity to ask any remaining questions. Each subject then proceeded at his or her own pace in making their asset allocation decisions for each of the 20 years. Most subjects took 25-45 minutes to make all of their decisions. After all the decisions were completed, each subject filled out a short questionnaire and a receipt documenting their earnings. Each subject then walked to the back of the room where they were paid individually and anonymously in cash for their performance, thanked, and dismissed from the laboratory.

The subject pool was 41 percent male and 59 percent female. The average age of participants was 40, with 19 percent in the 18-25 age bracket, 37 percent in the 25-39 age bracket, 31 percent in the 40-59 age bracket and 14 percent were 60 or older. Each subject was asked to self-report on how much experience he or she had with investment decisions similar to those in the experiment. On a one to seven scale (1 = none at all, 7 = a great deal) the average response to this investment experience question was 3.2, with 36 percent answering 1 or 2, 58 percent answering 3, 4 or 5, and 7 percent answering 6 or 7.

3. Data analysis and experimental results

3.1 Econometric methods

The empirical analyses presented below consist of running regressions in which the dependent variable is the share of stocks. The nature of this experiment involves sequential repeated decisions, in which inter-temporal choices in contiguous periods may not be entirely independent. To address the issue of potential time dependency between contiguous observations, we averaged the data for each participant every two years. Another potential issue, shown in Figure 3, is that the dependent variable is constrained to the interval 0-100. Two methods of estimation are presented: OLS (Table I) and the Tobit model (Table II) which better handles the constraint issue.

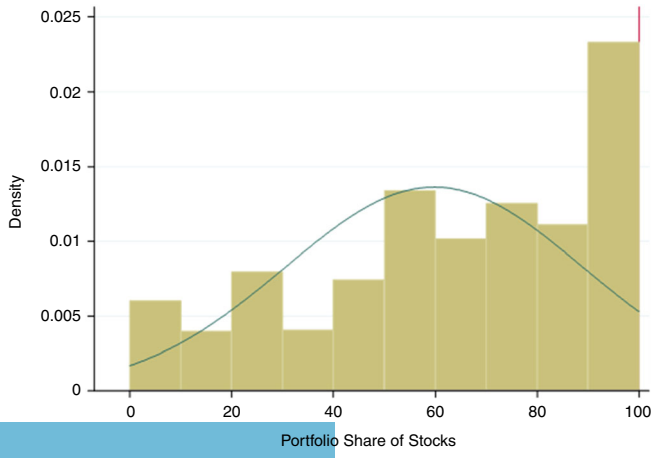


Figure 3.
Right constraint of the dependent variable

	Full sample							
	(1)		(2)		(3)		(4)	
	Coeff.	p	Coeff.	p	Coeff.	p	Coeff.	p
Dependent variable is share of stocks								
Male	7.06	0.001	8.14	0.000	7.26	0.000	7.10	0.001
Age	0.18	0.009	0.21	0.003	0.19	0.007	0.19	0.008
C-CAPM	14.78	0.000	15.78	0.000	14.96	0.000	14.81	0.000
Down14	−7.84	0.023	n/a	n/a	n/a	n/a	n/a	n/a
UP58	1.33	0.695	n/a	n/a	n/a	n/a	n/a	n/a
Down	n/a	n/a	−7.51	0.000	n/a	n/a	n/a	n/a
UP	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
UP14	n/a	n/a	n/a	n/a	7.48	0.027	8.40	0.013
Down58	n/a	n/a	n/a	n/a	−6.92	0.043	n/a	n/a
UP912	n/a	n/a	n/a	n/a	n/a	n/a	1.86	0.583
Constant	40.90	0.000	41.77	0.000	39.78	0.000	39.13	0.000
Observations	590		590		590		590	
$F(5, 584)$	21.98							
$F(4, 585)$			29.56					
$F(5, 584)$					23.03			
$F(6, 583)$								
$F(5, 584)$							22.12	
$F(6, 583)$								
Prob > F(.)	0.0000		0.0000		0.0000		0.0000	
Adj-R^2	0.1512		0.1624		0.1575		0.1520	

