International Journal of
Financial Studies

MDPI

Article

Financial Literacy and Credit Card Payoff Behaviors: Using Generalized Ordered Logit and Partial Proportional Odds Models to Measure American Credit Card Holders' Likelihood of Repaying Their Credit Cards

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Abstract: According to the Federal Reserve of the United States, in the second quarter of 2024, American credit card debt reached USD 1.14 trillion, the highest balance ever recorded. In an age of high-interest, complex credit cards, how does financial literacy affect credit card debt repayment? Also, how could financial literacy and education stop the rise in credit card debt in America? To answer these questions, we use microdata from the latest wave of the Survey of Consumer Finances for 2022. We aim to capture the likelihood of credit card repayment behaviors related to the monthly balances owed by 3865 credit card holders. We consider three categories of self-reported credit card payoff behavior: hardly ever, sometimes, and always or almost always. Given the ordinal nature of our outcome variable, we perform a series of likelihood-ratio and Brant tests to assess the assumption of the proportionality of odds across response categories. Following the failure of the tests, we conclude with the selection of a generalized ordered logit/partial proportional odds model that allows us to relax the parallel lines constraint for those variables for which it is not justified. In our logistic regressions, we account for a comprehensive set of demographic characteristics, and from our results, we highlight the following: For credit card holders with low financial literacy, we find that the odds of moving to a higher category of payoff behavior are 21% and significantly lower than those of high financial literacy respondents. Further, for college-educated card holders, the odds of paying off always or almost always versus sometimes and hardly ever are 2.49 times and significantly greater than the odds for credit card holders without a college education. Credit card holders who are minority group members, female, under 45, have dependents, or earn less than USD 50,000 demonstrate a tendency for poor credit card payoff behavior. In our conclusion, we discuss how to improve credit card repayments. We stress the importance of monitoring people closely. We also aim to provide better financial advice to certain groups. Lastly, we present a more realistic approach to building and sustaining financial literacy.

Keywords: financial literacy; financial decision-making; credit card repayment; household finances; ordinal data; generalized ordered logit model; partial proportional odds model

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Received: 11 November 2024
Revised: 27 January 2025
Accepted: 30 January 2025
Published: 5 February 2025

Citation: Giannikos, C. I., & Korkou, E. D. (2025). Financial Literacy and Credit Card Payoff Behaviors: Using Generalized Ordered Logit and Partial Proportional Odds Models to Measure American Credit Card Holders' Likelihood of Repaying Their Credit Cards. *International Journal of Financial Studies*, *13*(1), 22. https://doi.org/10.3390/ijfs13010022

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1. Introduction

We study credit cards, and we explore the credit card debt payoff behaviors of American credit card holders. We stress that American credit card debt has been staggering.

According to the Federal Reserve (FED) of the United States (U.S.), in the second quarter of 2024, American credit card debt reached USD 1.14 trillion, the highest balance ever recorded (FED, 2024). So, we must study and improve credit card holders' repayment behaviors. This is urgent to help curb rising credit card debt.

1.1. Background

Credit cards, by design, aim at facilitating transactions operating as a substitute for cash or a check, providing a line of credit while offering fraud protection. When holders pay their balances, credit cards serve their purpose. They also boost credit scores. Plus, they offer rewards like miles, points, or cash back on purchases. Unfortunately, at the same time, some of the credit cards' unique design characteristics (e.g., the low required minimum payments or the possibility to carry a balance from month to month that holders can pay over time) often lead credit card holders to make suboptimal decisions.

Credit card users often underestimate their debt and obligations. They are also tempted to overspend and frequently carry balances that pay punishing interest rates. Several more paradoxical consumers' repayment behaviors have been recorded. For instance, Ricaldi et al. (2022) used the credit card debt puzzle to describe inefficient behavior in households. They have enough liquid assets to pay off their credit card debt, but they choose not to.

About American credit card holders, who are the focus of our own research, and the patterns of their repayment behaviors, we share the following. According to the FED report about the economic well-being of U.S. households in 2023, "eighty-two percent of U.S. adults had a credit card" and they were "evenly split between the people who paid off their balances in each of the previous 12 months and people who carried balances from month to month at least once in the prior year". (FED, 2023, p. 40). The widespread use of American credit cards, and credit card holders' debt, offers a rich ground for researchers. They can investigate the soundness of consumers' financial decisions.

