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Information Architecture and Intertemporal Choice: A Randomized Field Experiment in the United States

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Information Architecture and Intertemporal Choice: A Randomized Field Experiment in the United States

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Doctor of Philosophy in Management

by

Yaron Levi

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Abstract of the Dissertation

Information Architecture and Intertemporal Choice: A Randomized Field Experiment in the United States

by

Yaron Levi

Doctor of Philosophy in Management

University of California, Los Angeles, 2015

Professor Ivo Welch, Chair

In a randomized field experiment, I show that information architecture significantly affects individuals' spending and savings behavior. I present users of a large online account aggregation provider with a personalized financial index. This index represents the inflation-protected, lifetime monthly cash flow that they can obtain, given their personal financial and demographic information and current market prices. Users receiving this information tool reduce their spending by 10.7% relative to a control group. This effect is sensitive to the description of the index using a consumption frame rather than an investment frame and to the presentation of an explicit comparison between the index and historical spending levels. Further, spending reductions are primarily in large, infrequent transactions. This experiment is the first to directly affect overall spending behavior and to demonstrate the importance of information architecture in that context. It demonstrates the potential of low cost digital information tools to impact financial behavior on a large scale.

The dissertation of Yaron Levi is approved.

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2015

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1 Introduction

Does the way financial information is presented have a real impact on financial behavior? A wide range of financial services are available through electronic devices including banking, loans, and investment services. The current technological environment allows for a complete control on the way that financial information is presented. The high processing power of modern computers and mobile devices combined with ever increasing internet speeds allow for low cost distribution of personalized financial information and analysis. By changing the way information is conveyed or framed, we have the opportunity to learn key determinants of individuals' financial activity in the field and to design powerful tools that can potentially impact financial behavior on a global scale. My paper shows that the design of financial information has a large impact on financial behavior outside the laboratory and identifies the mechanisms that cause this change in behavior.

I study the impact of information architecture on the saving-spending decision. Households generally prefer to smooth their consumption over their lifetime (e.g., [AM63]). However, solving the relevant optimization problem would challenge even a trained economist. An individual must consider many personal and macroeconomic factors such as longevity, lifetime earnings, future expenses, inflation, and interest rates. Previous studies suggests that most individuals seem to have little chance to successfully save for retirement on their own. First, most households are not familiar with basic financial concepts such as inflation and interest, or even with their own financial information, such as their mortgage terms ([Cam06], [BP08], [Lus08], [GST09], [LM11]). Second, self-control problems, procrastination, and inertia may divert individuals from implementing an optimal savings plan. ([MS01], [TB04], [ACL07], [BCL11], [BCL13]). Managing the presentation of information can potentially help individuals overcome these difficulties and make better saving decisions. However, researchers have different

views on whether individuals should save more or less (a full discussion on optimal savings is in [Ski07]). Instead of proposing an optimal saving plan, I design an information tool that attempts to simplify the information environment and leaves the judgment on optimal saving behavior to the individuals.

My experiment is implemented into an account aggregation online software available at no cost to the general public by Personal Capital. Account aggregation technology is provided by large commercial banks, as well as small technology firms. This service allows users to link all their financial accounts into one place, including checking, savings, credit, mortgage, investment, and retirement accounts. The software then provides a continuously-updating analysis of the user's financial activity, including net worth, spending, and investment returns.

Existing services often present current spending in comparison to historical spending (e.g., a time series plot) or in comparison to current income (e.g., cash flow statement). However, an individual who wants to smooth his consumption needs to compare his spending activity to his net worth, including the projected value of future income, and make the required adjustments. Such a comparison requires assumptions about random factors such as future income and longevity, as well as some mathematical skills that users might be lacking.

I propose an information tool that allows for a direct comparison between spending levels and current net worth. Based on the user's net worth, age, state of residence, and current market prices, the index represents the user's risk-free, inflation-protected, lifetime affordable monthly cash flow. Put differently, it is the quoted monthly cash flow of a single, inflation-protected, lifetime annuity.

Monthly cash flow is the commonly used unit of measure for spending activity (e.g., for rent, car payments, bills). By converting net worth into monthly cash flow, the index provides a new context for spending activity. I show that this new reference point indeed impact spending behavior of individuals potentially by reducing the cognitive effort required for individuals to calculate it on their

own or simply by serving as an anchor ([TK74], [CHK12]). The index uses only current assets held by the user and therefore does not make assumptions about future income. Thus, the index represents the current financial status of the user rather than a projected one. The index relies on current market prices of life annuities obtained from multiple large insurance companies via Hueler's Income Solutions® annuity platform, making it model free.

I conduct a seven-arm randomized field experiment (including a control group) to test the effect of the financial index on users' spending behavior. The six treatment groups differ across three dimensions: inclusion or exclusion of a direct comparison between the index level and spending, the framing of the index as potential consumption or as an investment return, and an immediate start of the cash flow represented by the index or a start upon retirement.

By including a time series plot that explicitly compares the index level to spending, users are promoted to use the index as a reference point for spending. Without this plot, users can still compare the index level with spending on their own. This variation in treatments allow for identification of the information architecture effect on spending behavior, in separation of the potential effect of providing new information content embedded in the index itself.

Providing an index representing a cash flow that starts at retirement (often used by financial planners), requires users to project their retirement age. Moreover, it might not induce users to change their savings behavior because the problem is presented as a problem of their conflicted future self, rather than of their current self ([Str55], [TS81]).

[BKM08b] and [BKM08a] demonstrate the effects of using a consumption frame or an investment frame on the perceived attractiveness of identical lifetime cash flows. This differential response is a manifestation of loss aversion. Under the consumption frame, loss is perceived to be a reduction in spending ability, while under the investment frame loss is perceived as low return (in case

of premature death). In my study, treatment groups receive an index named either the Financial Sustainability Index (FSI) to promote consumption framing or the Life Annuity Index (LAI) to promote an investment frame. This variation in treatments allows for testing the importance of framing of the cash flow, as well as for differentiating the effect of the information design from the effect of the information content.

My paper documents the changes in financial behavior between the three months prior to the experiment's launch and the following four month. I find that none of the treatment groups changed their income levels in comparison to the control group. This is probably because income is difficult to adjust over the short run. The treatment groups that received an index named FSI, which represents a cash flow starting immediately and an explicit plot comparing their spending with the index level, reduced their monthly spending by about 10% in comparison to the control group and the other treatment groups. This reduction in spending translates into a significant increase in savings.

I test the source reduction in spending activity and find a significant drop in both the standard deviation of monthly spending and in the sum of the five largest transactions. In contrast, I do not find a change in expenditure on utilities, mortgages, gasoline/fuel, restaurants, and groceries. This indicates that the source of the spending drop is a reduction in infrequent large transactions (like vacations) and not from a change in everyday spending activity.

To the best of my knowledge, my study is the first field experiment to impact overall spending directly. It demonstrates the importance of information architecture in the context of savings, specifically, the effects of framing and an explicit context of the information.

This study proposes an information architecture tool that can effectively impact savings behavior. The tool is model free as it only relies on market prices and users' current financial information. Given the digital nature of the tool, it can

be distributed on a large scale at an insignificant cost and respond in real time to macroeconomic shifts, as well as to changes in the user's financial information. The tool requires little time and cognitive effort from its users (in comparison to financial education for example). The information tool is effective in overcoming behavioral inertia given its impact on users' spending behavior without proposing a specific course of action or being presented before an important financial decision. (Unlike setting a default option for people choosing a retirement contribution rate, for example.)

Insights from this study provide additional evidence for the importance of framing in the context of the annuitization puzzle ([BPT11]). This evidence can potentially assist both the financial industry and government efforts to increase the popularity of lifetime income vehicles. This study has important insights for the proposed [Lif13], which would require defined contribution plan administrators to provide income disclosures that include estimated lifetime monthly income given current retirement savings. First, I propose overcoming the need for assumptions by using annuities market prices. Second, proper context and framing of an individual's cash flow has critical importance in affecting their savings behavior as intended by the act.

2 Literature Review

2.1 Attempts to Affect Saving Rates

Many researchers have studied ways to affect savings behavior. Most of these studies have argued that households need to increase their savings (e.g., monetary incentives), or at least that saving more is better than the alternatives (e.g., choice architecture).

Classical economics suggest that providing monetary incentives such as tax

benefits or employer retirement contribution matching should encourage people to save more. [CFL14] show that only active savers, who are wealthier and better prepared for retirement, respond to tax subsidies for retirement. Moreover, these active savers respond by shifting funds from taxable accounts into retirement accounts, rendering the subsidies ineffective. [CLM02a] show that adopting an employer match can increase 401(k) participation, and that the match threshold affects contribution rates. [DGL06] show that employer match rates for IRA contributions significantly raises both IRA participation and contributions. Moreover, they find that even larger incentives to contribute are almost ineffective when provided through the tax code. The striking differences in these elasticities highlights the role of information simplicity and salience in affecting saving choices. [CLM11] show that despite the presence of employer matching contributions in 401(k) plans, a substantial fraction of employees fail to contribute up to their employer's match threshold. Employees above the age of 59.5 who contribute less than the maximum matching threshold simply forgo an arbitrage opportunity because they can withdraw the funds at any time with no penalty. A letter educating employees about the "free lunch" they were forgoing had an insignificant and modest effect on retirement contribution rates. This evidence indicates that such policies might be more effective when combined with other interventions that account for employee passivity or sharply reduce the complexity of the savings and investment decision.

Providing financial education does not seem to affect savings behavior. [CLM02a] investigated the effect of financial education on 401(k) contributions and show that the effects are modest at best. [FLN14] conducted a meta-analysis of 201 studies on the relationship between financial literacy, financial education, and financial behavior. They conclude that although there is correlation between financial literacy and financial behavior, financial education has negligible effects on financial behavior. Financial education might not be the desired method for helping peo-

ple improve their financial decisions. As [Wil11] points out, voluntary financial education is widely available today, yet seldom used. Effective education would therefore need to be mandatory. The price to individuals in time spent on education rather than, for example, earning more income could be enormous. Effective financial education would need to be extensive, imparting skills ranging from performing basic math to assessing the reliability of information sources targeting complex financial decisions, as well as the heterogeneity of consumer financial circumstances and values.

