

Individual Predictors of Financial Outcomes: Parsing out the predictive roles of  
Time Discounting and Financial Literacy

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## Abstract

During the last 30 years the US has experienced a fivefold increase in bankruptcies. While national and global economic trends can partly explain this sharp increase in defaulting behavior, the individual predictors of creditworthiness remain under-investigated. We sought to examine the effect of education, financial literacy, and time discounting on individual income and creditworthiness. Data from a US sample of adults revealed positive correlations among education, financial literacy, time discounting, income, and creditworthiness. However, general education and financial literacy fully mediated the relationship between time discounting and income, suggesting time discounting may act through education in its relationship with income. Financial literacy mediated the relationship between time discounting and creditworthiness, suggesting an indirect effect of temporal discounting on creditworthiness via financial literacy. Hierarchical regressions illustrated that variability in general education and financial literacy uniquely predict variability in income, whereas variation in financial literacy alone uniquely predicts FICO scores beyond known correlates of the construct (age, sex, gender, race, income, education, time discounting). Multivariate canonical correlation analyses show a significant association between income and creditworthiness on the one hand and time discounting, education, and financial literacy on the other. These data suggest that creditworthiness is a multifaceted construct, where programs geared towards improvement of finance skills are likely to be effective if they also reflect individual variability in time discounting. These findings are discussed in the context of our emergent efforts in understanding consumer banking competence and how to potentially improve such competence.

*Keywords:* Financial Literacy, Time Discounting, Education, Income, Creditworthiness

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Individual bankruptcy rates have soared in the United States from 300,000 yearly in 1980 to 1.5 million per year starting in 2001 (White, 2009). In addition, between 1945 and 2009 liabilities of US households have grown from 20% of disposable personal income to an astonishing 129%. The recent financial crisis has further demonstrated the perils of mass bankruptcy. According to the American Bankruptcy Institute (2010), the ratio of household debt to disposable income was at a record high, as the Great Recession was unfolding in 2009. Certainly striking, the consistently low income to debt ratio among people along with the sharp rise in indebtedness and defaulting over the recent past underscores the precarious state of individual financial dynamics in the United States, where many households fail to make saving and investment decisions according to normative models (Campbell, 2016). A recent report from the Federal Deposit Insurance Corporation (FDIC) indicated that 29.3 percent of households do not have a savings account, while about 10 percent do not have a checking account (FDIC 2012). As it is often the case marginalized social groups and individuals of low socio-economic status tend to be disproportionately affected. The same report also showed that even though only 8 percent of Whites are unbanked (e.g. have no checking account, or otherwise a relationship with a traditional financial institution, such as a bank), this number increases to 21.4 percent for Blacks, 20.1 percent for Hispanics, 22.2 percent for foreign-born non-citizens, and increases up to 28.2 percent for individuals from lower income households (less than \$15,000 annually in household income). Unbanked individuals are faced with crippling fees from alternative financial services (AFS) providers (e.g. payday loan) which for a single individual can add in excess of \$500 annually in fees, compared to regular banks. These problems have captured the attention of

various government agencies, such as the Financial Industry Regulatory Authority (FINRA), which, in conjunction with the Treasury Department, carried out the first National Financial Capability Study in the United States. The data revealed that half of the surveyed individuals faced difficulties with monthly bills and expenses, and a majority did not have emergency savings at their disposal. Many also failed to save for predictable life events such as children's college education or one's own retirement, and more than a quarter of the sampled individuals reported having to engage in high-cost borrowing from AFS. Interestingly, even though many of the respondents reported feeling adept at dealing with their own finances, many of them nonetheless engaged in banking behaviors that generated a sizeable volume of fees and other expenses, while only a few individuals shopped around and compared bank offers, before deciding on a financial product (FINRA Foundation, 2009).

Institutional external factors (e.g., increase in subprime lending, greater complexity of financial markets, and a shift towards self-management of finances [Immergluck & Smith, 2005; McKenzie & Liersch, 2011; Meier & Sprenger, 2012; Poterba, Venti, & Wise, 2007]) can explain some of the variability in indebtedness and bankruptcies. For instance, since the 1970s changes in legislature have resulted in a shift from *defined benefit* pension plans, which guarantee the amount paid on retirement, to *defined contribution* plans administered by employers, which do not guarantee the amount of the benefit paid on retirement, and shift the burden of risk away from companies and towards individuals (Frydman & Camerer, 2016; Poterba, Venti, & Wise, 2007). These trends further increase the importance of individual retirement savings in a country where many save too little for their post-employment life, and the average personal savings rate is 3 percent - consistently one of the lowest in the world (Guidolin & La Jeunesse, 2007; Lusardi & Mitchell, 2014).

While institutional external factors are constantly debated, and likely account for some of the indebtedness and bankruptcies in the US, the understanding of how individual internal characteristics impact financial dynamics remains elusive. Even if one intuitively thinks the problem is largely an issue of low incomes, this still does not paint a clear picture. Among National Football League (NFL) players, who earn substantially more than most people, 15 percent end up declaring bankruptcy 12 years after retirement (Carlson et al. 2015), suggesting that we need a better understanding of the factors guiding individual financial performance.

Two prominent markers of financial performance are income and creditworthiness, where the latter denotes a borrower's ability and willingness to repay a loan. Research on individual predictors of creditworthiness suggests that defaulting can be treated as an intertemporal choice, where those who discount the value of future goods should be more likely to default, as it offers financial benefits in the present – increased money availability in the present – but also costs in the long run, where one experiences the negative effects of compromised credit history (Chatterjee, Corbae, Nakajima, & Rios-Rull, 2007; Fehr, 2002; Meier & Sprenger, 2012). Time discounting (or time preference, temporal discounting) denotes one's relative valuation of a good at an earlier date, compared to its valuation at a later date. Discounting the value of future rewards is associated with lower scholastic achievement, and worse health-related behaviors (Chabris, Laibson, Morris, Schuldt, & Taubinsky, 2008; Chapman, 1996; Eigsti et al., 2006; Frederick, Loewenstein, & O'Donoghue, 2002; Kirby & Herrnstein, 1995; Kirby, Petry, & Bickel, 1999; Mischel, Shoda, & Rodriguez, 1989) showing its importance in predicting a host of beneficial behaviors to the individual beyond a metric of financial performance.

A recent report, documenting a positive relationship between time discounting and creditworthiness, demonstrated that individuals preferring later larger payouts relative to sooner

smaller ones during an intertemporal choice task tended to have significantly higher FICO scores, compared to those who exhibited a stronger preference for sooner smaller relative to later larger rewards (Meier & Sprenger, 2012). While this finding shows that the inability to delay gratification is associated with creditworthiness, it also poses a question about directionality, i.e., whether one causes the other, and whether other variables may mediate or moderate this relationship.

We theorized that a pre-potent response to resist sooner smaller for later larger rewards is critically important but that other factors help to explain people's inability to repay their loans or having to declare bankruptcy altogether. Based on the aforementioned FINRA findings, we further posited that, in addition to the influence of stable individual time discounting preferences, variability in individual financial dynamics can be further explained by other factors such as general education or acquired finance-specific knowledge, as individuals with more formal education, or those who have a greater understanding of financial concepts ought to be better equipped to successfully interact with the ever-increasing complexity in the contemporary financial markets. .