1.2. Research Gap

The literature cites several factors that affect credit card debt payoff decisions. The factors include respondents' income, education, gender, race, and family size. They also include behavioral factors, like precautionary savings motives, inertia, and a lack of self-control. In our own paper, we emphasize the role of the factor of financial literacy.

The literature presents many definitions and measures of financial literacy. For instance, according to Remund (2010, p. 284), "financial literacy is a measure of the degree to which one understands key financial concepts and possesses the ability and confidence to manage personal finances through appropriate short-term decision-making and sound, long-range financial planning, while mindful of life events and changing economic conditions".

From their own point of view, Lusardi and Mitchell (2014, p. 6) determined financial literacy as "people's ability to process economic information and make informed decisions about financial planning, wealth accumulation, debt, and pensions". Interestingly, for the purposes of our paper, Lusardi and Tufano (2015, p. 333) also referred to "debt literacy" as a component of financial literacy that measures knowledge about debt and "the ability to make simple decisions regarding debt, applying basic knowledge about interest compounding to everyday financial choices".

We want to stress that financial literacy is popular. Many studies on financial decision-making mention it. However, few studies exist on financial literacy and credit card repayment behaviors. In the Literature Review section of our work, we review several exemplary works. But we suggest that there is room for more work. Furthermore, with our own work, we aspire that by employing the latest U.S. data, we provide important updated

measurements for American credit card holders. Also, we offer insights to help deter a rise in American credit card debt.

1.3. Objectives

To assess the effect of financial literacy on credit card repayment behaviors, we use U.S. microdata from the Survey of Consumer Finances (SCF) and its latest 2022 wave. We note that starting from 2016, levels of financial literacy were added to the SCF, with the inclusion of the three Lusardi and Mitchell (2011) standard questions. These questions cover inflation, interest rates, and risk diversification. They could help build an objective financial literacy index. At the same time, SCF offers a rich set of questions. They capture respondents' views on credit, their credit card application intentions, and existing card balances. They also cover the ability to carry balances, pay them off over time, and the available and remaining credit.

For the purposes of our research, we focus on the SCF question that captures respondents' self-reported credit card repayment behavior. Moreover, besides financial literacy, we also account for respondents' gender, education, race, and age. We also consider their income and if they have financial dependents. We stress that, due to the nature of the responses to the credit card payoff question, we use generalized ordered logit and partial proportional odds models, followed by robustness and diagnostic tests. We aim to measure how financial literacy affects credit card repayment. We will also check if this effect holds after accounting for other factors. We also want to know, using our results and the latest research, how to best build and sustain financial literacy to lead to healthy credit card repayment habits.

1.4. Contributions

The present century is the era of financial reforms with the inclusion of newer and more complex financial products in the markets. In our work, we study credit cards, which are widely available as a financial product, but they also have considerable interest rates and complex terms for consumers. Thus, it is first in this context that we deem our study to be very relevant and timely.

In finance and economics, the concepts of financial literacy and illiteracy and their effects on decision-making are popular but not easily quantifiable. We aim to help quantify how financial literacy affects major financial decisions, like credit card debt repayment.

Lastly, due to the rise in U.S. credit card debt, we believe our work offers timely, relevant findings. These support the need for financial literacy in making good decisions, especially in repaying credit card debt. We hope our work helps readers, educators, policymakers, and financial advisers. Finally, we offer some suggestions about how to best achieve financial literacy and how to make the most of financial literacy measures and tools. We also urge better monitoring of credit card holders in specific groups.

1.5. The Structure of the Paper

The structure of the paper is as follows. In Section 2, we review the literature on financial literacy. We focus on its role in financial decisions, especially credit card repayment behaviors. Here, we present evidence from both developed and developing countries. In Section 3, we present the research database and our methods. We explain the need for using generalized ordered logit and partial proportional odds models to predict credit card repayment likelihood. In Section 4, we present our findings from univariate and multivariate generalized ordered logistic regressions. In Section 5, we conclude by highlighting our findings. They suggest policies to improve financial advice and monitoring for some credit card users. They also aim to boost and sustain financial literacy. We highlight the limitations of our research, and we delineate some future directions for our work.