In his American Finance Association presidential address dedicated to household finance, [Cam06] supports avoidance of financial education: "As a financial educator, I am tempted to call for an expansion of financial education. However, academic finance may have more to offer by influencing consumer regulation, disclosure rules, and the provision of investment default options. Work on these topics offers a powerful practical rationale for the study of household finance."

Choice architecture is a powerful tool for affecting financial behavior. It includes how many choices are offered, which options are offered, in what order, how the choices are presented, what the context is, and what the default option is. Potential causes for the success of this tool include opt-out costs, procrastination, inattention, and psychological anchoring. [MS01], [CLM02a], [CLM04], [TB04], and [BCL13] find that choice architecture has a significant effect on 401(k) contributions. A large-scale study in Denmark by [CFL14] shows that setting defaults to raise retirement contributions increases savings rates and does not crowd out other saving vehicles. To the best of my knowledge, there is no evidence demonstrating that choice architecture works in a digital setting, where the cost of deselecting a default option is significantly lower than sending a form letter, for example.

It is important to note that most attempts to increase savings for retirement focus on contributions to retirement accounts. However, the only way to increase

savings is to either increase income or cut spending. Apart from tax benefits and employer retirement contribution match, contributions to retirement accounts is merely a change in asset allocation. Contributions to retirement accounts would increase savings only if individuals spent just their disposable income. However, [ABS14] use tax data to document substantial preretirement withdrawal rates. For every $1 contributed to the accounts of people under age 55, $0.40 simultaneously flows out of the 401(k)/IRA system, not counting loans. The leakage is getting worse especially after the last recession. Suggestions to make 401(k) accounts less liquid, even in the presence of demand for illiquidity ([BCL11]), might diminish the ability for individuals to smooth their lifetime consumption.

2.2 Information Architecture

Information architecture includes the design of how information is conveyed or framed. Many studies find this tool to have a strong impact on financial behavior. [CHK12] show that a variety of minimal numerical savings cues have large effects on retirement contribution choices, even when these cues are at best minimally informative. A form letter from Indiana University to students showing what their monthly student loan payment would be after graduation induced students to reduce borrowing in comparison to the national average ([Lor14]). [GMS12] show that providing information on how changes in contributions to a retirement account translate into a change in projected monthly income has a significant effect on contributions. [BM11] show that providing information that makes people think less narrowly about finance costs reduces the take-up of future payday loans.

Information architecture has been found to have a strong impact on behavior in many other areas. For example, researchers found that a simple and inexpensive information intervention can help individuals minimize index fund fees ([CLM10]), take advantage of tax benefits in the grocery store and impact alcohol consumption ([CLK09]), make more fuel-efficient car choices ([LS08]), reduce caloric intake

([RLA10], [DSB13]), impact school selection of low income families ([HW08]), and choose lower-cost Medicare drug plans ([KMS08]).

2.3 Digital Environment and Financial Behavior

The digital environment strongly impacts financial behavior of individuals. Investors who switch from phone-based trading to online platforms change their investment behavior ([BO01], [BO02], and [CLM02b]). In less than three years, almost 70% of Kenyan adults gained access to virtual bank accounts, enabling them to transfer funds using their cell phones and improving risk-sharing by smoothing income shocks ([JS11], [JS14]). The Federal Reserve Board conducts an annual survey of consumers' use of mobile financial services, documenting wide-spread use of smartphones across all levels of income and education to access personal financial information and to check credit before making a large purchase ([Con14]).

3 Experiment Design

My experiment is embedded in Personal Capital's personal financial management software. Personal Capital is a wealth management company that offers free online software to the general public that includes account-aggregation technology. Users can link all their online financial accounts including checking, savings, investments, credit, loans, pension, mortgage, and others. Assets with no electronic presence, including real estate and art, can be added manually. The information is dynamically aggregated into a complete, up-to-date financial picture that includes net worth, spending, income, investment portfolio holdings, diversification analysis, and financial services fees analysis.

I randomly assign Personal Capital's users into seven experiment groups. The different treatments are described below and summarized in Table 1. Apart from the control group, each of the six treatment groups received an information in-

tervention that includes a personalized financial index. The interventions differ in the name of the index, the cash flow represented by the index, and inclusion or exclusion of an explicit comparison between the index and historical spending. All experiment interventions were presented on the top of the "dashboard" page, which is the first page users visit after logging into the app.

3.1 Control Group

Figure 1 presents the full dashboard page of the control group, which is also the pre-experiment page for all the other treatment groups. The top of the page contains a time series plot of net worth, as well as total income and spending over the last 30 days.

3.2 FSI Group

Figures 2 shows the full dashboard page of the Financial Sustainability Index (FSI) group. Figure 3 shows only the top of the page, which includes the experiment materials. The FSI group users received a personalized financial index named the "Financial Sustainability Index," which represents an affordable, risk-free, inflation protected, lifetime, monthly cash flow starting immediately given the individual's net worth, age, state of residence, and current market prices. Put differently, it is the quoted monthly cash flow of an immediate, inflation-protected, lifetime annuity.[1]. The index is presented both on the top of the page and as a time series plot, which explicitly compares the index level with historical monthly spending.[2] In addition, the group received the sensitivity of the index to a $10K

[1]Monthly Social Security benefits were added for users who currently receive them.

[2]Experiment materials were presented in addition, and not as a substitution, to the pre-experiment dashboard page content. However, for the three of the groups that received a time series plot comparing the index level with historical spending (FSI, inflated FSI, and LAI groups), the plot replaces the pre-experiment dashboard cash flow section, which compares recent income and spending. The omitted cash flow section was still available in other parts of the app after the experiment's launch. Removal of the cash flow section from the dashboard does not impact the inference of this study regarding the importance of an explicit reference point for spending.

increase in net worth, a short explanation about the index, a link to a FAQ page, as well as a link to the personal information page of the app.

The financial index hedges market risk, inflation risk, and longevity risk, which are major risk factors for individuals financial planning. To illustrate the importance of considering longevity risk in financial planing, note that out of a group of 65-year-old men, the first 5% are expected to die within three years, and the last 5% are expected to live more than 30 years ([Act10]). To illustrate the importance of considering inflation risk, note that inflation reduced the purchasing power of money by 38% over the past 20 years.[3] The financial index does account hedge counter-party risk.

There are several non-exclusive channels through which the index tool could impact savings decisions. Presentation of net worth as a monthly cash flow instead of a lump sum might mitigate an "illusion of wealth" feeling, as documented by [GHB14]. The authors show that people perceive lump sums to be larger than their monthly equivalents, which translates into a higher likelihood to increase their savings rate.[4]

Monthly cash flow is the commonly used unit of measure for spending activity (e.g., for rent, car payments). By converting net worth into monthly cash flow, the index provide a new context for spending activity. This reference point might impact spending by reducing the cognitive effort required for individuals to calculate it on their own or simply by serving as an anchor ([TK74], [CHK12]). The time series comparing index level with historical monthly spending promotes the users to explicitly compare the two.

[3] [BCL14] find that highlighting the effects of inflation increases demand for cost of living adjustments, which might also trigger users to pay more attention to the financial index in this study.

[4] They also show a reversal for higher amounts of wealth; however, the reversal was only documented in their laboratory studies and not in their field study. In addition, the reversal occurred when the monthly cash flow levels were about 17 times higher than the median salary of the participants.

By presenting how an additional $10,000 in net worth would impact the index level, the tool shows the lifetime income consequences of potential gains or losses. [GHB14] show that people are more sensitive (measured by change in satisfaction) to changes in wealth expressed as monthly amounts compared to when they are expressed as lump sums, and are more likely to increase their savings rates when presented with monthly amounts. [GMS12] show that people are more likely to increase their savings rates when presented with information about how additional contributions will translate into annual income in retirement. This increased sensitivity of users to changes in cash flows in comparison to changes in lump sums is probably due to more familiarity with this unit of measure.

Importantly, the treatment does not propose a specific course of action, nor it is being presented before an important financial decision. (Unlike setting a default option for people choosing a retirement contribution rate, for example.) In order for the treatment to impact spending behavior, the user will have to decide which changes to implement and overcome behavioral inertia.

A comparison of the FSI group with the control group reveals the effect of the FSI intervention on savings activity in addition to the effect of having a treatment at all.

3.3 Inflated FSI Group

Users in the Inflated FSI group received the same treatment as of the FSI group except that the index was inflated by 20%. Some researchers believe that annuities are overpriced.[5] By inflating the index, I eliminate the concern that people respond to the index simply because it reports an overly pessimistic cash flow.[6]

[5]Discussion on the annuitization puzzle is in the data section.

[6]Since the spending to financial index is larger than 1 for almost the users, I am unable to test the differential change in spending as a function of the spending to index ratio between the FSI and the Inflated FSI groups.

3.4 Partial FSI Group

Figure 4 shows the top of the dashboard page of the Partial FSI group. Users in this group received the same treatment as the FSI group excluding the time series plot comparing the financial index to historical monthly spending. By including a time series plot that compares the index level with historical spending, the users are promoted to use the index as a reference point for spending. Without this plot, users can still compare the index level with spending on their own. The Partial FSI treatment allows for the identification of the information architecture effect on spending behavior in separation of the potential effect of providing new information content embedded in the index itself.

3.5 Retirement FSI Group

Figure 5 shows the top of the dashboard page of the Retirement FSI group. Users in this treatment group received the same treatment as the FSI group excluding the time series plot comparing the index level with historical spending. In addition, the potential cash flow quoted by the index represents a cash flow stream starting at retirement age, as indicated by the user.

Many financial planning tools provide a projection of net worth (or income) at retirement. However, psychologists and economists realize that an individual can be viewed as two conflicted agents: a current self and a future self (e.g., [Str55], [TS81]). Some financial planning tools try to resolve this conflict by creating a commitment to the future self or by improving the vividness or connectedness with the future self ([HGS11]). A comparison of the saving activity of the Retirement FSI group with the Partial FSI group isolates the effect of framing the saving problem as a problem of the current self rather than of the future self.

3.6 LAI Group

Figure 6 shows the top of the dashboard page of the Life Annuity Index (LAI) group. Users in this group received the same treatment as of the FSI group except the index name was Life Annuity Index. [BKM08b] and [BKM08a] demonstrate the effects of using a consumption frame or an investment frame on the perceived attractiveness of identical lifetime cash flows. This differential response is a manifestation of loss aversion. Under the consumption frame, loss is perceived to be a reduction in spending ability, while under the investment frame loss is perceived as low return (in case of premature death). By comparing the LAI group with the FSI group, we can detect the effect of the cash flow framing on spending behavior.