Notes: Variable description: dependent variable is share of stocks; gender: 1, if male; 0 if female; age, years of age for subject i ($i = 1, \ldots, 59$); C-CAPM, covariance between (1/account balance) and Dow Jones stocks' returns; Down14, dummy variable (1 if Years 1 through 4 for group DOWN, 0 otherwise); Down58, dummy variable (1 if Years 5 through 8 for group DOWN, 0 otherwise); UP14, dummy variable (1, if years 1 through 4 for group UP; 0 otherwise); UP58, dummy variable (1, if Years 5 through 8 for group UP; 0 otherwise); UP912, dummy variable (1, if Years 9 through 12 for group UP; 0 otherwise)

Table I.
OLS – two years average

3.2 Results

As shown in models 1 and 2 in Tables I (OLS model) and 2 (Tobit model), a market bust/boom[1], operationally defined as four consecutive years of large negative/positive returns, affects the Up and Down groups differentially after controlling for the observable characteristics of gender and age, and a constructed covariance measure of stock returns and the inverse of each subject's account balance (to proxy for the Consumption CAPM, (C-CAPM)). The Down group allocated 7.84 percent (Down14 (14 referring to Years 1-4 of the experimental task), $p < 0.05$) less to stocks during the bust years (Years 1-4) than they did in the remaining years (Years 5-20) and/or what the Up group held in stocks for the entire 20 periods of investing. The UP group was not affected in the bust years (Years 5-8 for the UP group) as indicated by the insignificance of the UP58 variable, ($p < 0.70$). The results from the OLS and Tobit models are similar in magnitude and significance.

All in all, subjects who experienced an early bust (Down) held 7.5 percent less stocks during the entire 20 periods of the experiment than subjects who started the experiment facing a boom (UP), as shown by the Down group dummy variable's estimated coefficient of −7.51 ($p = 0.000$) in regression (2), Table I, or, alternatively, −8.87 ($p = 0.000$) in regression (2), Table II.

	Full sample							
	(1)		(2)		(3)		(4)	
	Coeff.	p	Coeff.	p	Coeff.	p	Coeff.	p
Dependent variable is share of stocks								
Male	7.43	0.001	8.72	0.000	7.60	0.001	7.46	0.001
Age	0.18	0.016	0.21	0.005	0.18	0.014	0.18	0.016
C-CAPM	15.54	0.000	16.74	0.000	15.70	0.000	15.57	0.000
Down14	−9.00	0.014	n/a	n/a	n/a	n/a	n/a	n/a
Up58	1.68	0.643	n/a	n/a	n/a	n/a	n/a	n/a
Down	n/a	n/a	−8.87	0.000	n/a	n/a	n/a	n/a
Up	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Up14	n/a	n/a	n/a	n/a	8.03	0.026	9.08	0.013
Down58	n/a	n/a	n/a	n/a	−7.21	0.049	n/a	n/a
Up912	n/a	n/a	n/a	n/a	n/a	n/a	2.63	0.469
constant	41.49	0.000	42.58	0.000	40.33	0.000	39.51	0.000
Observations	590		590		590		590	
Prob > χ^2	0.0000		0.0000		0.0000		0.0000	
Pseudo R^2	0.0183		0.0199		0.0189		0.0183	

Note: Variable description: same as the ones in Table I

Table II.
Tobit model – two years average

The average returns on stocks for Years 5-20 (i.e. the years after the initial shock for each group) are significantly different between the two groups. The Up group faced average returns equal to 0.33 percent, while the returns for the Down group were significantly higher and equal to 9.41 percent. Despite the higher returns, the Down group held 5.27 percent (Tobit model, $p = 0.022$) less in stocks during Years 5-20, than they did in the remaining years, or to what the Up group held in their entire 20 periods, as shown in Table III.