2. Financial Literacy and Financial Behaviors in the Literature

Financial literacy has been highlighted in the literature as a key input for sound financial behavior. The lack of financial literacy has been linked to poor decisions in many financial areas. These include retirement savings, investment choices, mortgage selection, refinancing, and credit card debt. Our paper also covers the last issue. This literature review has three parts. First, we document evidence of the benefits of financial literacy on important financial decisions. Next, we cover findings about the harm of financial illiteracy on debt-related decisions. Finally, we focus on studies about financial literacy and credit card use. In our coverage, we share research findings from the United States and from around the world.

About the positive effect of financial literacy on crucial financial decisions, we first refer to Lusardi and Mitchell (2011); the authors used data from the 2004 Health and Retirement Survey and reported that financial literacy was a strong predictor of retirement planning and wealth. Hastings and Mitchell (2020) used experimental evidence from Chile and showed that financial literacy was correlated with accumulated retirement savings. Van Rooij et al. (2011) found that those with high literacy were more likely to invest in stocks and thus earned higher returns on their investments. Cupák et al. (2020) controlled for an elaborate set of covariates including risk aversion, and they reported that financial literacy was positively related to investment in risky assets as well as debt securities. They also found that the relevance of financial literacy varied considerably with the distribution of wealth as well as across several socio-economic dimensions. There is also more evidence about the positive impact of financial literacy from the recent COVID-19 pandemic. For instance, Clark et al. (2021) studied the early days of the COVID-19 pandemic and reported that the more financially literate respondents were better able to absorb financial setbacks associated with the virus. According to the authors, self-reported financial fragility was inversely related to financial literacy, while the authors concluded that financial knowledge could provide some extra protection during a pandemic.

About the negative effect of financial illiteracy on financial decisions, Lusardi and Tufano (2015) provided evidence that individuals with lower levels of debt literacy tended to transact in high-cost manners, incurring higher fees and using high-cost borrowing. Further, debt illiteracy was particularly severe among women, the elderly, minorities, and those who were divorced or separated. Gathergood and Weber (2017) studied UK data, and they reported that poor financial literacy might lead to mistakes in mortgage choices. Lastly, to add one more angle to the discussion, we share Lusardi and Mitchell's (2014, p. 138) commentary that a lack of financial literacy not only makes consumers' economic lives difficult, but "in the longer term, differences in financial literacy also contribute to wealth inequality". For instance, Lusardi et al. (2017) estimated that 30–40 percent of retirement wealth inequality was accounted for by financial knowledge.

About the role of financial literacy on credit card behaviors, which is also the focus of our own article, we first refer to Klapper and Lusardi (2020), who studied financial literacy and financial resilience and provided evidence from all over the world. To measure financial literacy, they used questions that assessed basic knowledge of the fundamental concepts of interest rates, interest compounding, inflation, and risk diversification. The authors documented that in developed countries, 51% of adults used a credit card, in contrast to only 11% in major emerging economies. Moreover, they recorded that worldwide, only one in three adults were financially literate—that is, they knew at least three out of the four financial concepts, while about credit products, only around half of adults in major emerging countries who used a credit card were financially literate.

Shen (2014) provided a literature review that analyzed consumer rationality and irrationality and financial literacy in the credit card market. Through a thorough review,

the author documented that consumers, as a whole, make a rational decision when they borrow using a credit card and bear the high interest rate; however, consumers make various mistakes in their individual credit card behavior. The author further articulated that financial literacy, affected by cognitive ability, financial knowledge, and financial education, could improve consumers' behavior.

Mottola (2013) used data from the 2009 National Financial Capability Study (NFCS) and explored the relationship among credit card behavior, gender, and financial literacy in a sample of 28,146 U.S. adults aged 18 and older. The author reported evidence that women were more likely to engage in costly credit card behaviors, like incurring late and over-the-limit fees, than men. Nonetheless, after controlling for several demographic variables, including financial literacy and a self-assessment of mathematical ability, the gender-based differences in credit card behaviors were eliminated.