3.7 Retirement LAI Group

Figure 7 shows the top of the dashboard page of the Retirement LAI group. Users received the same treatment as those in the Retirement FSI group except the index name was Life Annuity Index. This treatment group is most similar to the information architecture proposed in the Lifetime Income Disclosure Act. The cash flow quoted by the index starts at the projected retirement age and the name of the index promotes an investment frame. The cash flow is not provided in the context of current spending activity. By comparing the spending behavior of the Retirement LAI group with that of the Retirement FSI group, I am able to identify the effect of using different framing for describing the index.

3.8 Supporting Experiment Materials

Apart for the control group, the dashboard page included a link to a FAQ page. The FAQ for each group were adjusted to reflect the corresponding index name and the starting date of the potential cash flow. For the four groups where the index was named FSI, the FAQ were vague about the market prices that were

used in the construction of the index. For the LAI and Retirement LAI groups, the FAQ stated that the quotes relied on annuity prices alone. The FAQ page for the FSI group is shown in Figures 8 and 9.

Upon the launch of the experiment, all treatment groups received an email introducing the index as a new feature of the software. Implementation of the experiment materials on mobile devices (iPhone, iPad, and Android) was not through the integral app pages but through a link to an external (secure) web page. Mobile app users were prompted on a weekly basis to check their personalized index using an internal new notification icon. iPhone users also had an external badge app icon prompting them to check their personalized financial index (Figure 10).

4 Data

4.1 Calculation of Indexes

In his Nobel Prize acceptance speech, [Mod86] drew attention to the annuitization puzzle, according to which only a few individuals purchase life annuities despite large individual welfare gains generated by hedging longevity risk. Many researchers have tried to resolve the annuitization puzzle using a rich set of arguments, such as incomplete annuity markets, absence of inflation-protected annuities, fees and expenses associated with annuities, high prices and asymmetric information, Social Security benefits, bequest motives, intra-family risk sharing, and limited ability to access the equity premium while annuitizing. As a whole, however, the literature has failed to find a sufficiently general explanation for consumers' aversion to life annuities. For a complete review of the annuitization puzzle, see [DBD05], [Bro07], and [BPT11]. Currently, the financial industry offers a diversified market for life annuities including features like inflation protection, survivor benefits, an increasing stream of income, and an income stream linked to

equity returns.[7] In my study, I do not address the annuitization puzzle or attempt to influence annuitization choices. Instead, I use the information contained in the annuities' prices to impact individuals' savings decisions.

I obtained annuity prices from Hueler's Income Solutions® annuity quoting platform. This platform allows individuals to obtain customized quotes on a real-time basis and evaluates identical contracts' quotes from multiple companies. All insurance companies providing quotes are A rated or above from Moody's, S&P, and A.M. Best. The investment management, distribution, administrative, and other costs associated with fixed annuity products are reflected in annuity quotes. I obtain the full annuities quotes grid of single, inflation-protected, life annuities for males (reflecting the majority of Personal Capital's users), with non-qualified income of $100K at all ages between 35 and 85, all commencement dates between immediate and the age of 85, and for all states. I use the average quoted price across the different companies providing a quote to construct the different financial indexes.

4.2 Sample Description

My sample consists of Personal Capital's users who are technology savvy and wealthier than the general population, due to both self-selection and the targeted marketing effort of the firm. I restrict the sample to users who are not clients of Personal Capital's wealth management service or are in the process of becoming a client, above the age of 35, not retired, and have used the app for at least four months prior to the launch of the experiment. I include users who have logged into the app at least once in the three months prior to the launch of the experiment and have used the mobile iPhone app at least once prior to the launch of the experiment.[8] I include only users who have linked at least one non-manual

[7] [BCL14] investigate how different features affect the attractiveness of annuities.

[8] Personal Capital's software is available on the web as well as on specialized mobile apps for iPhone, iPad, and Android devices. On mobile devices, the experiment materials were not

financial account and have both average monthly income and spending between $1K and $500K in the three months prior to the experiment's launch and net worth between $5K and $20M.

Table 2 presents summary statistics of the sample as documented on the experiment's launch day on March 17, 2014. The sample includes 3,138 users across the seven groups. Age, planned retirement age, and state of residence are self-reported that users could update at any time. The average age was 45 and the average planned retirement age was 64. The average number of years to retirement was 19. Users had been using the app for 11 months on average prior to the launch of the experiment. The average number of monthly logins during the three months prior to the launch of the experiment was 16 (median of 7). Users had an average of 19 accounts and an average of 16.5 non-manual accounts. Most of the accounts linked were asset accounts (e.g., checking, investment, retirement), with an average of 14 asset accounts and an average of 5 liability accounts (e.g., credit, mortgage, loan). Some users did not have liability accounts, but they had linked checking accounts and used cash, checks, and debit cards for their spending activity. The average net worth was $1.1M, with an average of $1.3M in assets and $0.2M in liabilities. Average monthly income, spending, and saving were calculated over the three months prior to the launch of the experiment. Average monthly income was $28K (median $15K). Income included dividends, in addition to all incoming transfers such as wages. Average monthly spending was $21K (median $12K). Average monthly savings was $6k (median $3K). The median savings-to-income

presented as an integral part of the app but through a link to a (secure) web page. During the experiment, only the iPhone app had the ability to send badge app icons (Figure 10) and notification on a weekly basis prompting users to check their personalized financial index. After the launch of the experiment, only the iPhone users increased their logins activity (in all treatment groups). While the results of this study hold for the entire sample (simply because about 70% are iPhone users), they do not hold for non-iPhone users. The fact that all treatment groups increased their login activity but only some of the groups changed their financial activity is indicative that the increased engagement is due to the notification, and not because of the new financial content. Of course, in order to impact financial behavior using an information intervention, individuals must be exposed to the information first.

ratio was 22% and median savings-to-net worth was 1%.

Table 3 presents the personalized index statistics for each of the treatment groups. I calculate an index for the control group as if the users were in the FSI group. Indexes for the control, FSI, Partial FSI, and LAI groups are calculated in the same way, therefore all have a similar index mean around \$3K and median around \$1.5K. The Inflated FSI group has a mean index level of \$3.7K and a median of \$1.9K. The Retirement FSI and Retirement LAI groups are calculated in the same way and both have a mean index of about \$9.5K and median of about \$5.5K.

In Table 4, I summarize the average monthly spending to personalized financial index ratio. The average ratio is about 27 for the control, FSI, Partial FSI, and LAI groups, and the median is about 8. The average ratio is 19 for the Inflated FSI group and the median is 7.2. The mean ratio is about 7 for the Retirement FSI and Retirement LAI groups, and the mean is about 2. Overall, there are only a few users with a spending-to-index ratio below 1.

5 Results

I estimate the following model:

$$\Delta Y_i = \alpha + G_i\beta + \epsilon_i, \tag{0.1}$$

where Y_i is one of the outcome variables such as average monthly logins, income, or spending. The dependent variable ΔY_i is the difference in the outcome variable between the four-month monthly average of that variable after the experiment's launch and the three-month average before it. Unless otherwise indicated, the difference is scaled by the pre-launch monthly average and the ratio is winsorized at the 1 and 99 percentiles. G_i is a vector of treatment group dummy variables

with the reference group omitted. The constant term α captures the reference group effect. $\epsilon_{i,d}$ is the error term.

In addition, I estimate the model:

$$1(\Delta Y_i > 0) = \alpha + G_i\beta + \epsilon_i, \tag{0.2}$$

where $1(\Delta Y_i > 0)$ is a dummy variable that equals 1 if ΔY_i is positive and 0 otherwise. This specification allows me to estimate the proportion of the sample responding to the treatment without being affected by large responses of a few individuals, as might be the case in equation 0.1.[9]

5.1 User Engagement

Table 5 reports the effect of the treatments on login behavior. Column 1 shows that users in the control group reduced their average monthly login frequency by about 15%, which is a typical engagement pattern for Personal Capital users. Initially, users log in frequently and then gradually reduce the frequency of logins and rely on weekly summary emails. None of the treatment groups reduced their login activity. The lowest effect was an 11.3% increase in logins in the Partial FSI group relative to the control group, the largest effect was a 21.7% increase in the Retirement LAI group. Column 2 shows that the differences between the FSI group and the other five treatment groups are not significant. Column 3 shows that only 32% of the control group increased their login frequency. In comparison, a higher proportion of each of the treatment groups increased their login frequency, with differences between 5.9 and 9.5 percentage points. Column 4 shows that the differences in proportion of groups increasing their login frequency between the FSI group and the five other treatment groups are insignificant.

[9]For brevity, I report OLS regression coefficients which, in this study, are identical to the marginal effects at the means of probit or logit regressions.

The different treatments induced users to pay more attention to their finances relative to the control group, both in terms of login frequency and proportion of the group with a frequency increase. Without successfully drawing attention from users, the treatment had little chance to affect financial behavior. This increased attention could be the result of interest in the new features or of the nudges by the notification and badge app icons. The fact that there were no significant differences across the different treatment groups indicates that users did not pay special attention to a specific feature of the interventions that differed across the group (e.g., the LAI was not more engaging than the FSI).

5.2 Income

In Table 6, I show the effect of the treatments on income. There were no significant differences in changes of average monthly income between any of the treatment groups and the control group (column 1) or between the FSI group and any of the other five treatment groups (column 2). Similarly, in columns 3 and 4 there are no significant differences between any of the groups in the proportions of the groups increasing their monthly income. The treatments had no impact on income. This result is not surprising since individuals typically have little control over their income level over a short period of time.

5.3 Spending

Table 7 presents the analysis of users' spending behavior. Column 1 shows that the spending of the control group increased by 20%. This significant increase is a result of low spending levels in January and February before the experiment's launch.[10]

[10]The average monthly spending before the experiment is calculated over the period 12/17/2013 to 3/16/2014. Though spending in December is high, it is lower toward the end of the month and generally low in January and February. I find the same pattern for all treatment groups, for Personal Capital's users not included in the experiment, and for Personal Capital's users in the prior year. I attribute this drop to a seasonal effect that does not impact the cross group inference of this study.