With regard to the role of education, and in particular finance-specific knowledge, researchers and policy makers alike have long prescribed that increasing financial literacy and financial education ought to successfully prevent people from reaching a state where bankruptcy is inevitable (Hilgert et al., 2003; Greenspan, 2005; Morton, 2005; Lusardi & Mitchell, 2007). Whereas financial literacy intuitively suggests what it may entail; providing a precise and exhaustive definition of the construct can be challenging. Researchers have agreed upon a definition of the construct where financial literacy denotes a general ability to manage one's financial affairs successfully through familiarity with and understanding of financial concepts

and instruments (Alba & Hutchinson, 1987; Fernandes, Lynch, & Netemeyer, 2014; Remund, 2010). Unfortunately, research striving to show that improved financial literacy leads to heightened financial expertise is not consistent, with some reports advocating for the usefulness of financial literacy, and others negating it (Adams & Rau, 2011; Collins & O'Rourke, 2010; Hastings et al., 2013; Hira, 2010; Thaler & Sunstein 2008; Willis, 2009). A recent meta-analysis (Fernandes, Lynch, & Netemeyer, 2014) sheds light on this issue by revealing that correlational studies of financial literacy show significantly larger effects compared to studies that experimentally manipulated financial literacy. A counterintuitive finding is that financial education interventions are characterized by statistically significant, but relatively small in magnitude effects. These interventions typically explain approximately 0.1 percent of the variance in the targeted financial behaviors (Fernandes, Lynch, & Netemeyer, 2014). In discussing possible explanations for this small effect, the authors suggest the following reasons may have limited the effectiveness of the experimental studies: intervention decay (i.e., the intervention did not last), or weak intervention effects in the actual acquiring of the financial knowledge. Among the correlational studies the authors argue that the greater predictive ability of financial literacy could be attributed to variables, putatively correlated with financial literacy or the financial behaviors investigated. According to Fernandes et al., these variables included confidence in financial information, propensity to plan, willingness to take financial risks, and numeracy (Fernandes, Lynch, & Netemeyer, 2014). When these variables are accounted for, the effects of financial literacy decrease in magnitude (Fernandes, Lynch, & Netemeyer, 2014). Their findings indicate that acquiring financial knowledge may be an intrinsically motivated process that develops over a long period of time – characteristics that make financial literacy difficult to manipulate experimentally. Therefore, teaching financial literacy that generates

prudent financial behaviors may not be something that can be improved by the teaching of finance alone, especially if this teaching is comprised of a single-trial intervention. Focusing on the training of financial expertise alone may not be conducive to the generation of sound financial practices. Given that substantial efforts have already established the relationships between time discounting, scholastic achievement, income and creditworthiness (Chabris, Laibson, Morris, Schuldt, & Taubinsky, 2008; Chapman, 1996; Eigsti et al., 2006; Frederick, Loewenstein, & O'Donoghue, 2002; Kirby & Herrnstein, 1995; Kirby, Petry, & Bickel, 1999; Meier & Sprenger, 2012; Mischel, Shoda, & Rodriguez, 1989), manipulations aiming to improve individual financial performance through financial literacy training will be more effective if they account for individual variability in education and temporal discounting preferences.

To summarize, individuals in the contemporary United States are faced with increasing indebtedness, while financial markets have become notably more complex. At the same time individuals are expected to be increasingly self-reliant in the management of their loans, savings, retirement, and investments. The concurrence of such institutional external factors create an unfavorable climate for individual financial performance, evidenced by the five-fold increase in bankruptcies over the last 3 decades. Whereas a precise fix to the current problem is yet to be found, substantial efforts have indicated that time discounting and financial literacy may be part of a more comprehensive solution to the existing problem with individual financial outcomes. Therefore within the framework of the current project our goal was to parse out the unique predictive ability of time discounting, financial literacy, and general education for individual markers of financial performance – income and creditworthiness. We believe it is conceivable that individuals less likely to discount the present value of future goods are not only more likely to stay longer in formal schooling, which has been repeatedly linked to better incomes, but also



may be better at assessing the potential long-run losses of poor financial decisions and thus seek, and more importantly benefit from, acquiring finance-specific knowledge. Specifically, we hypothesize that time discounting predicts individual income and creditworthiness, but these relationships should be fully mediated by general education and financial literacy. Such findings would be of importance both theoretically and practically in designing interventions to improve financial behaviors.

## Method

### Participants and Procedure

Data was collected from two hundred forty-five individuals (101 females) whose income spanned low- \$11,225 per household member (25<sup>th</sup> percentile) to moderate \$32,750 per household member (75<sup>th</sup> percentile), and were aged 21 to 69 ( $M_{age} = 33.51$ ). Of the total study sample FICO scores were available for one hundred thirty-one (62 females) low- to moderate-income participants, from ages 23 to 69 ( $M_{age} = 33.94$ ). All participants were recruited through Amazon's Mechanical Turk from across the United States. Participants provided consent prior to completing the survey measures in accordance with the guidelines set by the local Institutional Review Board, and were compensated \$2.00 for their participation.

### Materials

#### *Measuring time discounting*

Researchers in psychology and economics have created a number of different methods to measure time preferences, and how they are related to economic outcomes, psychological functioning, and behavior more generally. We used a ( $\beta$ ,  $\delta$ ) model of immediacy bias and individual discounting (Frederick et al., 2002; Weber et al., 2007), which has recently been demonstrated to perform best among other time preferences measures (Burks, Carpenter, Götte,

& Rustichini, 2012). Participants were presented with 22 items and prompted to choose between a sooner and smaller (SS) payout or a later larger one (LL) for three time periods. In the first time period participants chose between a SS payout that day, and a LL one a month later (0-1). For the second period they chose between a SS payout that day, and a LL one six months later (0-6). Finally, in the third period participants chose between a SS payout six months later, and a LL one seven months later (6-7). On all items the LL payouts remained the same at \$80, whereas the SS ones started at \$75 in the first pair and decreased in increments of \$5 for each subsequent item. An individual discount factor (IDF) was calculated for each period by dividing the value of the item at which individuals switched from preferring the SS to the LL payout of \$80. For instance, if an individual opted for the \$65 payout the day of testing versus \$80 in a month, but chose \$80 a month from now over \$60 that day, we treated the \$65 as the switching point, where  $65/80$  became that person's individual discount factor for period (0-1). A greater discount factor is indicative of lower degree of time discounting, or greater preference for LL payouts compared to SS payouts.

Within the framework of the  $(\beta, \delta)$  model (Frederick et al., 2002) the three distinct time periods were included in order to derive a measure of immediacy bias ( $\beta$ ), and more stable, deliberative time discounting ( $\delta$ ) (Laibson, 1997; Harrison et al., 2002). Participants'  $\delta$  were derived from their IDF for the (6-7 month) time period; whereas, participants  $\beta$  was calculated by dividing their (0-1 month) period IDF to their (6-7 month) period IDF.

#### *Other Variables*

Participants' knowledge of financial instruments was measured by the financial literacy scale (Lusardi, 2008), which assesses understanding of the basic concepts in finance, necessary to make saving decisions. The scale provides an assessment of a person's knowledge of basic

arithmetic, interest rates, inflation, risk diversification, as well as more complex concepts such as bonds, stocks, mutual funds, and asset pricing.

Participants' FICO scores were used to represent their creditworthiness. FICO scores were first introduced in 1989, and are calculated by the FICO Corporation (formerly Fair Isaac Corporation). Currently, FICO scores are mostly used by banks and other credit grantors when evaluating prospective clients' risk of default. Whereas the exact formula of the FICO score is not disclosed, FICO breaks down into the following five components: 35% payment history, 30% amounts owed, 15% length of credit history, 10% types of credit used, 10% new credit inquiries ([www.myfico.com](http://www.myfico.com)). The data from which FICO is calculated is based on consumer credit files of the three national credit bureaus: Experian, Equifax, and TransUnion.

Participants were also asked to report their highest level of formal education, and their annual household income. Formal education was standardized prior to inclusion in the analyses. Participant's household income was divided by the number of household members, and due to a significant positive skew, the variable was log-transformed prior to including it in the analyses.