Barboza et al. (2021) explored the role of financial literacy and personal traits such as overspending or lack of self-control on credit card use with the help of a sample of 156 U.S. college students. The authors documented that among personal traits, that of overspending resulted in a lack of payment in full in credit card debt, while this effect dominated any gains derived from financial literacy. Thus, according to the authors, financial literacy appeared to play a marginal role in avoiding month-to-month credit card debt.

Tahir et al. (2020) used a nationally representative data set of Australia and examined the relative strength of the association of financial literacy, attitudes toward balancing spending and savings, and financial satisfaction with credit card debt-taking behavior. The authors found that higher financial literacy was associated with less credit card debt. Yet, when they incorporated the other factors, this relationship was reduced. The authors called for the inclusion in the financial literacy curricula of components that encourage a savings attitude to reduce problematic debt-taking.

Lastly, particularly about some emerging economies, some interesting empirical findings from studies that investigated the relationship between financial literacy and credit card behaviors are as follows. Hamid and Loke (2021) analyzed a sample of 451 credit card users in Malaysia and showed that financial literacy had a positive effect on credit cardholders' decision-making, while socio-economic factors related to education, income, ethnicity, marital status, and number of credit cards held influenced credit card repayment decisions.

Hernández-Mejía et al. (2021) studied the relationship between financial literacy and the use of credit cards in Mexico. The authors used a sample of 2170 people, controlled for a series of sociodemographic variables, and recorded that Mexican cardholders had a higher level of financial literacy than the general population. They further documented that female cardholders had a lower level of financial literacy than male ones; yet, male cardholders were more likely to be part of the group of fee payers.

For the purposes of our own work, we consult all previous works to incorporate a full set of independent variables, besides financial literacy, to explain credit card payoff behaviors. We comment that unavoidably, some of the works were limited by their selected sample size, and/or inability to generalize from the sample to the whole population. At the same time, there are always concerns about the accuracy and objectivity of the selected measure of financial literacy. With our own work, we aspire to construct a robust model relying on an objective index of financial literacy and also account for a concise series of factors. We aim to provide new insights on U.S. credit card payoff behaviors. Using a national sample, we will share the latest measurements based on the most recent data.

3. Materials and Methods

3.1. Data Source

For the purposes of the research, we employed data from the Survey of Consumer Finances (SCF) for 2022 (SCF, 2023). The SCF is a triennial interview survey of a nationally representative sample of U.S. families, sponsored by the Board of Governors of the Federal Reserve System with the cooperation of the U.S. Department of the Treasury. The SCF aims to provide detailed information on the financial characteristics of U.S. households. The survey collects data on families' assets and liabilities, their current and past employment, their pensions, their income, their inheritances, and their consumer attitudes. Data on the demographics of the families are also collected. Below, we share some information about the SCF sample as provided in the SCF codebook (SCF, 2022).

The SCF employs a dual-frame sample incorporating both an area-probability (AP) sample and a special list sample developed from a sample of tax records and obtained under very strict rules governing confidentiality. The AP sample is intended to provide good coverage of characteristics such as home ownership, home mortgages, and credit card debt that are broadly distributed in the population, while the special list sample is designed to disproportionately select families that are likely to be relatively wealthy.

Given that the SCF sample is not an equal-probability design, the descriptive statistics that we report in this paper are sample-weighted. Moreover, in our research, we use data from the first implicate of the public data sets. Lastly, following Cupák et al. (2020, p. 7), in our analysis for all individual-level characteristics, we use the respondent and not the notion of the SCF head. For this decision, we are also driven by Lindamood et al. (2007, p. 198), who comment that the respondent of the SCF is usually the most financially knowledgeable person in the household, so this person may not be the designated head.

Before proceeding with the presentation of the 2022 SCF sample, we wish to account for a possible limitation of our data set. Here, we wish to acknowledge the difficulty encountered not only in the SCF but in all public surveys. Respondents are uneasy in revealing and sharing their families' finances and debt positions.