In comparison to the control group, spending decreased significantly (about 10%) in both the FSI group and the inflated FSI group. Spending change for of all the other treatment groups was similar to the change in the control group. Column 2 shows that the difference in change of average monthly spending between the Inflated FSI group and the FSI group is insignificant. The difference between the FSI group and all the other treatment groups is positive and significant at around 10%. Columns 3 and 4 show the same pattern in the proportion of groups that increased their spending. About 7% more users in the FSI and the Inflated FSI groups decreased their spending in comparison to the control group. The proportions of users increasing their spending in all the other treatment groups were not different than of the control group.

Users in the FSI group responded to the treatment and reduced their spending. It is important to note that almost all users' spending levels are significantly higher than their financial index. This study shows the response to the treatments among "over spenders" only.[11] The Inflated FSI group responded in the same way, showing that users are insensitive to the exact measure of the index. The Partial FSI group did not respond to the treatment, showing that providing an explicit comparison between the index and spending levels is crucial. Also, it suggests that the new information provided by the index has no importance without relevant context. The Retirement FSI group did not respond to the treatment. Both the Retirement FSI and the Partial FSI groups did not respond to the treatment, demonstrating that mitigation of the two-agent problem has no effect on spending, at least not without a context for spending. The LAI group did not respond to the treatment either, demonstrating the importance of using a consumption frame to describe the tool rather than an investment frame. A comparison of the Retirement LAI group with the Retirement FSI groups reveals that the framing of the index does not matter when presenting non immediate cash flows and removing

[11] I do not detect a stronger response to the treatment for users with a higher spending-to-index ratio.

the plot comparing index to spending. These results indicate that the information content of the indexes had little importance. User responses depend on the design of the information, specifically the framing and context of the information.

5.4 Savings

Table 8 shows the treatment effects on savings behavior. Savings are the difference between income and spending. The change in savings is the difference between the averages of monthly savings in the four months after the experiment's launch and the three months before. Since savings are often negative or close to zero, I scale the difference by net worth. Savings increase is a binary variable with the value of 1 if savings change is positive.

Given the previous analysis of income and spending, the results of this analysis are not surprising. Column 1 shows that the control group had a significant drop in spending behavior. In comparison, both the FSI and the Inflated FSI groups had a significantly higher change in savings, while all the other treatment groups were not different from the control group. The change in savings of the FSI group is not different from that of the Inflated FSI group and is significantly higher than that of the other treatment groups (column 2). Column 3 shows that an additional 7.8% of the FSI group users increased their savings relative to the control group. The Inflated FSI group has the second largest increase in proportion of users increasing their savings; however, this result is not statistically significant. Column 4 shows that the difference in proportion of users increasing their savings between the FSI and the Inflated FSI groups is insignificant. There were significantly more users increasing their savings in the FSI group in comparison to the Partial FSI, Retirement FSI, and Retirement LAI groups. Although 3% more users increased their savings in the FSI group than in the LAI group, this difference is not statistically significant.

5.5 Source of Spending Cuts

Next, I explore where the FSI and Inflated FSI groups cut their spending. One possibility is that these users implemented a change in their everyday lives that would cut spending each month (e.g., eat less often in restaurants). Another possibility is that users avoid or cut back on large infrequent transactions (e.g., luxurious vacations).

I check the expenditures in different spending categories. Although I observe detailed information on each transaction, the millions of different transaction types makes the classification into categories challenging.[12] I test changes in spending behavior in all the reliable and well-defined spending classifications: utility bills, mortgages, gasoline/fuel, restaurants, and groceries and do not find any significant effect in the different treatment groups. Mortgages and fuel spending are difficult to adjust in the short run. Cutting expenses such as restaurant outings and groceries probably require habit adjustments and more mental effort. Overall, I do not find that users changed their spending behavior in any of the frequently occurring expenditures.

In Table 9, I examine whether users in the FSI and Inflated FSI groups were more likely to avoid large, infrequent transactions. The dependent variable is change in spending standard deviation defined as the difference between monthly spending standard deviation in the four months after the experiment's launch and the three months before. This difference is scaled by net worth. Column 1 shows that the FSI and inflated FSI groups decreased the volatility of monthly spending in comparison to the control group. The other treatment groups were not different from the control. Column 2 shows that both the FSI and the inflated FSI groups had similar reductions in spending volatility. All the other treatment groups experienced a significantly higher change in spending volatility (higher but

[12]Several start-up firms are currently developing better categorization algorithms.

insignificant for the Retirement FSI). In columns 3 and 4, I do not find significant differences in the proportion of groups increasing their spending volatility.

In Table 10, I test the change in extreme transactions. In columns 1 and 2, the dependent variable is the difference in sums of the largest five transactions in the four months after the experiment's launch and the three months before it. The difference is scaled by the pre-experiment sum. Columns 1 and 2 show that the FSI and Inflated FSI groups cut their extreme transactions in comparison to all the other groups. Columns 3 and 4 show that a larger proportion of users in the FSI and Inflated FSI groups cut their extreme transactions in comparison to all the other groups. However, this difference is not statistically significant. Overall, these results indicate that the FSI and Inflated FSI treatments caused users to cut or avoid making large, infrequent transactions.

6 Conclusion

I design an information tool that presents an individual's net worth as a potential lifetime monthly stream of income based on current market prices. In a seven-arm randomized field experiment, I test the impact of the information tool on the users of an online account aggregation software. I find that this information manipulation significantly decreases spending and increases savings. The impact of the intervention is sensitive to using a consumption frame or an investment frame and to providing an explicit comparison between the index level and spending. I find that individuals reduced their spending by avoiding or reducing infrequent large transactions, not by reducing their everyday spending activity, such as for restaurant outings or grocery expenditures.

To the best of my knowledge, this study is the first field experiment to impact overall spending directly. It demonstrates the importance of information architecture in the context of savings, specifically, the effects of framing and of

providing context to the information. Given the low distribution costs of digital information tools and the high usability of financial online applications, this study demonstrates the potential of digital information architecture to impact financial behavior on a global scale.

The information tool suggested in this study is model free, requires little time and cognitive effort from its users (in comparison to financial education for example), and responds immediately to both macroeconomic shifts and to changes in the users financial information. The information tool does not offer an explicit course of action for the users to take. Instead, it attempts to simplify the saving-spending decision.

Insights from this study provide an additional evidence for the importance of framing in the context of the annuitization puzzle ([BPT11]). The findings have the potential to inform and support both the financial industry and government efforts to increase the popularity of lifetime income vehicles. This study has important insights for the proposed [Lif13], which would require defined contribution plan administrators to provide income disclosures that include estimated lifetime monthly income given current retirement savings. First, I propose overcoming the need for assumption by using annuities market prices. Second, proper context and framing of the cash flow have critical importance in affecting saving behavior as intended by the act.

I plan to explore the impact of the different treatments on financial behavior over a long horizon, as well as to test whether the effects reverse after the removal of the experiment's content from the app. A long horizon study would be able to reveal the effect of the tool on income levels, financial risk-taking, retirement age, and debt management. Future research should explore the effect of the tool on different populations, including retirees, under-spenders, and less-wealthy individuals. Different variations of the tool might be more effective such as allowing for household composition or customization of the potential cash flows (bequest,

children's college expenses, reducing cash flow stream).

7 Tables

Table 1: Treatment Groups

#	Group	Index name	Cash flow	Index and spending plot
1	Control	-	-	no
2	FSI	Financial Sustainability Index	starts immediately	yes
3	Inflated FSI	Financial Sustainability Index	starts immediately, inflated by 20%	yes
4	Partial FSI	Financial Sustainability Index	starts immediately	no
5	Retirement FSI	Financial Sustainability Index	starts at retirement	no
6	LAI	Life Annuity Index	starts immediately	yes
7	Retirement LAI	Life Annuity Index	starts at retirement	no

Table 2: Summary Statistics

Variable	Obs	Mean	Std. Dev.	P10	P50	P90
Age	3,138	44.59	7.93	36	43	56
Retirement age	3,138	63.96	4.33	60	65	67
Years to retirement	3,138	19.36	8.4	7	21	29
Months since registration	3,138	11.42	5.93	5	10	20
Average monthly logins	3,138	16.21	25.15	.67	7	42
Number of accounts	3,138	18.99	9.43	9	17	31
Number of non-manual accounts	3,138	16.54	8.15	8	15	27
Number of asset accounts	3,138	14.22	7.47	6	13	24
Number of liability accounts	3,138	4.77	4.14	1	4	10
Net worth	3,138	1,128,106	1,493,896	72,558	637,307	2,623,589
Total assets	3,138	1,354,776	1,607,205	122,705	861,807	3,011,307
Total liabilities	2,843	241,853	307,316	1,291	142,218	637,733
Average monthly income	3,138	27,623	37,699	5,459	15,377	59,728
Average monthly spending	3,138	21,418	30,453	4,050	11,752	43,579
Average monthly savings	3,138	6,130	23,630	-7,498	2,847	23,091
Savings/income	3,138	0.01	0.95	-0.6	0.22	0.65
Savings/net worth	3,138	0.01	0.05	-0.01	0.01	0.04

Summary statistics are as documented on the experiment launch day. Monthly averages are calculated over the preceding three months. Savings is the difference between income and spending. Saving/income is the ratio of the monthly averages. Saving/ net worth uses average monthly savings.

Table 3: Personalized Financial Index by Group

Group	Obs	Mean	Std. Dev.	P10	P50	P90
Control	458	3,373	5,562	160	1,729	7,977
FSI	422	3,310	4,853	166	1,576	8,116
Partial FSI	434	2,890	4,602	141	1,407	7,047
LAI	426	3,467	6,765	171	1,585	7,529
Inflated FSI	450	3,709	6,228	262	1,935	9,020
Retirement FSI	477	8,807	12,789	608	5,158	17,652
Retirement LAI	471	10,090	13,770	733	5,775	22,576

Index levels were documented on the experiment's launch date. Financial index for the control group is calculated as if they were in the FSI group. Indexes for the control, FSI, Partial FSI, and LAI groups represent a potential monthly cash flow starting immediately. Inflated FSI group index is inflated by 20% in comparison to the FSI group. Indexes for the Retirement FSI and Retirement LAI groups represent a potential monthly cash flow starting at retirement.