The mediation analyses utilized a bootstrapping procedure, which is a nonparametric resampling method intended for mediation analyses characterized by smaller sample sizes. Even though the results do not change in significance depending on whether or not bootstrapping was used, this method offers a more robust test of the model, since it is more powerful than the conservatively biased Sobel test for mediation (Carre, Iselin, Welker, Hariri, & Dodge, 2014; Sobel, 1982). We used the PROCESS tool, designed for SPSS (Hayes, 2012), which generates a 95% confidence interval for the indirect effects using 10,000 iterations.

We also report canonical correlation analysis (Hotelling, 1936; Johnson & Wichern, 1992), which assesses the degree of association between two sets of variables (as opposed to a

simple correlation, or regression where multiple variables are used to predict a single dependent variable). Using canonical correlation is especially appropriate when predicting multiple inter-correlated outcome variables. Within the current study, one of the variable sets includes participants' income and FICO scores, whereas the other one contains their time-discounting score, general education, financial literacy, and age, as well as two binary indicators for race (white vs. non-white) and sex (male vs. female).

Similar to a principal components analysis the method derives the first canonical dimension, representing an underlying latent association between the sets of variables, by estimating the weights that maximize the correlation of the two weighted sums (linear composites) of each variable set. The first dimension is then extracted, and the variable weights that produce the second largest correlation between the summed scores is calculated, where the next set of summed scores is orthogonal to the first. Thus each successive canonical dimension explains *unique* additional proportion of variability in the two sets of variables. It is important to note that there can be as many canonical dimensions as there are variables in the smaller of the two sets, which is two in the case of our analysis).

In the current study we estimated two sets of canonical weights for each set of variables in order to derive the two canonical dimensions, each of which is characterized by a canonical correlation coefficient ( $r$ ) which is the square root of the explained variability ( $R^2$ ) between the two sets of variables.

We performed the canonical correlation analysis using MATLAB. Figure 10 shows the correlation coefficients (canonical loadings) of each observed variable in the set with the weighted summed scores for the first linear composite. The canonical dimension (linear composite) could be interpreted as an underlying latent variable whose degree of relationship

with each of the observed variables in the set (how much the observed variable contributes to the latent variable) is reflected in the observed variable's canonical loading. The error bars represent a 95% confidence interval calculated by bootstrapping the data (4000 samples with replacement) and choosing the symmetrical range around each average that contains 95% of all values in the loading distribution.

## Results

### Analytic Approach

Within the results section we first focus on income and report bivariate correlations, a mediation model, and a hierarchical regression model predicting this variable. We then turn our attention to participants' creditworthiness, as measured by their FICO scores, and report an identical set of analyses. We conclude our results section by reporting multivariate canonical correlation analyses examining the relationship between income and creditworthiness (on the dependent variable side) and the other set of predictor variables, including time discounting, financial literacy, general education, race, sex, and age (on the independent variable side).

### Time Discounting and Income

Participants' average time discounting scores across the three time periods and income were significantly correlated, Spearman's  $\rho = .183$ ,  $p < .004$  (Figure 1). Separately examining the relationship between immediacy bias ( $\beta$ ) and income, as well as the deliberative discount factor ( $\delta$ ) and income, revealed no significant effects ( $\beta - \rho = .058$ ,  $p = .364$ ;  $\delta - \rho = .087$ ,  $p < .177$ ), suggesting that the relationship between time discounting and income may be driven by people's discounting preferences across a wider range of time periods. For a complete correlation matrix showing all variables of interest in the current investigation, please see Figure 1.

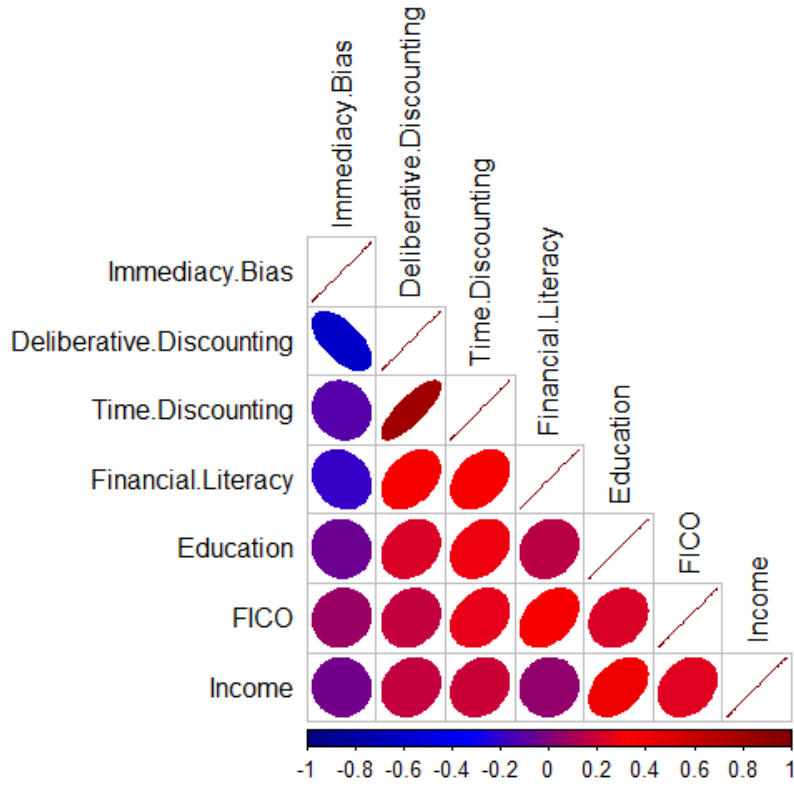


Figure 1. Correlation matrix illustrating the direction and magnitude (ellipse color intensity) between financial literacy and the other variables of interest in the current investigation.

### Mediation Model for Income

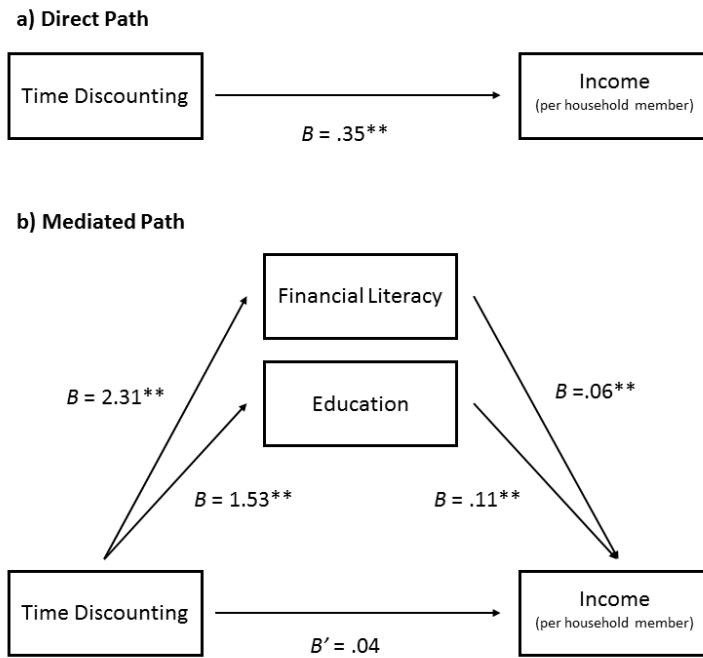
Mediation analyses were conducted to test the hypothesis that education, and especially knowledge of financial constructs, as measured by the Financial Literacy scale (Lusardi, 2008), mediate the impact of time discounting on income (Figure 2). Results revealed that time discounting was a significant predictor of both education,  $B = 1.53$ ,  $SE(B) = .41$ ,  $p < .0002$ , and financial literacy  $B = 2.31$ ,  $SE(B) = .44$ ,  $p < .0000$ . The model also shows that financial literacy predicts income,  $B = .06$ ,  $SE(B) = .02$ ,  $p < .0036$ , 95% CI = .02, .09, and so does general education,  $B = .11$ ,  $SE(B) = .02$ ,  $p = .0000$ , 95% CI = .07, .15. Whereas the direct effect of time discounting on FICO is significant,  $B = .35$ ,  $SE(B) = .15$ ,  $p < .0175$ , its indirect effect fails to reach conventional levels of statistical significance,  $B = .04$ ,  $SE(B) = .15$ ,  $p < .7617$ .