3.2. The 2022 SCF: Sample Characteristics

The public data set of the 2022 SCF included 4595 households. For our research, we focused on those households that held "a credit card such as Visa, MasterCard, Discover, or American Express card that allowed the holders to carry a balance from month to month that they could pay off over time" (SCF variable x7973 from the codebook (SCF, 2022) set equal to 1). We also accounted for "a company or store-branded credit card that could only be used at the specific merchant labeled on the card" (SCF variable x7974 set equal to 1). Thus, we reduced the sample to 3865 observations. In Table 1, we present some of the characteristics of the 2022 SCF credit card holders' sample.

Table 1. Sample characteristics of 2022 SCF credit card holders.

Characteristic	Percentage
Gender	
Women	40.67%
Men	59.33%
Race	
White (Non-Hispanic)	70.38%
Black (Non-Hispanic)	11.38%
Hispanic	10.12%
Asian	4.57%
Other or Mixed Race	3.55%

Table 1. *Cont.*

Characteristic	Percentage
Education	
Less Than High School	5.54%
High School	21.81%
Some College	26.98%
College	27.01%
Master's	12.88%
Advanced Degree	5.78%
Work	
Self-Employed	9.88%
Employed By Others	58.34%
Retired	24.46%
Unemployed Or Not In Labor Force	7.32%
Financial Dependents	
1	16.45%
2	13.74%
3	5.08%
4 or more	2.71%
No Financial Dependents	62.02%
Income	
Under USD 15,000	3.40%
USD 15,000 to USD 24,999	6.80%
USD 25,000 to USD 34,999	7.67%
USD 35,000 to USD 49,999	13.69%
USD 50,000 to USD 74,999	17.23%
USD 75,000 to USD 99,999	12.99%
USD 100,000 to USD 149,999	17.20%
USD 150,000 to USD 199,999	6.77%
USD 200,000 and over	14.25%

Source: Authors' tabulations, 2022 Survey of Consumer Finances (SCF, 2023). Weighted data.

From Table 1, we observe that the sample was relatively more male-dominated. Further, about race, white credit card holders were more prominent than holders of other races. Regarding education, over 46% of the sample had a college degree. Nineteen percent had a postgraduate education. Most credit card holders were employed, and 38% had at least one financial dependent in their household. Lastly, about income, 38% of credit card holders made more than USD 100,000.

3.2.1. Credit Cards in the 2022 SCF

In Table 2, we summarize some descriptive statistics on credit cards for 2022.

Table 2. Descriptive statistics pertinent to the credit cards of 3865 respondents in the 2022 SCF.

	Mean	Median	Standard Deviation	Min	Max
# of Credit Cards Held	4.11	3	1.59	1	20
Total Balance Still Owed	USD 3169	USD 170	USD 7833	USD 0	USD 139,000
Total Credit Limit	USD 28,891	USD 17,000	USD 38,279	USD 0	USD 15,000,000
Interest Rate Paid	15.39%	17%	8.19%	0%	39%

Source: Authors' computations, 2022 Survey of Consumer Finances (SCF, 2023). Weighted data.

Table 2 shows that, on average, the 2022 SCF respondents had four credit cards. Their average total balance owed after the last payment was USD 3169. Further, the average

total credit limit of the respondents was USD 28,891, and the mean interest rate paid was a little bit more than 15%. Also, the sample had a large standard deviation. It applied to both the total balance owed and the total credit limit. We also saw an unusually high maximum value of USD 1,500,000, which appeared twice in the sample. Lastly, we stress that a considerable 31% of the sample had a zero total balance still owed.

3.2.2. The Credit Card Payoff SCF Question

Next, we turn our focus to the 2022 SCF question (SCF, 2022) that inquires about credit card pay off behavior. The question set up is given below, while in Table 3, we tabulate the responses.

> "Thinking only about Visa, MasterCard, Discover, and American Express cards you can pay off over time, and store cards, do you almost always, sometimes, or hardly ever pay off the total balance owed on the account each month?"

The responses showed that 60% of cardholders always or almost always paid off their accounts each month. In contrast, 22% hardly ever did.