Table 4: Average Monthly Spending to Personalized Financial Index Ratio by Group

Group	Obs	Mean	Std. Dev.	P10	P50	P90
Control	458	28.96	72.06	1.65	7.67	58.94
FSI	422	27.87	59.54	2.09	8.99	63.2
LAI	426	26.1	51.43	2.24	8.32	67.02
Partial FSI	434	26.55	49.17	1.88	9.49	65.3
Inflated FSI	450	18.81	38.57	1.59	7.2	42.51
Retirement FSI	477	7.07	14.23	0.66	2.36	15.62
Retirement LAI	471	7.43	19.95	0.57	2.08	14.13

Index levels were documented on the experiment's launch date. Indexes are described in the main text and in Table 3. Average monthly spending is calculated over the three months preceding the experiment's launch.

Table 5: Change in Average Monthly Logins

	(1) $\Delta logins$	(2) $\Delta logins$	(3) $1(\Delta logins>0)$	(4) $1(\Delta logins>0)$
FSI	0.176***		0.070**	
	(3.32)		(2.14)	
Inflated FSI	0.120**	-0.055	0.068**	-0.002
	(2.32)	(-1.01)	(2.10)	(-0.07)
Partial FSI	0.113**	-0.063	0.062*	-0.009
	(2.15)	(-1.14)	(1.89)	(-0.26)
Retirement FSI	0.164***	-0.012	0.088***	0.018
	(3.19)	(-0.22)	(2.76)	(0.54)
LAI	0.183***	0.008	0.059*	-0.011
	(3.48)	(0.14)	(1.82)	(-0.32)
Retirement LAI	0.217***	0.042	0.095***	0.025
	(4.22)	(0.77)	(2.98)	(0.76)
Reference group	Control	FSI	Control	FSI
Reference group mean	-0.155***	0.020	0.323***	0.393***
	(-4.24)	(0.52)	(14.21)	(16.50)
N	3,138	2,680	3,138	2,680

$\Delta logins$ is the difference in average monthly logins between four months after the experiment's launch and the three months prior to it, scaled by the later. $1(\Delta logins > 0)$ is a binary variable that equals 1 if $\Delta logins$ is positive and 0 otherwise. Explanatory variables are experiment group binaries. t-statistics are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 6: Change in Average Monthly Income

	(1) $\Delta income$	(2) $\Delta income$	(3) $1(\Delta income>0)$	(4) $1(\Delta income>0)$
FSI	0.017		0.029	
	(0.43)		(0.87)	
Inflated FSI	-0.014	-0.031	0.005	-0.024
	(-0.36)	(-0.77)	(0.15)	(-0.72)
Partial FSI	0.020	0.003	-0.011	-0.039
	(0.51)	(0.08)	(-0.32)	(-1.17)
Retirement FSI	-0.007	-0.024	0.058*	0.029
	(-0.17)	(-0.59)	(1.79)	(0.88)
LAI	0.019	0.002	0.020	-0.009
	(0.48)	(0.05)	(0.61)	(-0.26)
Retirement LAI	0.014	-0.003	0.021	-0.008
	(0.36)	(-0.08)	(0.65)	(-0.24)
Reference group	Control	FSI	Control	FSI
Reference group mean	0.002	0.019	0.393***	0.422***
	(0.06)	(0.65)	(17.09)	(17.59)
N	3,138	2,680	3,138	2,680

$\Delta income$ is the difference in average monthly income between the four months after the experiment's launch and the three months prior to it, scaled by the later. $1(\Delta income > 0)$ is a binary variable that equals 1 if $\Delta income$ is positive and 0 otherwise. Explanatory variables are experiment group binaries. t-statistics are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 7: Change in Average Monthly Spending

	(1) $\Delta spend$	(2) $\Delta spend$	(3) $1(\Delta spend>0)$	(4) $1(\Delta spend>0)$
FSI	-0.107**		-0.066**	
	(-2.51)		(-1.97)	
Inflated FSI	-0.098**	0.009	-0.077**	-0.011
	(-2.34)	(0.21)	(-2.32)	(-0.32)
Partial FSI	-0.001	0.106**	-0.006	0.060*
	(-0.02)	(2.49)	(-0.18)	(1.77)
Retirement FSI	-0.003	0.104**	0.022	0.088***
	(-0.07)	(2.49)	(0.67)	(2.64)
LAI	-0.015	0.092**	-0.005	0.061*
	(-0.34)	(2.15)	(-0.15)	(1.79)
Retirement LAI	-0.004	0.103**	0.019	0.085**
	(-0.09)	(2.46)	(0.57)	(2.54)
Reference group	Control	FSI	Control	FSI
Reference group mean	0.211***	0.104***	0.559***	0.493***
	(7.18)	(3.45)	(24.05)	(20.36)
N	3,138	2,680	3,138	2,680

$\Delta spend$ is the difference in average monthly spending between the four months after the experiment's launch and the three months prior to it, scaled by the later. $1(\Delta spend > 0)$ is a binary variable that equals 1 if $\Delta spend$ is positive and 0 otherwise. Explanatory variables are experiment group binaries. t-statistics are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 8: Change in Average Monthly Savings

	(1) $\Delta savings$	(2) $\Delta savings$	(3) $1(\Delta savings>0)$	(4) $1(\Delta savings>0)$
FSI	0.007***		0.078**	
	(2.96)		(2.37)	
Inflated FSI	0.005**	-0.002	0.046	-0.031
	(2.21)	(-0.78)	(1.44)	(-0.95)
Partial FSI	0.001	-0.005**	0.020	-0.058*
	(0.56)	(-2.35)	(0.60)	(-1.74)
Retirement FSI	0.001	-0.005**	-0.004	-0.081**
	(0.65)	(-2.33)	(-0.11)	(-2.50)
LAI	0.002	-0.004*	0.043	-0.035
	(0.99)	(-1.92)	(1.32)	(-1.03)
Retirement LAI	0.001	-0.006***	0.018	-0.060*
	(0.31)	(-2.65)	(0.56)	(-1.83)
Reference group	Control	FSI	Control	FSI
Reference group mean	-0.009***	-0.003*	0.354***	0.431***
	(-6.08)	(-1.72)	(15.59)	(18.20)
N	3,138	2,680	3,138	2,680

Savings is the difference between income and spending. $\Delta savings$ is the difference in average monthly savings between the four months after the experiment's launch and the three months prior to it, scaled by net worth at the launch of the experiment. $1(\Delta savings > 0)$ is a binary variable that equals 1 if $\Delta savings$ is positive and 0 otherwise. Explanatory variables are experiment group binaries. t-statistics are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 9: Change in Standard Deviation of Monthly Spending

	(1) $\Delta\sigma(spend)$	(2) $\Delta\sigma(spend)$	(3) $1(\Delta\sigma(spend)>0)$	(4) $1(\Delta\sigma(spend)>0)$
FSI	-0.005**		-0.029	
	(-2.47)		(-0.87)	
Inflated FSI	-0.004**	0.001	-0.030	-0.001
	(-2.21)	(0.30)	(-0.90)	(-0.02)
Partial FSI	0.001	0.006***	-0.001	0.029
	(0.26)	(2.67)	(-0.02)	(0.84)
Retirement FSI	-0.003	0.002	-0.014	0.015
	(-1.29)	(1.22)	(-0.45)	(0.44)
LAI	-0.001	0.004*	-0.039	-0.010
	(-0.65)	(1.77)	(-1.17)	(-0.29)
Retirement LAI	-0.001	0.004**	-0.041	-0.012
	(-0.36)	(2.11)	(-1.27)	(-0.36)
Reference group	Control	FSI	Control	FSI
Reference group mean	0.004***	-0.001	0.574***	0.545***
	(2.72)	(-0.81)	(24.70)	(22.48)
N	3,138	2,680	3,138	2,680

$\Delta\sigma(spend)$ is the difference in the standard deviations of monthly spending between the four months after the experiment's launch and the three months prior to it, scaled by net worth at the launch of the experiment. $1(\Delta\sigma(spend) > 0)$ is a binary variable that equals 1 if $\Delta\sigma(spend)$ is positive and 0 otherwise. Explanatory variables are experiment group binaries. t-statistics are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 10: Change in Extreme Transactions

	(1) $\Delta Xtran5$	(2) $\Delta Xtran5$	(3) $1(\Delta Xtran5>0)$	(4) $1(\Delta Xtran5>0)$
FSI	-0.333***		-0.019	
	(-2.83)		(-0.57)	
Inflated FSI	-0.269**	0.064	-0.019	0.000
	(-2.32)	(0.55)	(-0.57)	(0.01)
Partial FSI	0.047	0.380***	-0.002	0.017
	(0.40)	(3.21)	(-0.07)	(0.49)
Retirement FSI	0.034	0.367***	0.038	0.057*
	(0.30)	(3.18)	(1.16)	(1.71)
LAI	0.015	0.348***	-0.015	0.004
	(0.13)	(2.93)	(-0.45)	(0.12)
Retirement LAI	-0.038	0.295**	-0.001	0.018
	(-0.33)	(2.55)	(-0.04)	(0.54)
Reference group	Control	FSI	Control	FSI
Reference group mean	0.861***	0.528***	0.583***	0.564***
	(10.56)	(6.27)	(25.28)	(23.47)
N	3,138	2,680	3,138	2,680

$\Delta Xtran5$ is the difference between the sums of the five largest transactions in the four months after the experiment's launch and the three months prior to it, scaled by the later. $1(\Delta Xtran5 > 0)$ is a binary variable that equals 1 if $\Delta Xtran5$ is positive and 0 otherwise. Explanatory variables are experiment group binaries. t-statistics are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