The indirect effect of time discounting on income via financial literacy was significant,  $B = .14$ , Boot  $SE(B) = .05$ , 95% CI = .05, .25, and so was the indirect effect of time discounting on income via general education,  $B = .17$ , Boot  $SE(B) = .06$ , 95% CI = .07, .32, thus demonstrating that both financial literacy and general education fully mediate the relationship between time discounting and income. Please see Figure 2 for a structural representation of the mediation model, and see Figure 3 for a graphical representation of the mediation model. Figure 4 shows a scatter plot of participants' income along the spectra of financial literacy and time discounting, along with the corresponding regression plane.

Switching the model around to test whether time discounting also mediates the relationship between financial literacy and income did not yield significant results,  $B = .00$ , Boot  $SE(B) = .01$ , 95% CI = -.0043, .0240. A model where time discounting mediates the relationship between general education and income also failed to reach conventional levels of statistical significance,  $B = .01$ , Boot  $SE(B) = .01$ , 95% CI = -.0025, .0186. Therefore, the current data

strongly suggest that while time discounting predicts income, it only does so via general education and finance-specific knowledge. The full mediation in the current model suggests that valuing future goods may cause one to invest in general education and acquiring finance-specific knowledge, which in turn are associated with greater earnings potential.





*Figure 2.* Mediation model showing the direct effect of time discounting on income (a), and the indirect effect of time discounting on income, as mediated by financial literacy and general education (b). Unstandardized regression coefficients are shown. (\* $p < .05$ . \*\* $p < .01$ .)

A. Financial Literacy mediates the relationship between time discounting and Income

B. Time Discounting does not mediate the relationship between financial literacy and Income

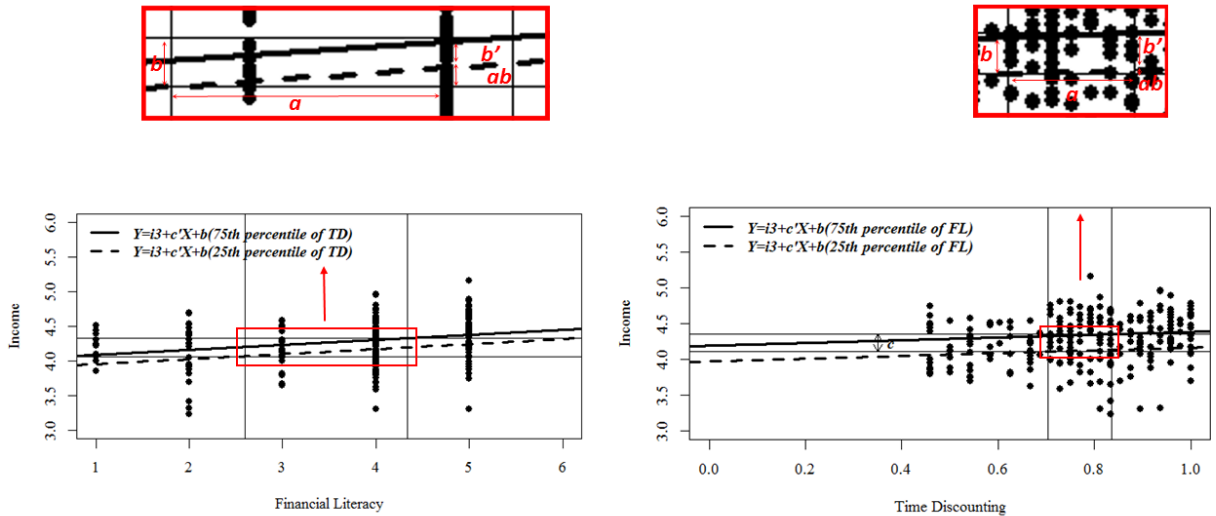


Figure 3. A graphical representation of financial literacy mediating the relationship between time discounting and income. Focusing on panel A  $b$  represents the amount of change in income, given a one unit change in time discounting; whereas,  $a$  represents the predicted amount of change in financial literacy, given a one unit change in time discounting. The slope of the simple regression lines illustrates the predicted change in income for a one unit change in financial literacy, adjusted for time discounting. The solid line represents the fourth quartile (indicating greater preference for later larger payouts) of time discounting, whereas the dotted line represents the first quartile of time discounting (indicating greater preference for sooner smaller payouts). The graph demonstrates that upon inclusion of financial literacy as a mediator in the relationship between time discounting and income, the indirect effect of time discounting,  $b'$ , has decreased in magnitude, and failed to reach conventional levels of statistical significance, in favor of the significant mediating effect of financial literacy,  $ab$ . An inspection of panel B, where time discounting was entered as the mediating variable in the model, and financial literacy was treated as the independent variable, failed to produce a mediating effect, as expected, and the graph reveals almost no decrease in magnitude from  $b$  to  $b'$ , representing the direct and indirect effects respectively.

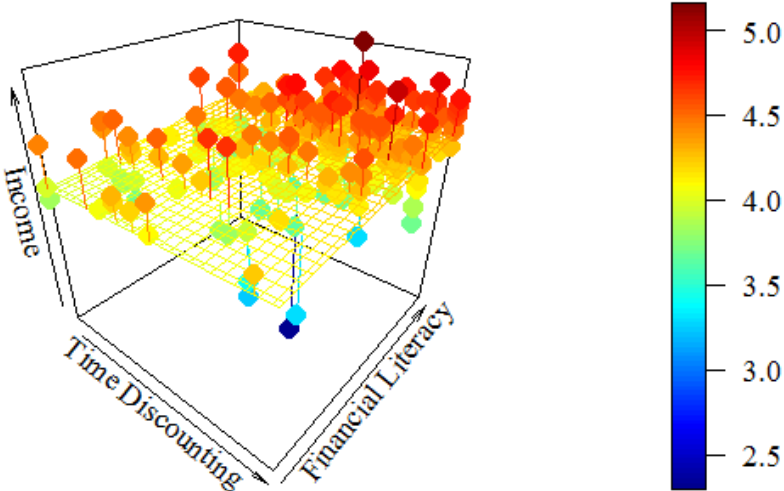


Figure 4. A scatter plot for income, including a regression plane for the same variable when predicted by financial literacy, and time discounting. Participants with higher incomes tended to score high on the financial literacy scale, and were most willing to delay future payouts. Financial literacy fully mediates the relationship between time discounting and income.