Table 3. Payoff credit card behavior in the 2022 SCF. Tabulation of responses given to the question: "Thinking only about Visa, MasterCard, Discover, and American Express cards you can pay off over time, and store cards, do you almost always, sometimes, or hardly ever pay off the total balance owed on the account each month?".

Response	Percentage
Hardly Ever	22.15%
Sometimes	17.48%
Always or Almost Always	60.37%

Source: Authors' tabulations, 2022 Survey of Consumer Finances (SCF, 2023). Weighted data.

3.3. Variable Definitions

3.3.1. Dependent Variable

We note that the SCF credit card payoff variable with its three possible responses, hardly ever, sometimes, and always or almost always, is an ordinal variable. For the purposes of our analysis, we recoded this trichotomous variable, which we called payoff, as follows: 1 = hardly ever, 2 = sometimes, and 3 = always or almost always.

3.3.2. Independent Variables: Financial Literacy

As we stated, we measure financial literacy using responses to three standard questions from Lusardi and Mitchell (2011) in the SCF. In Appendix A, we show how these financial literacy questions are framed. Table 4 shows how SCF credit card holders responded to these questions.

Table 4 shows that about 49% of 2022 SCF credit card holders answered all three financial literacy questions correctly. Also, 2.4% of respondents could not answer any question correctly. We note that 2022 SCF credit card holders seemed more at ease with inflation and compound interest. But they were less comfortable with risk diversification. In total, 85.27% of respondents answered the inflation question correctly, 79.50% answered the interest rate question correctly, and 66.33% answered the risk diversification question correctly. On the risk diversification question, we had the highest non-response rate. Almost 19% chose "don't know" or refused to answer.

Next, we created a binary variable, low financial literacy, for our research. We coded it as 1 if the respondent answered 0 to 1 of the three financial literacy questions correctly, and 0 otherwise.

Table 4. Financial literacy of credit card holders in the 2022 SCF.

Panel A: Distribution of Responses to Financial Literacy Questions			
	Correct	**Incorrect**	**Don't Know/Refuse**
Risk Question	66.33%	14.90%	18.77%
Interest Rate Question	79.50%	18.00%	2.50%
Inflation Question	85.27%	12.58%	2.15%

Panel B: Joint Probabilities of Answering the Financial Literacy Questions Correctly				
	All 3	**Only 2**	**Only 1**	**No Correct Responses**
Percentage	48.90%	35.67%	13.06%	2.37%

Source: Authors' computations, 2022 Survey of Consumer Finances (SCF, 2023). Weighted data.

3.3.3. Independent Variables: Binary Variables

For the rest of our explanatory variables, we used a series of binary ones, which we describe below. To choose the explanatory variables, we consulted researchers on the same question. This included Allgood and Walstad (2013), Robb (2011), Mottola (2013), and Hamid and Loke (2021). We note that for the variables' descriptions, we followed Mottola (2013, p. 13), and we determined our variables as follows.

Female (coded as 1 if the respondent indicated she was female and 0 otherwise).

College Educated (coded as 1 if the respondent indicated they were a college graduate or had postgraduate education).

Present Dependents (coded as 1 if the respondent indicated that they have at least one financial dependent in the household and 0 otherwise).

Minority (coded as 0 if the respondent indicated that they were white and 1 otherwise).

Income Less Than 50 K (coded as 1 if household income is less than USD 50,000 and 0 otherwise).

Age Less Than 45 (coded as 1 if the respondent's age was less than 45 and 0 otherwise).

We also report that we tested the independent variables for collinearity and found none.

3.4. Statistical Methods

3.4.1. Ordered Logit Model

Given our ordinal outcome variable, we first resorted to ordered logit models. These models assume the same relationship between each pair of outcome groups. This is known as the proportional odds, or parallel regressions, assumption. In our own case, this would mean that the coefficients that describe the relationship between, say, hardly ever versus all higher categories of the response variable are the same as those that describe the relationship between the next lowest category and all higher categories. We stress that we could not know the exact distance between the response values of our payoff variable. But we started by assuming that this holds.

Our tests failed. These included likelihood-ratio tests of proportionality of odds and Brant tests for the parallel regression assumption. They showed that the coefficients differed across regressions. In Table 5, we report all diagnostic test results. We note that the null hypothesis is that there is no difference in the coefficients between the models.