Next, we analyze how subjects behave during market booms. We find that the timing of the boom during a subject's sequential investing experience matters greatly. As shown in regression (3) of Tables I and II, two findings stand out. First, subjects in the Up group that began investing during a boom period allocate more to the risky

	Full sample			
	(1)		(2)	
	Coeff.	p	Coeff.	p
Dependent variable is share of stocks				
Male	7.83	0.001	7.84	0.001
Age	0.19	0.012	0.19	0.012
C-CAPM	15.90	0.000	15.91	0.000
Down520	−5.27	0.022	n/a	n/a
UP520	n/a	n/a	5.344	0.020
Constant	42.06	0.000	37.79	0.000
Observations	590		590	
Prob > χ^2	0.0000		0.0000	
Pseudo R^2	0.0181		0.0181	

Notes: Variable description: same as the ones in Table I plus Down520, dummy variable (1 if Years 5 through 20 for group Down, 0 otherwise); UP520, dummy variable (1, if Years 5 through 20 for group UP; 0 otherwise)

Table III.
Stock holdings during Years 5-20

asset during this initial boom period (Up14 = 7.48, $p < 0.05$). Second, subjects in the Down group that experience a boom period after a market bust period allocate less to the risky asset during this boom period (Down58 = −6.92, $p < 0.05$). The result from regression (3) suggests that the effect of the early bust experience was very strong for the Down group, to the point of persisting later during the boom years.

Regression (4) shows the response of the Up group to a second boom, during Years 9-12, of similar magnitude to the one they faced in Years 1-4 but occurring after a market bust in Years 5-8 (see Figure 1). As shown in Tables I and II, the response of the Up group to a boom-bust-boom investing sequence was a return to mean levels of risk taking; the Up912 variable is statistically insignificant suggesting the second boom did not substantively affect subjects as did the first boom.

Other correlations show results that are typical in the literature of financial risk aversion. For instance, males hold more stocks than females (Tables I and II, first row), and stocks act as a hedge providing subjects with high returns in the bad times (when their account balances are low), as shown by the C-CAPM variable coefficient being positive and significant (Tables I and II, third row). Lastly, we find that the age variable is positively correlated with stocks (Tables I and II, second row); elder participants seem to be less risk averse than the younger ones in our sample, a somewhat atypical result, but not completely unprecedented (William *et al.*, 1992 for instance)

3.2.1 The effect of differential stock returns. The annual returns on the stock investment from Years 5-20 in the Up condition are identical to the returns in the Down condition from Years 1-16. But given the nature of our study, the initial difference in stock returns at the beginning of the experiment introduces a substantial difference in means in overall stock returns for each group during the 20 periods of the experiment (1.19 percent for the Down group and 5.63 percent for the Up group). This creates a potential confounding factor in that the differences in observed stock holdings across groups may not be entirely, or even primarily, explained by the early experiences of each group, but rather driven by the differences in overall average stock returns. To investigate this possibility we added the differential in stock returns across groups as an additional explanatory variable, and all results in Tables I and II remained qualitatively unchanged, quantitatively similar, and statistically significant at 5 percent across columns 1-4. Hence, it seems that the differences in observed behavior are not due to differences in overall stock returns.

3.3 Robustness

The existence of participating subjects with financial literacy raises a question on the effect of our results. The asset allocation choices of financially literate individuals might be based on their subjective professional experience, which might bias our findings. However, according to a study by Kahneman and Klein (2009), subjective experience is an unreliable indicator of judgment accuracy in an unpredictable environment. Due to the fact that by design our experiment confronts subjects with an unpredictable environment, we might expect that one's expertise has almost no effect on financial decision making.

Nevertheless, and despite the fact that the distribution of the self-reported financially literate individuals in the sample was relatively narrow, we did control for financial literacy in a different set of regressions. The results of that set of regressions (regressions can be shown upon request) do not change qualitatively. Thus subjective financial literacy indeed does not affect our initial findings.