### **Hierarchical model for Income**

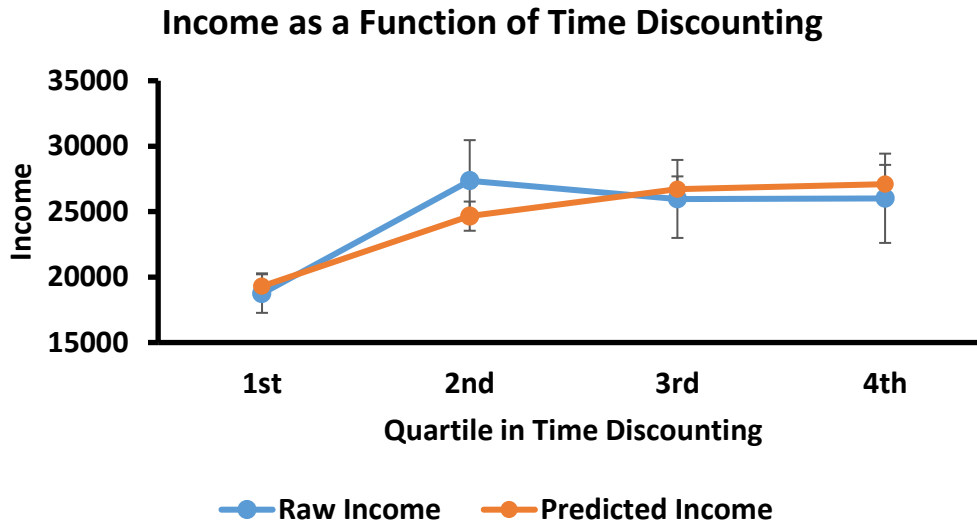
Hierarchical linear regression analyses (Refer to Table 1 for coefficients and summary statistics) were performed to examine how much of the variability in income could be specifically attributed to time discounting, general education, and financial literacy, while controlling for other potential correlates of income (age, gender, race). Regressing income on participants' individual discount factor yielded a significant overall regression ( $R^2 = .023$ ,  $p = .018$ ), and time discounting was a significant predictor of FICO scores ( $B = .353$ ,  $SE(B) = .148$ ,  $p = .018$ ). Adding age, gender, race in level two of the current model did not result in a significant increase in explained variance (overall  $R^2 = .038$ ,  $p = .054$ ;  $R^2$  change =  $.015$ ,  $p = .295$ ), where time discounting was the only significant predictor of FICO,  $B = .344$ ,  $SE(B) = .149$ ,  $p = .022$ . Including participants' general education in level 3 of the hierarchical regression yielded a significant increase in explained variance (overall  $R^2 = .148$ ,  $p = .000$ ;  $R^2$  change =  $.110$ ,  $p = .000$ ), where having more general education was associated with increased income ( $B = .121$ ,  $SE(B) = .022$ ,  $p = .000$ ), and marginally so was participant sex ( $B = -.087$ ,  $SE(B) = .044$ ,  $p = .047$ ), whereas none of the coefficients of the remaining predictors in the third level of the regression reached conventional levels of statistical significance, including time discounting  $B = .160$ ,  $SE(B) = .144$ ,  $p = .269$ . Including participants' financial literacy in level 4 of the hierarchical regression yielded a significant increase in explained variance (overall  $R^2 = .171$ ,  $p = .000$ ;  $R^2$  change =  $.023$ ,  $p = .011$ ), where having more general education ( $B = .114$ ,  $SE(B) = .022$ ,  $p = .000$ ) and having greater finance-specific knowledge ( $B = .054$ ,  $SE(B) = .021$ ,  $p = .011$ ) was associated with increased income, whereas none of the other coefficients of the remaining predictors in the fourth level of the regression reached conventional levels of statistical significance, including time discounting  $B = .056$ ,  $SE(B) = .148$ ,  $p = .704$ . (See Figure

5 for a comparison between the raw income and the predicted income from the fourth level of the hierarchical regression.)

**Table 1**  
*Summary of Hierarchical Regression Analysis for Variables Predicting Income (N = 245)*

Variable	Level 1			Level 2			Level 3			Level 4		
	<i>B</i>	<i>SE(B)</i>	$\beta$	<i>B</i>	<i>SE(B)</i>	$\beta$	<i>B</i>	<i>SE(B)</i>	$\beta$	<i>B</i>	<i>SE(B)</i>	$\beta$
Time Discounting	.353	.148	.152*	.344	.149	.148	.160	.144	.069	.056	.148	.024
Race				.017	.052	.021	-.008	.050	-.010	-.004	.049	-.005
Sex				-.079	.046	-.109	-.087	.044	-.121*	-.065	.044	-.090
Age				.003	.002	.069	.001	.002	.039	.000	.002	.005
Education							.121	.022	.343**	.114	.022	.322**
Financial Literacy										.054	.021	.167**
$R^2$		.023			.038			.148			.171	
<i>F</i> for change in $R^2$		5.72*			1.24			30.80**			6.54**	

*Note:* Income was log-transformed, and Education was standardized. Race assumes a value of "1" if non-white, and Sex assumes a value of "1" if the participant was female. \* $p < .05$ . \*\* $p < .01$ .



*Figure 5.* Participants' Income as a function of their intertemporal choice. Those least willing to delay payouts (1<sup>st</sup> quartile in time discounting) had significantly lower income, relative to those most willing to delay future payouts (4<sup>th</sup> quartile in time discounting). The graph depicts raw income as well as predicted income from the hierarchical regression model including financial literacy and controlling for race, sex, age, and education. Error bars represent standard errors.

### **Time Discounting and FICO**

Participants' average time discounting across the three time periods and FICO scores were significantly correlated, Spearman's  $\rho = .242$ ,  $p < .005$  (Figure 1), similar to earlier reports (Meier & Sprenger, 2012). We separately examined the relationship between immediacy bias ( $\beta$ ) and FICO, and the deliberative discount factor ( $\delta$ ) and FICO. As was the case with income, the data revealed that immediacy bias ( $\beta$ ) did not predict creditworthiness,  $\rho = .131$ ,  $p = .137$ , but neither did the deliberative discount factor ( $\delta$ ) did,  $\rho = .051$ ,  $p < .564$ , unlike earlier reports (Meier & Sprenger, 2012) showing that the relationship between time discounting and creditworthiness may be driven by people's discounting preferences across a wider range of time periods. For a complete correlation matrix showing all variables of interest in the current investigation, refer to Figure 1.

### ***Mediation Model for Creditworthiness***

Mediation analyses were conducted to test the hypothesis that education, and especially knowledge of financial constructs, as measured by the Financial Literacy scale (Lusardi, 2008), mediate the impact of time discounting on creditworthiness (Figure 6). Results revealed that time discounting was a significant predictor of both education,  $B = 1.87$ ,  $SE(B) = .54$ ,  $p < .0008$ , and financial literacy  $B = 2.38$ ,  $SE(B) = .54$ ,  $p < .0001$ . The model also shows that financial literacy predicts creditworthiness,  $B = 28.07$ ,  $SE(B) = 7.78$ ,  $p < .0004$ , 95% CI = 12.68, 43.45, but general education does not,  $B = 12.73$ ,  $SE(B) = 7.68$ ,  $p = .1001$ . Whereas the direct effect of time discounting on FICO is significant,  $B = 165.5$ ,  $SE(B) = 50.4$ ,  $p < .0013$ , its indirect effect fails to reach conventional levels of statistical significance,  $B = 74.74$ ,  $SE(B) = 52.98$ ,  $p < .1608$ .

The indirect effect of time discounting on FICO via financial literacy was significant,  $B = 66.88$ , Boot  $SE(B) = 29.91$ , 95% CI = 24.92, 150.85; whereas, the indirect effect of time

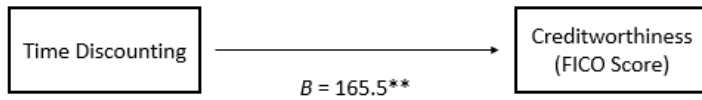


discounting on FICO via education failed to reach conventional levels of statistical significance,  $B = 23.88$ ,  $\text{Boot SE}(B) = 14.55$ ,  $95\% \text{ CI} = -1.27, 58.21$ . (Refer to Figure 6 for a structural representation of the mediation model).