We comment that significant test statistics provide evidence that the parallel regression assumption has been violated. From Table 5, we remark that both tests showed (p-value < 0.05) that there is a violation of the proportional odds assumption. A detailed elaboration of the Brant test further revealed that the parallel regression assumption was violated by the variables "female" and "present dependents".

Table 5. Diagnostic tests of proportionality of odds across response categories.

	Approximate Likelihood-Ratio Test	Brant Test
chi2	17.15	22.73
Prob > chi2	0.0165	0.002

Source: Authors' computations, 2022 Survey of Consumer Finances (SCF, 2023). Weighted data.

3.4.2. Generalized Ordered Logit/Partial Proportional Odds Model

After our tests of proportionality of odds across response categories failed, we concluded with a different approach, which was the generalized ordered logit/partial proportional odds model as described by McCullagh (1980) and Peterson and Harrell (1990).

This alternative model allowed us to overcome our limitations by fitting partial proportional odds models, where the parallel lines constraint was relaxed for those variables for which it was not justified, that is, for the variables "female" and "present dependents". Our diagnostic test results refer to a Wald test of the final model's parallel lines assumption. This returned a chi2 of 5.37 with a *p*-value of 0.3724. The insignificant test statistic indicated that the final model did not violate the proportional odds or parallel lines assumption.

Next, we used Stata/SE 18.0 to run the generalized ordered logistic regressions. We relied on the gologit2 routine (Williams, 2006). For our interpretations, we referred to Williams (2016).

4. Results

4.1. Generalized Ordered Logistic Regressions

Table 6 shows the ordered estimates for two models. Model 1 is a bivariate analysis of how financial literacy affects self-reported credit card payoff behavior. Model 2 is a multivariate analysis. It explains credit card payoff behavior, accounting for factors beyond financial literacy. In Model 2, we did not impose parallel line constraints for the variables "female" and "present dependents". The final models had no violations of the proportional odds assumption. Both the Wald and likelihood-ratio chi-squared tests confirmed this.

Table 6. Generalized ordered logit estimates for credit card payoff behavior: odds ratios and *p*-values in ( ) underneath the coefficients for n = 3865 respondents.

	Model 1 Bivariate Analysis Coefficient	Model 2 Multivariate Analysis Coefficient
Low Financial Literacy	0.44 ***	0.79 **
	(0.000)	(0.014)
Female		
1 vs. 2&3		0.77 ***
		(0.005)
1&2 vs. 3		0.64 ***
		(0.000)
College Educated		2.49 ***
		(0.000)
Present Dependents		
1 vs. 2&3		0.76 **
		(0.004)
1&2 vs. 3		0.65 ***
Minority		0.62 ***
		(0.000)
Income Less Than 50 K		0.62 ***
		(0.000)

Table 6. *Cont.*

	Model 1 Bivariate Analysis Coefficient	Model 2 Multivariate Analysis Coefficient
Age Less Than 45		0.74 ***
		(0.000)
Pseudo R2	0.0125	0.0878
Wald test of proportional odds assumption	chi2(1) = 3.15	chi2(5) = 5.37
	Prob > chi2 = 0.0759	Prob > chi2 = 0.3724

Payoff: 1 = hardly ever; 2 = sometimes; 3 = always or almost always. *** *p*-value less than 0.01, ** *p*-value less than 0.05. Authors' computations, 2022 Survey of Consumer Finances (SCF, 2023).

Next, we proceed with the interpretation of our results. Model 1 indicated that for credit card holders with low financial literacy, the odds of being in payoff category 3 (always or almost always) as opposed to payoff categories 1 (hardly ever) and 2 (sometimes) were only 0.44 times the odds for their counterparts with high financial literacy. Equivalently, for credit card holders with low financial literacy, the odds of moving to a higher category in the payoff outcome variable were 66% [i.e., $(0.44 - 1) \times 100$] lower than those of their high financial literacy counterparts. This effect was statistically significant (p-value = 0.000).