8 Figures

Figure 1: Full Dashboard Page of the Control Group

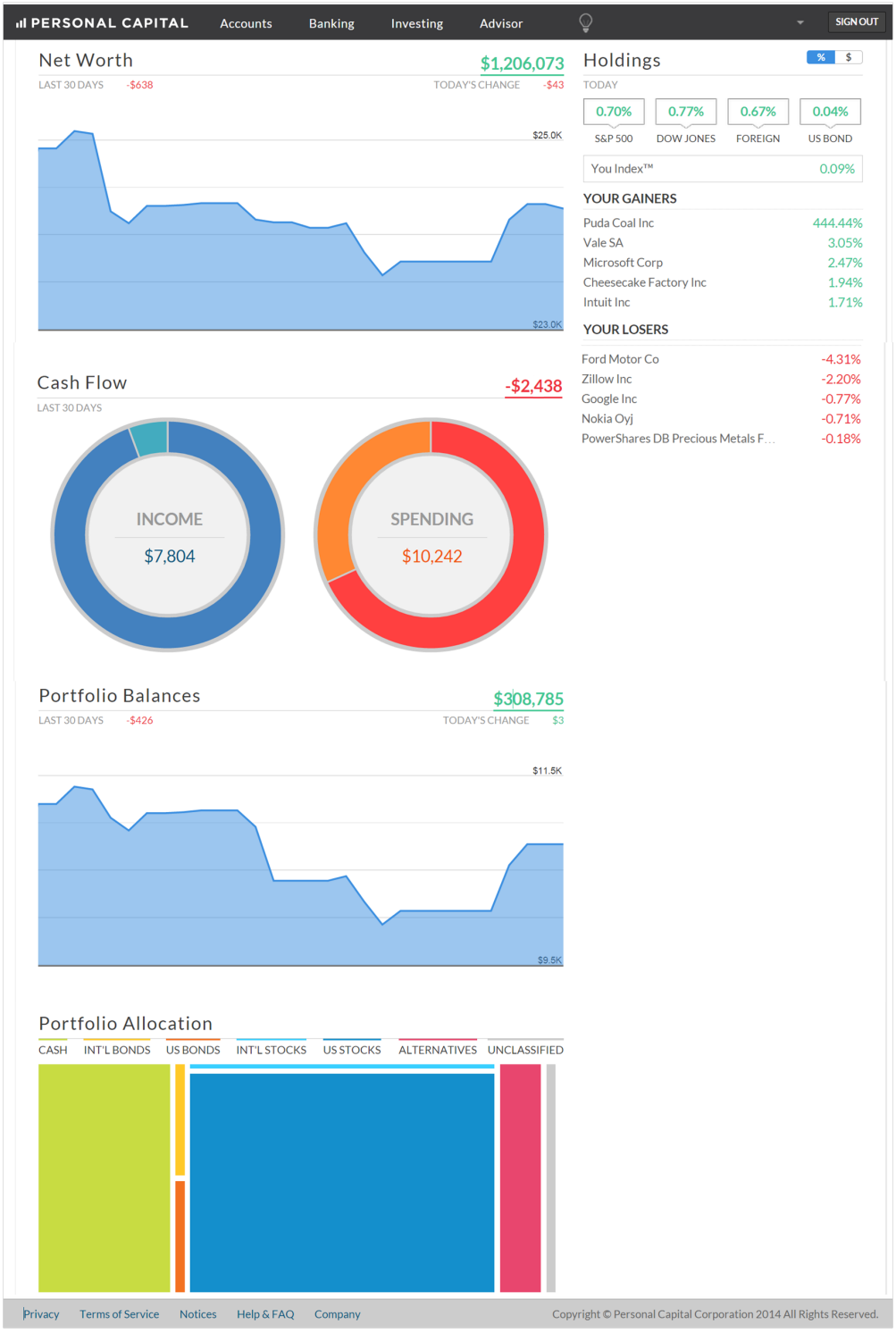


Figure 2: Full Dashboard Page of the FSI Group

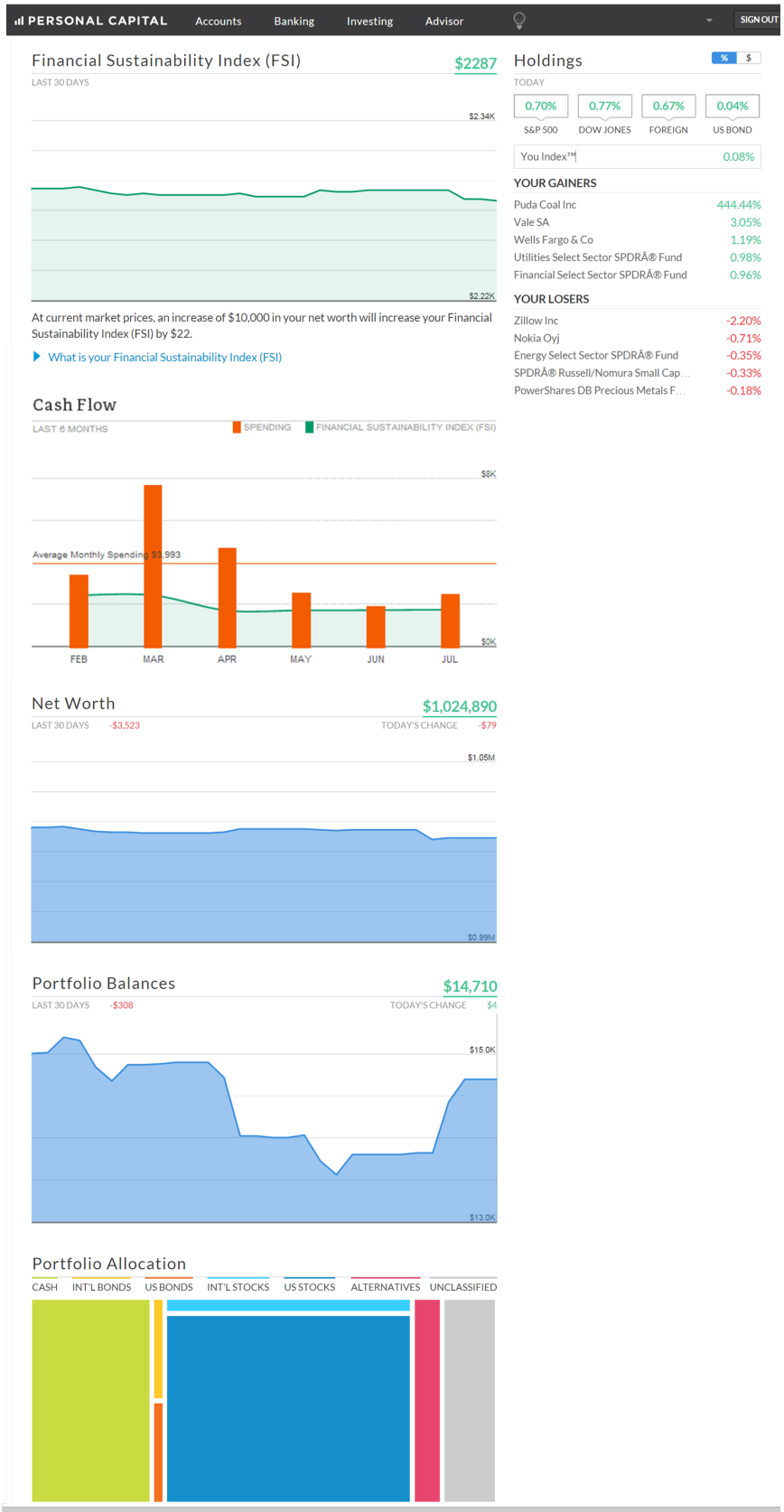


Figure 3: Top of Dashboard Page of the FSI Group

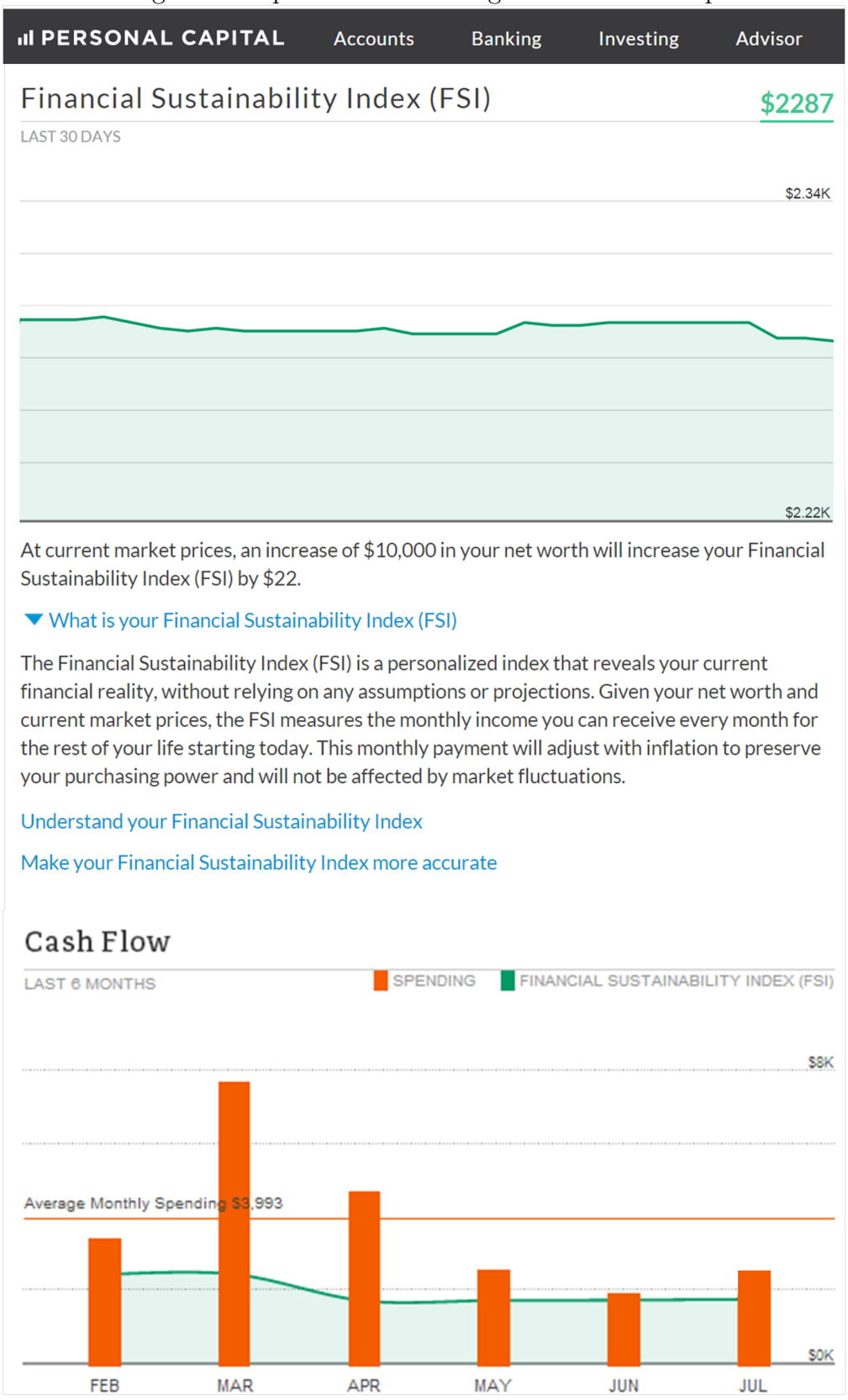


Figure 4: Top of Dashboard Page of the Partial FSI Group

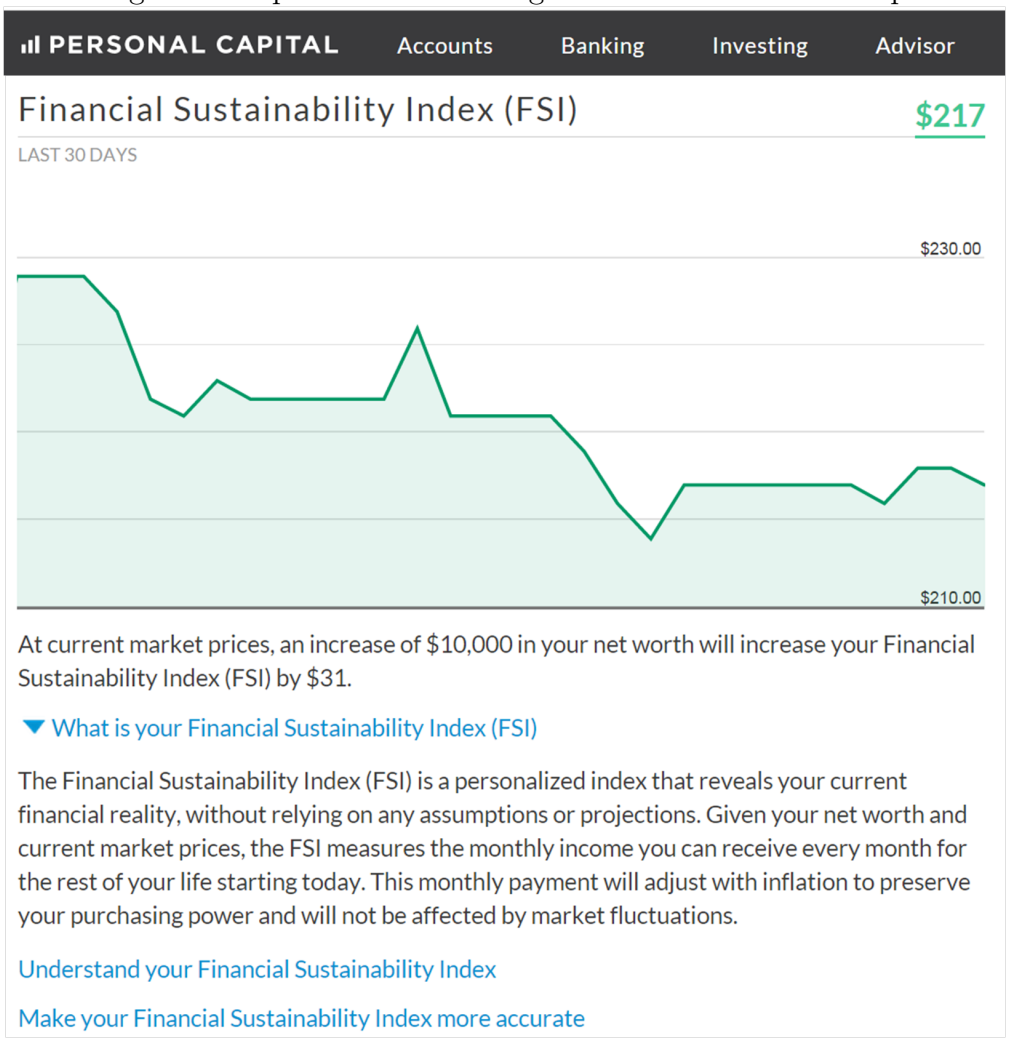


Figure 5: Top of Dashboard Page of the Retirement FSI Group

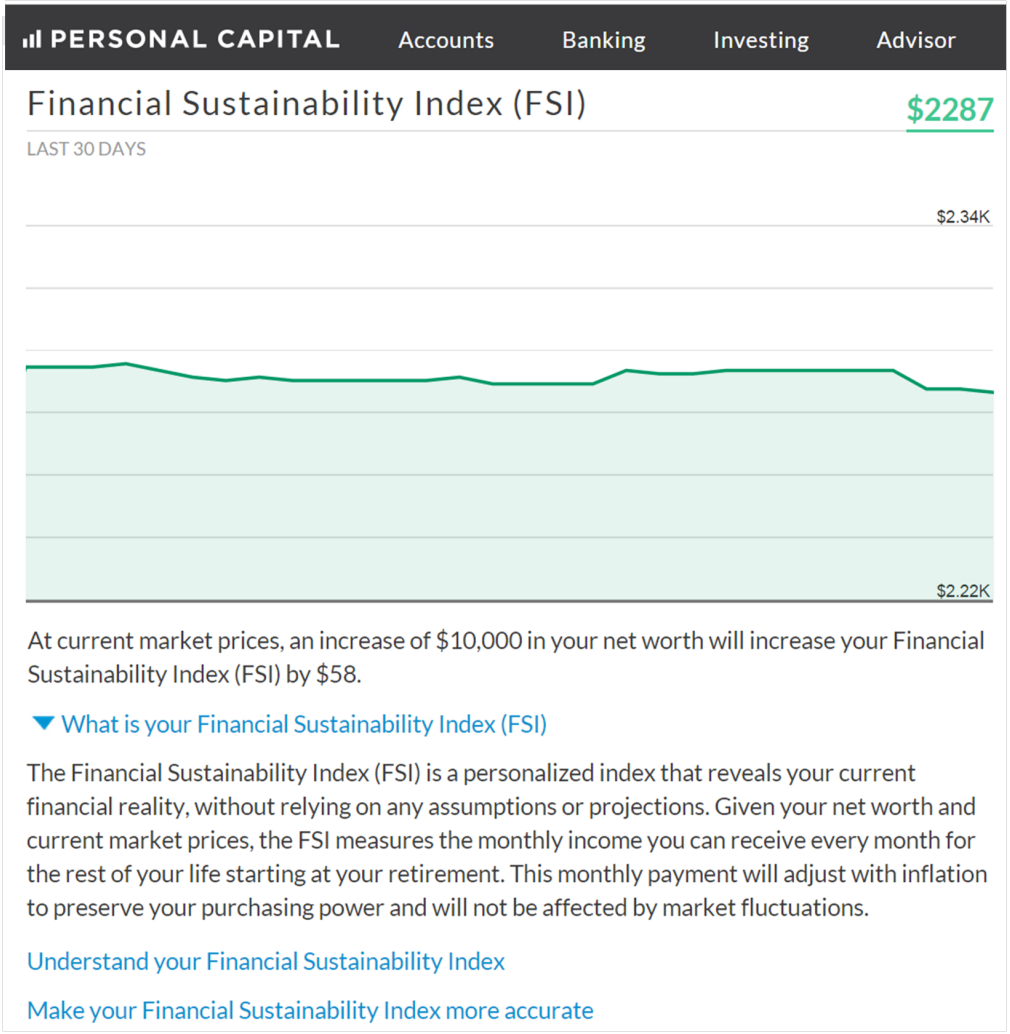


Figure 6: Top of Dashboard Page of the LAI Group

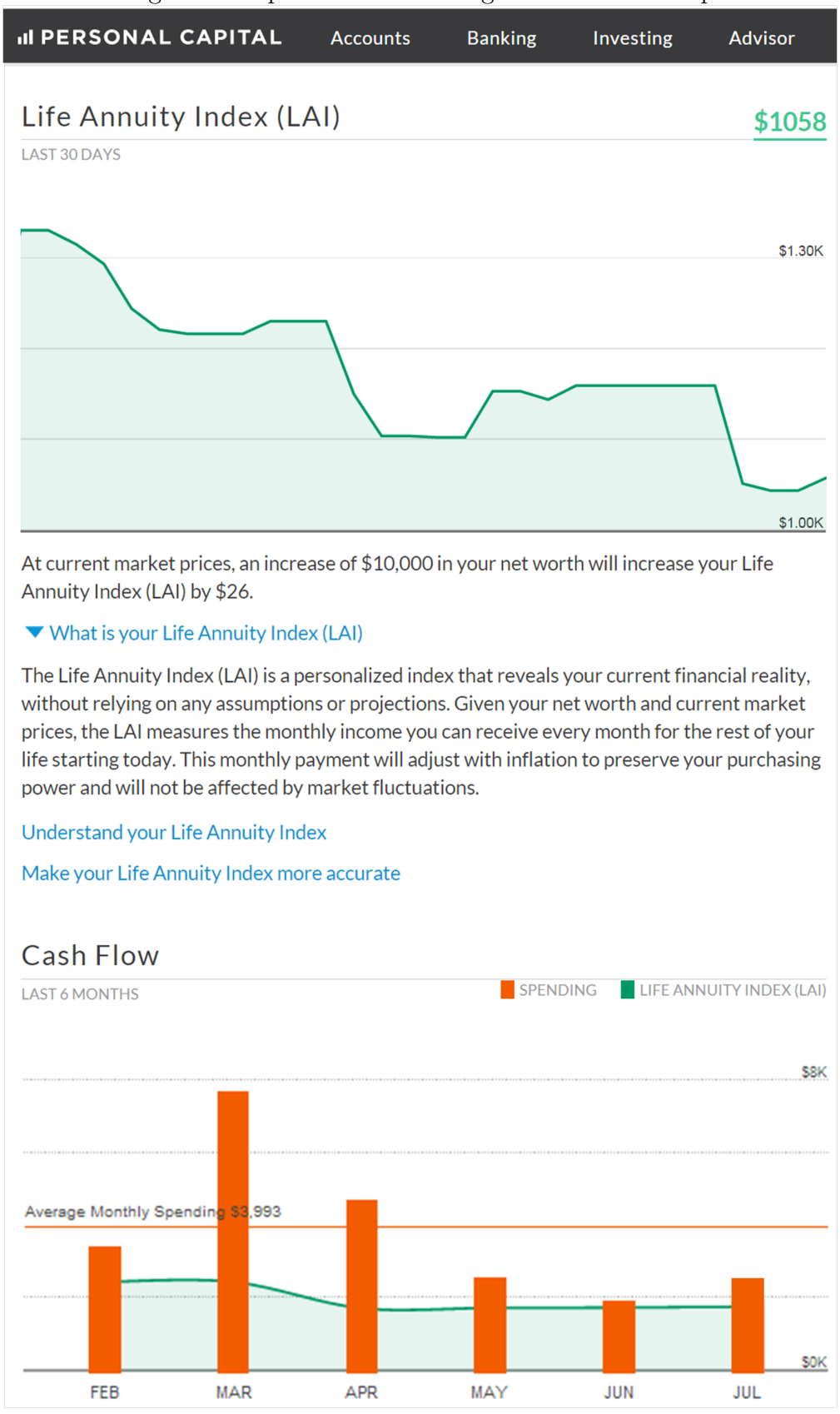


Figure 7: Top of Dashboard Page of the Retirement LAI Group

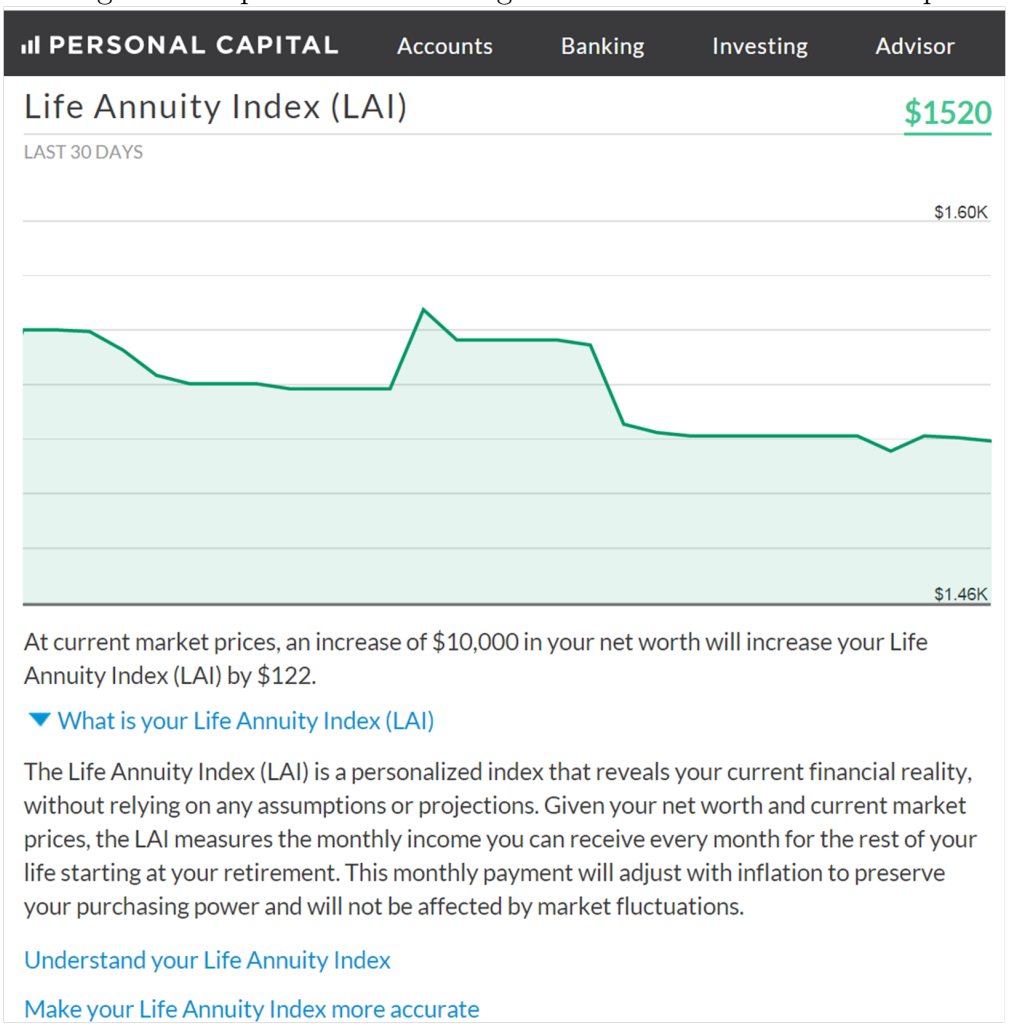


Figure 8: FAQ for the FSI Group, Part 1

What is your Financial Sustainability Index?

The Financial Sustainability Index (FSI) is a personalized index that reveals your current financial reality, without relying on any assumptions or projections. Given your net wealth and current market prices, the FSI measures the monthly income you can receive every month for the rest of your life starting today. This monthly payment will adjust with inflation to preserve your purchasing power and will not be affected by market fluctuations.

What can I learn from the Financial Sustainability Index?

Having all of your financial information in a single location is a great first step. The next step is to understand what this information actually means. Do you have enough money? Should you be saving more? Can you afford to increase your spending? The goal of the FSI is to give you reliable answers to these hard questions.

What are the problems with current solutions?

Unfortunately, people often struggle to come up with the correct answers to personal finance questions. Instead of using reliable numbers, they tend to rely on short-cuts, such as whether or not the amount of money in an investment account *seems* like a lot, or if it's more than our peers have saved. However, these shortcuts often lead to the wrong conclusions when it comes to financial planning.