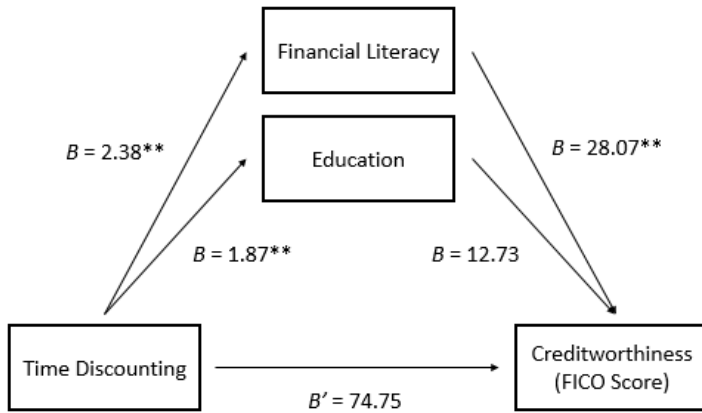
An identical model, but with financial literacy as a single mediator, showed identical results such that in the full mediation model, financial literacy was a significant predictor of FICO,  $B = 28.74$ ,  $\text{SE}(B) = 7.82$ ,  $p < .0003$ , and the indirect effect of time discounting on FICO via financial literacy was also significant,  $B = 68.50$ ,  $\text{Boot SE}(B) = 29.00$ ,  $95\% \text{ CI} = 27.52, 149.00$ . However, the indirect effect of time discounting on FICO failed to reach conventional levels of statistical significance,  $B = 97.00$ ,  $\text{SE}(B) = 51.60$ ,  $p < .0624$ , therefore further highlighting the mediating role of financial literacy in the relationship between time discounting and creditworthiness (Refer to Figure 7 for a graphical representation to the mediation model, and Figure 8 for a scatter plot of FICO scores along financial literacy and time discounting).

Switching the model around to test whether time discounting also mediates the relationship between financial literacy and creditworthiness did not yield significant results,  $B = 5.30$ ,  $\text{Boot SE}(B) = 3.53$ ,  $95\% \text{ CI} = -.3205, 14.41$ . Therefore the current data strongly suggest that while time discounting predicts creditworthiness, it only does so via finance-specific knowledge, but not via general education. Given that financial literacy alone fully mediates the relationship between time discounting and participants' FICO scores in the current model there are grounds to argue that valuing future goods may cause one to invest in acquiring finance-specific knowledge, which in turn is associated with greater creditworthiness.

## a) Direct Path



## b) Mediated Path



*Figure 6.* Mediation model showing the direct effect of time discounting on creditworthiness (a), and the indirect effect of time discounting on creditworthiness, as mediated by financial literacy, but not general education (b). Unstandardized regression coefficients are shown. (\* $p < .05$ . \*\* $p < .01$ .)

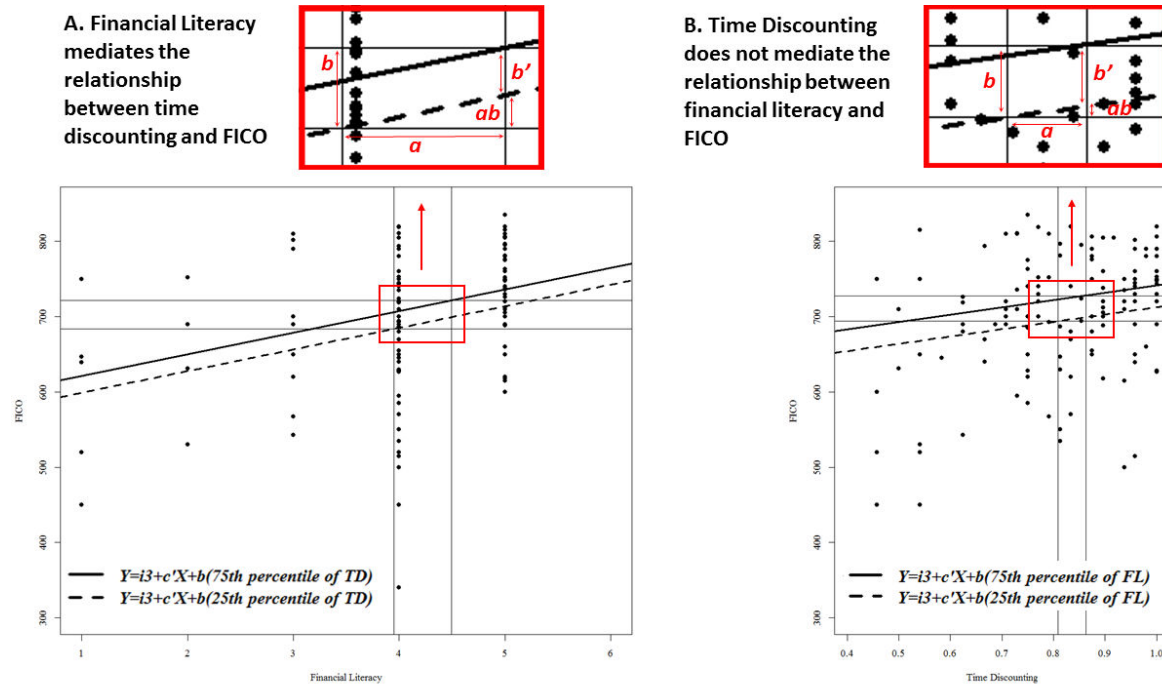


Figure 7. A graphical representation of financial literacy mediating the relationship between time discounting and creditworthiness. Focusing on panel A  $b$  represents the amount of change in creditworthiness, given a one unit change in time discounting; whereas,  $a$  represents the predicted amount of change in financial literacy, given a one unit change in time discounting. The slope of the simple regression lines illustrates the predicted change in FICO for a one unit change in financial literacy, adjusted for time discounting. The solid line represents the fourth quartile (indicating greater preference for later larger payouts) of time discounting, whereas the dotted line represents the first quartile of time discounting (indicating greater preference for sooner smaller payouts). The graph demonstrates that upon inclusion of financial literacy as a mediator in the relationship between time discounting and creditworthiness, the indirect effect of time discounting,  $b'$ , has decreased in magnitude, and failed to reach conventional levels of statistical significance, in favor of the significant mediating effect of financial literacy,  $ab$ . An inspection of panel B, where time discounting was entered as the mediating variable in the model, and financial literacy was treated as the independent variable, failed to produce a mediating effect, as expected, and the graph reveals almost no decrease in magnitude from  $b$  to  $b'$ , representing the direct and indirect effects respectively.

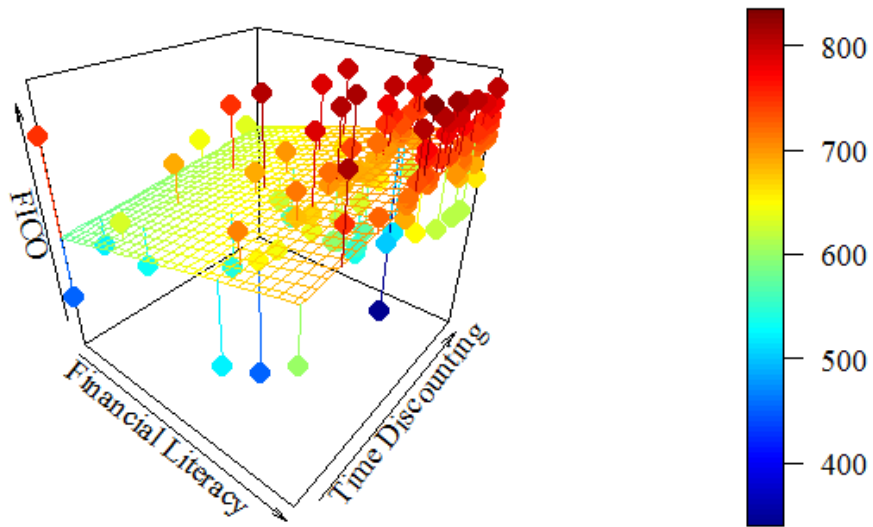
*Hierarchical model for Creditworthiness*