Another concern of our study was the age dispersion and its effect on decision making. Specifically, the average age in the sample is 40 with a standard deviation equal to 14.66. Risk aversion is presumably different in different age groups. For example, according to a study by William *et al.* (1992), risk aversion decreases with age, up to 65 years old. After 65 years old, risk aversion increases again. So, financial choices can be affected by age. For this reason we checked for the robustness of our results by controlling for age.

We examined three different age groups: the first group includes individuals between 18 and 30 years old, the second group between 31 and 50 years old, and the third group was 51 years old and over. We found that the first group is negatively correlated with stock holding, while the second group is positively correlated. The results for the third group are insignificant. Most importantly, our main findings are still very similar as before checking for age, both qualitatively and quantitatively (regressions can be shown upon request).

As additional checks on the issue of potential time dependency between contiguous observations and their impact on the variability of the residuals, we averaged the data over four periods while still using OLS specifications and we also allowed for fixed and random effects in the one and two year average specifications via mixed linear models. In all cases results stayed very similar to the ones already discussed (regressions can be shown upon request).

4. Concluding remarks

While some studies have examined the impact of early life idiosyncratic factors (Bucciol and Zarri, 2013) and aggregate shocks (Malmendier and Nagel, 2011) on subsequent portfolio decisions, to the best of our knowledge this is the first laboratory study investigating the role of early aggregate shocks on subsequent investment behavior.

Laboratory studies such as ours have the advantage that causal links can be tested, since shocks can be isolated from confounding factors in the design of the experiment. Our main finding suggests that the effects of early booms and busts are strong and persistent. The primary implication of this result is that an investor's early risky asset return experience will strongly influence subsequent investment decisions.

This study also extends the effects of prior events to economic and financial decision making, by complementing the findings of the existing literature on biological and psychological effects (Pechtel and Pizzagalli, 2011, for instance).

Note

1. By this definition, the Down group experiences a bust in Years 1-4 and a boom in Years 5-8; the Up group experiences a boom in Years 1-4, a bust in Years 5-8, and another boom in Years 9-12.

References

Bucciol, A. and Zarri, L. (2013), "Financial risk aversion and personal life history", Working Paper No. 5, Department of Economics, University of Verona, Verona, February.

Giuliano, P. and Spilimbergo, A. (2009), "Growing up in a recession: beliefs and the macroeconomy", Working Paper No. w15321, National Bureau of Economic Research, Cambridge, MA.

Holman, E.A. and Silver, R.C. (1998), "Getting 'stuck' in the past: temporal orientation and coping with trauma", *Journal of Personality and Social Psychology*, Vol. 74 No. 5, pp. 1146-1163.

Kahneman, D. and Klein, G. (2009), "Conditions for intuitive expertise", *American Psychologist*, Vol. 64 No. 6, pp. 515-526.

Malmendier, U. and Nagel, S. (2011), "Depression babies: do macroeconomic experiences affect risk taking?", *The Quarterly Journal of Economics*, Vol. 126 No. 1, pp. 373-416.

Malmendier, U., Tate, G. and Yan, J. (2011), "Overconfidence and early-life experiences: the effect of managerial traits on corporate financial policies", *The Journal of Finance*, Vol. 66 No. 5, pp. 1687-1733.

Markowitz, H. (1952), "Portfolio selection", *The Journal of Finance*, Vol. 7 No. 1, pp. 77-91.

Pechtel, P. and Pizzagalli, D.A. (2011), "Effects of early life stress on cognitive and affective function: an integrated review of human literature", *Psychopharmacology*, Vol. 214 No. 1, pp. 55-70.

William, B., Riley, J. and Victor Chow, K. (1992), "Asset allocation and individual risk aversion", *Financial Analysts Journal*, Vol. 48 No. 6, pp. 32-37.

Corresponding author
Dimitra Papadovasilaki can be contacted at: dpapadovasilaki@unr.edu