Another approach involves using financial calculators to come up with a multi-decade financial plan. While these plans can be useful, they are highly dependent on many assumptions about the distant future, such as years of remaining work, market returns, inflation rates and other variables. Alas, history demonstrates that these assumptions are often very inaccurate, which means that our detailed financial plans can be misleading. Life is full of unexpected events, especially over long time horizons.

How is the Financial Sustainability Index different?

The Financial Sustainability Index takes a new approach to financial planning. Instead of making assumptions about the distant future, it simply tells you what you can purchase in the financial markets at current market prices.

The monthly income stream eliminates all the major risk factors that are relevant to your financial future:

- *Market risk* - The FSI income stream will not be affected by any market fluctuation.
- *Inflation risk* – Over the last 20 years, cash lost 37% of its value. The FSI presents possible real monthly income that preserves your purchasing power.
- *Longevity risk* – The FSI represent the income you can receive for the rest of your life.

The FSI is simple, fast and intuitive. The Index is based upon extensive field studies in the areas of household finance, behavioral economics and psychology to help you make the best financial decisions. It does not require you to read through lengthy financial reports. It adjusts instantly to your financial information and market conditions. All information is described in terms of monthly income (rather than a lump sum) so that you can think more clearly about your financial future.

Figure 9: FAQ for the FSI Group, Part 2

What should I do with this information?

The FSI does *not* tell you how much you should be spending, or how to divide your savings between bonds and stock. Rather, it is simply a useful piece of information that helps you understand where you stand.

Using this index you can measure how far are you from a sustainable level of spending. For example, if your average monthly spending is far above your FSI level, then your current spending levels are not sustainable. Perhaps you should cut back, or even postpone your retirement. On the other hand, if your FSI is above your spending levels, then you might consider increasing your spending and enjoying higher living standards.

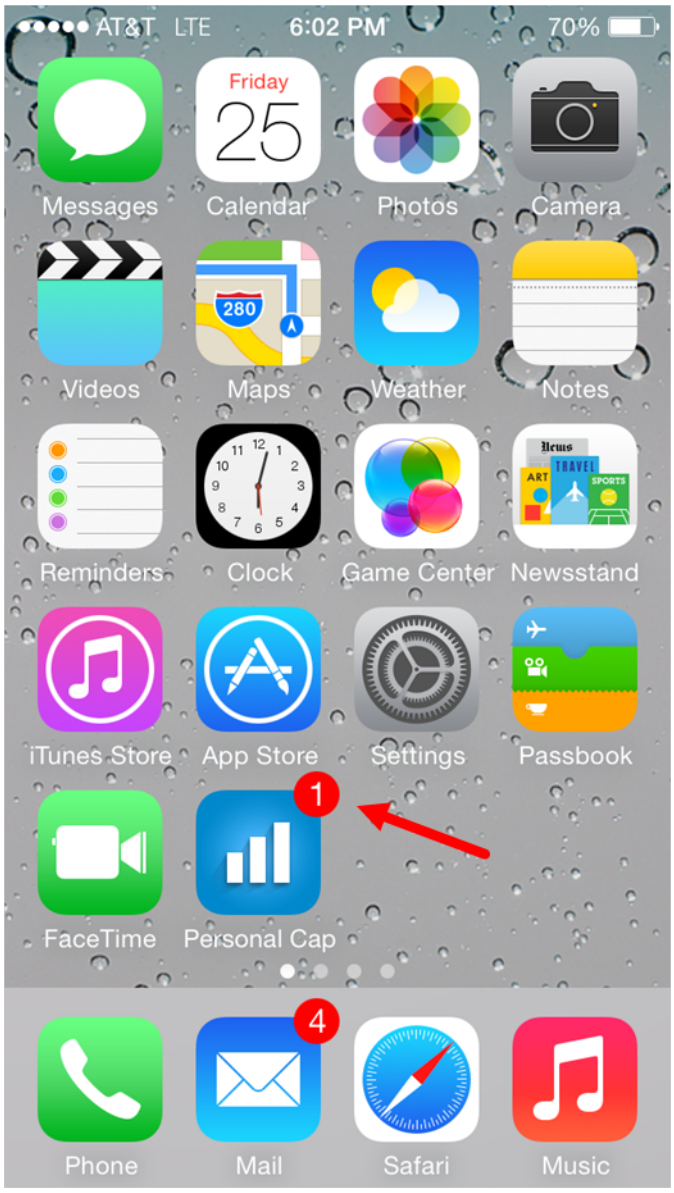
From your Personal Capital dashboard, you can see how additional savings or spending affect your FSI. You might want to consult the dashboard or speak to one of our dedicated Personal Capital financial advisors about the potential impact of additional spending or saving.

This data are for informational purposes only and does not constitute a recommendation to buy or sell securities. You should not rely on this information as the primary basis of your investment, financial, or tax planning decisions. Third party data is obtained from sources believed to be reliable. However, we cannot guarantee that data's currency, accuracy, timeliness, completeness or fitness for any particular purpose.

How is the index calculated?

The index is calculated daily using your net worth, personal information and current market prices of many asset classes including government bonds, fixed income securities, inflation swaps and annuities. The index is sensitive to changes in your net worth, as well as to shifts in market conditions such as inflation and interest rates.

Figure 10: iPhone Badge App Icon



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