Hierarchical linear regression analyses (Refer to Table 2 for coefficients and summary statistics) were performed to examine how much of the variability in FICO scores could be specifically attributed to time discounting and financial literacy, while controlling for potential and known correlates of FICO scores (income, education, age, gender, race). Regressing FICO on participants' individual discount factor yielded a significant overall regression ( $R^2 = .08$ ,  $p = .001$ ), and time discounting was a significant predictor of FICO scores ( $B = 165.5$ ,  $SE(B) = 50.4$ ,  $p = .0013$ ). Adding income, education, age, gender, race in level two of the current model also resulted in significant increase in explained variance (overall  $R^2 = .161$ ,  $p = .001$ ;  $R^2$  change =  $.084$ ,  $p = .034$ ), where time discounting was the only significant predictor of FICO,  $B = 114.04$ ,  $SE(B) = 51.93$ ,  $p = .030$ , and income was marginally predictive,  $B = 50.64$ ,  $SE(B) = 25.99$ ,  $p = .054$ . Including participants' financial literacy scores in level 3 of the hierarchical regression yielded a significant increase in explained variance (overall  $R^2 = .229$ ,  $p = .000$ ;  $R^2$  change =  $.067$ ,  $p = .001$ ), where greater financial literacy was associated with increased creditworthiness ( $B = 26.72$ ,  $SE(B) = 8.17$ ,  $p = .001$ ), and so was income ( $B = 55.22$ ,  $SE(B) = 25.07$ ,  $p = .029$ ), whereas none of the coefficients of the remaining predictors in the third level of the regression reached conventional levels of statistical significance, including time discounting  $B = 60.65$ ,  $SE(B) = 52.61$ ,  $p = .251$ . (See Figure 9 for a comparison between the raw FICO scores and the predicted FICO scores from the third level of the hierarchical regression.)

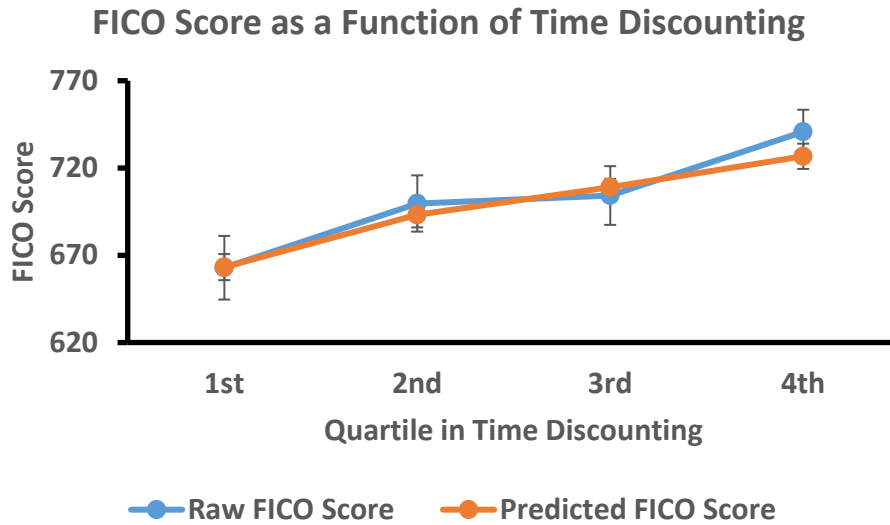
**Table 2**  
*Summary of Hierarchical Regression Analysis for Variables Predicting FICO (N = 131)*

Variable	Level 1			Level 2			Level 3			Level 4		
	<i>B</i>	<i>SE(B)</i>	$\beta$	<i>B</i>	<i>SE(B)</i>	$\beta$	<i>B</i>	<i>SE(B)</i>	$\beta$	<i>B</i>	<i>SE(B)</i>	$\beta$
Time Discounting	165.51	50.41	.278*	131.94	50.39	.221	114.04	51.92	.191	60.65	52.61	.102
Race				-16.71	18.16	-.077	-24.16	18.85	-.111	-22.62	18.16	-.104
Sex				-26.08	14.77	-.150	-27.85	14.77	-.160	-13.90	14.85	-.080
Age				.524	.740	.060	.662	.744	.075	.063	.740	.007
Income				64.50	24.14	.226**	50.64	25.99	.177	55.22	25.07	.194*
Education							12.63	8.98	.138	9.268	8.71	.101
Financial Literacy										26.72	8.17	.296**
$R^2$		.077			.148			.161			.229	
<i>F</i> for change in $R^2$		10.78**			2.60*			1.98			10.69**	

*Note:* Income was log-transformed, and Education was standardized. Race assumes a value of "1" if non-white, and Sex assumes a value of "1" if the participant was female. \* $p < .05$ . \*\* $p < .01$ .



*Figure 8.* A scatter plot for FICO scores, including a regression plane for the same variable when predicted by financial literacy, and time discounting. Participants with higher FICO scores tended to score high on the financial literacy scale, and were most willing to delay future payouts. Financial literacy fully mediates the relationship between time discounting and creditworthiness.



*Figure 9.* Participants' FICO scores as a function of their intertemporal choice. Those least willing to delay payouts (1<sup>st</sup> quartile in time discounting) had significantly lower FICO scores, relative to those most willing to delay future payouts (4<sup>th</sup> quartile in time discounting). The graph depicts raw FICO scores as well as predicted FICO scores from the hierarchical regression model including financial literacy and controlling for race, sex, age, income, and education. Error bars represent standard errors.

***Canonical Correlation Results***

In order to examine the relationship between our two dependent measures (income and FICO) and our predictor variables (i.e., Temporal Discounting, Education, Financial Literacy, Race, Age, and Sex), a canonical correlation analysis was conducted. The canonical correlation analysis revealed two latent variables (LVs), of which only the first was statistically significant,  $F_{(12, 164)} = 3.0885$ ,  $R^2 = 0.37257$ ,  $p < .0005$ , and second LV,  $F_{(5, 83)} = .6070$ ,  $R^2 = 0.08958$ ,  $p = .187$ . Inspection of Figure 10 shows that income and creditworthiness are highly correlated ( $r = 0.61$ ,  $R^2 = 0.37257$ ) with time discounting, education, and financial literacy. Therefore, the data shows that individuals who are more likely to discount future value in the present (smaller numbers indicate greater degree of time discounting), who have completed fewer years of formal schooling, and who have acquired only limited finance-specific knowledge tend to have poorer economic outcomes – namely lower incomes as well as lower FICO scores.



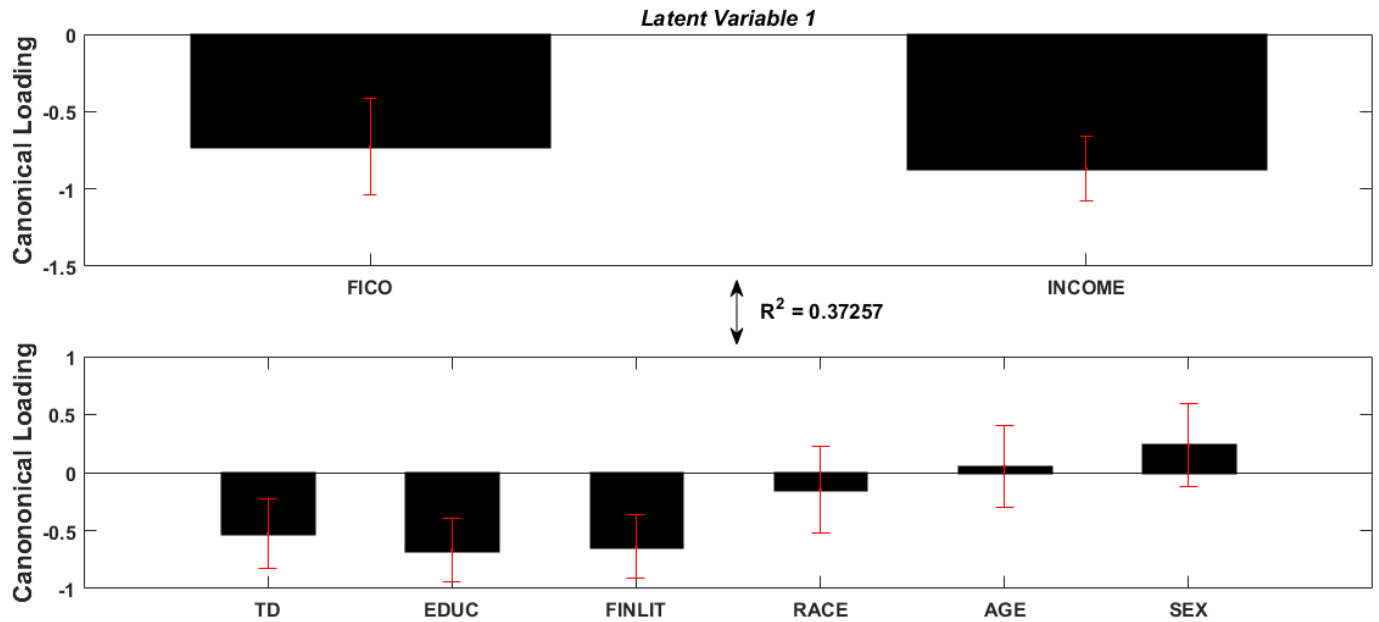


Figure 10. Pair of linear composites for the canonical correlation analysis;  $F_{(12, 164)} = 3.0885$ ,  $R^2 = 0.37257$ ,  $p < .0005$ . The bars on this graph depict the magnitude of each variable's correlation, or canonical loading, with the first set of weighted canonical scores. The top panel contains participants' economic outcomes (creditworthiness, income) and the bottom panel contains the predictor variables (time discounting, general education, financial literacy, race, age, and sex).

### Discussion

The current report shows that financial literacy and general education fully mediate the relationship between time discounting and income, and that financial literacy alone fully mediates the relationship between time discounting and creditworthiness. Being less likely to discount the present value of future goods was associated with possessing greater financial knowledge which in turn was associated with an increase in creditworthiness, as indicated by greater FICO scores. Furthermore, after including financial literacy in the hierarchical model, time discounting was no longer a significant predictor of income or creditworthiness, thus demonstrating that variability in financial literacy uniquely predicts variability in these variables beyond that explained by variation time discounting. In the case of predicting income, a hierarchical regression model with four levels illustrated three important points. First, even after adding known correlates of income (race, sex, age) time discounting remains the only significant predictor of income. Second, adding general education in the third level of the hierarchical model resulted in a non-significant coefficient for time discounting, where education was the strongest predictor of income, with the sex variable indicating that females earn less. Third, after adding financial literacy in the fourth level of the hierarchical model time discounting remained non-significant, and only education and financial literacy remained significant predictors of income, where demographic variables did not seem to exert statistically significant influence, illustrating that variability in general education and financial literacy uniquely predict variability in income beyond known correlates of the construct.

In the case of predicting creditworthiness, a hierarchical regression model with four levels illustrated two important points. First, even after adding known correlates of creditworthiness (race, sex, age, income, and education) time discounting remains the only

significant predictor of the outcome variable. Second, adding financial literacy in the fourth level of the hierarchical model resulted in a non-significant coefficient for time discounting, illustrating that variability in financial literacy uniquely predicts variability in FICO scores beyond known correlates of the construct. The significant income predictor in the fourth level of the model likely reflects the fact that individuals with greater income are seen as more creditworthy by the credit rating agencies.

Our analyses paint an interesting picture for the role of general education attainment in predicting financial performance. Not surprisingly greater education and having more finance specific knowledge (e.g. measured financial literacy) are associated with greater income; however, even though education is positively correlated with financial literacy, time discounting, and creditworthiness, only financial literacy mediated the relationship between time discounting and creditworthiness. Taken altogether these data suggest that both higher education and having more finance-specific knowledge are linked to better incomes, but importantly only greater understanding of how asset and credit markets work is linked to greater creditworthiness.

Tying the findings together, the multivariate analyses confirm that both income and creditworthiness hinge upon people's stable time discounting preferences, time spent in formal education, and their financial literacy, where demographic predictors of these constructs failed to reach statistical significance.

It is important to note that we are not refuting the significant role that temporal valuation plays in financial decision-making. Rather we hope our data illustrates that achieving financial literacy is a complex and multiply-determined phenomenon. It is unlikely that the inability to resist temptation, however stable a trait it can be, solely determines people's creditworthiness. Given that financial literacy mediates the relationship between time discounting and

creditworthiness, but time discounting does not mediate the relationship between financial literacy and creditworthiness we have reason to believe that financial literacy plays a more proximal role in creditworthiness. Importantly, time discounting represents a crucial building block for both (financial literacy and creditworthiness). The relationships between time discounting, health promoting behaviors, and, most importantly for the subject of this investigation, scholastic achievement (Chabris, Laibson, Morris, Schuldt, & Taubinsky, 2008; Chapman, 1996; Eigsti et al., 2006; Frederick, Loewenstein, & O'Donoghue, 2002; Kirby & Herrnstein, 1995; Kirby, Petry, & Bickel, 1999; Mischel, Shoda, & Rodriguez, 1989) have already been concretely established. Therefore it is conceivable that valuing future goods may nudge one to seek and engage in financial training or education as one sees the long run value of such activity, whereas those who discount the present value of future goods, may be less likely to see the long run benefit in financial education and thus either not enroll in it, or not benefit as much from it. An improved financial knowledge in turn allows consumers to be more competent banking clients and thus avoid repayment delays, defaulting, and possibly bankruptcy altogether.

A recent meta-analysis of a number of financial literacy studies shows that greater effect sizes are observed when the construct is only measured, rather than manipulated (Fernandes, Lynch, & Netemeyer, 2014). These findings suggest that the building of financial expertise is an intrinsically motivated process that likely develops over a long period of time (and therefore is difficult to manipulate experimentally), is multiply determined, and is influenced by people's temporal valuation of future rewards. If this is indeed the case, acquired financial literacy that truly translates into prudent financial behaviors may not be something that can be improved by the teaching of finance alone, especially if this teaching is comprised of a single-trial intervention. Examining the effects of time discounting, education, and financial literacy on

financial performance in isolation is less conducive to the development of effective interventions than investigating how one's finance-specific knowledge is developed through broader factors, such as general education or variables that assess people's stable valuation preferences, when predicating financial outcomes. In doing so, interventions geared to improve individual financial performance can be tailored to educate specific segments of the population in ways that will be uniquely suited to them.

The challenges of consistently linking financial savviness to creditworthiness (Adams & Rau, 2011; Collins & O'Rourke, 2010; Fernandes, Lynch, & Netemeyer, 2014; Hastings et al., 2013; Hira, 2010; Thaler & Sunstein 2008; Willis, 2009) may also be due to the fact that we are not necessarily optimally assessing financial literacy. Being aware of financial concepts and how financial instruments and markets function, which is what financial literacy entails, does not necessarily mean that one knows how to use these financial instruments, or how one can use them well. Mere financial expertise does not necessarily translate into prudent banking practices. For instance, many people understand what a stock mutual fund is, and how it works, but they may not know the concrete steps they need to make in order to invest into one. Therefore future research ought to investigate not only how aware of financial constructs individuals are, but also how individuals utilize assets, credits, financial markets, and in particular banking institutions and AFS providers for their saving and investment needs.

Our results suggest that the first step to improving incomes and creditworthiness involve improving temporal discounting performance. Once interventions are developed to help individuals value future goods, then individuals will benefit from education, both general and financially specific education. This means that pushing financial education on individuals before

they value future goods, may not have positive effects on income and creditworthiness that one would anticipate.

As individuals across most of the world live longer, and are persistently faced with decreasing incomes understanding how financial decisions and banking practices affect them becomes exceedingly critical. Focusing on identifying the benefit of time discounting, general education, financial literacy, and concrete banking strategies, will allow us to better understand what consumer banking competence represents, how it can be measured, and how it can help predict creditworthiness with the ultimate goal of reducing defaulting on loans, and consequently bankruptcies.

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