Model 2, which accounted for more factors besides financial literacy, indicated the following. First, for credit card holders with low financial literacy, the odds of always or almost always paying off behavior as opposed to the combined hardly ever and sometimes categories were 0.79 times the odds for their counterparts with high financial literacy, given that all the other variables in the model were held constant. This indicated that for credit card holders with low financial literacy, the odds of moving to a higher category of paying off their balance owed by the end of the month were 21% [i.e., $(0.79 - 1) \times 100$] lower than those of high financial literacy respondents, holding all other variables constant. The decrease was still significant (p-value = 0.014) but numerically lower when compared with the effect of low financial literacy in Model 1.

In Model 2, the coefficients for female were consistently positive and less than one, indicating decreases in odds, which were statistically significant too, but there were differences across cut-off points. For female card holders, the odds of being in category 3 (always or almost always) as opposed to categories 1 (hardly ever) and 2 (sometimes) were 36% [i.e., $(0.64 - 1) \times 100$] lower than the odds of their male counterparts, holding everything else fixed. For female card holders, the odds of being in category 1 (hardly ever) as opposed to categories 2 (sometimes) and 3 (always or almost always) were 23% [i.e., $(0.77 - 1) \times 100$] lower than the odds of their male counterparts, holding everything else fixed.

Similarly, the coefficients for present dependents gave evidence that keeping all other variables constant, the presence of one more financial dependent was expected to lead to a decrease in the odds of moving to a higher category in the payoff variable. Nonetheless, the greatest differences were that those with one more dependent appeared less likely to put themselves in the always or almost always versus the combined sometimes and hardly ever categories [i.e., $(0.65 - 1) \times 100$ or 35% drop in odds] than in the hardly ever versus the combined sometimes and always or almost always categories [i.e., $(0.76 - 1) \times 100$ or 24% drop in odds].

Moreover, in Model 2, being a minority increased the odds of always or almost always credit card payoff behavior (versus the combined sometimes and hardly ever categories of credit card payoff behaviors) by a factor of only 0.62. Equivalently, for minority (non-white) respondents, the odds of being in category 3 (always or almost always) as opposed to

categories 1 (hardly ever) and 2 (sometimes) were 38% [i.e., $(0.62 - 1) \times 100\%$] lower than those of their white counterparts, holding all other factors constant.

Furthermore, in Model 2, having an income less than USD 50,000 increased the odds of being in category 3 (always or almost always) as opposed to categories 1 (hardly ever) and 2 (sometimes) by a factor of only 0.62. Equivalently, for credit card holders with an income less than USD 50,000, the odds of always or almost always payoff behavior versus the combined sometimes and hardly ever categories were 38% [i.e., $(0.62 - 1) \times 100\%$] lower than those of their counterparts with an income greater than USD 50,000, holding all other factors constant. The effect was also statistically significant.

Likewise, in Model 2, having an age less than 45 increased the odds of being in category 3 (always or almost always) as opposed to categories 1 (hardly ever) and 2 (sometimes) by a factor of only 0.72. In other words, for credit card holders with an age less than 45, the odds of always or almost always payoff behavior versus the combined sometimes and hardly ever categories were 28% [i.e., $(0.72 - 1) \times 100\%$] lower than those of their counterparts with an age greater than 45, holding all other factors constant. The effect was also statistically significant (p-value = 0.000).

Lastly, from Model 2, holding all other factors fixed, for college-educated respondents, the odds of paying off always or almost always versus sometimes and hardly ever payoff categories were 2.49 times greater than the odds for credit card holders without a college education. Thus, college education appeared to have an important effect on healthy payoff behavior, in the sense that for college-educated individuals, the odds of being in category 3 (always or almost always) as opposed to categories 1 (hardly ever) and 2 (sometimes) were 149% [i.e., $(2.49 - 1) \times 100\%$] higher than those without a college education. The effect was also statistically significant (p-value = 0.000).

Our results show a 21% drop in healthy credit card repayment due to low financial literacy. College education boosts those odds by 149%. So, we must find ways to improve credit card holders' financial literacy and education. Also, the negative effects on credit card holders being a minority are considerable. Their odds of moving to healthier credit card behavior decreased by 38%. For females, the decrease in odds was 23% to 36%. For those under 45, it was 28%. For those with dependents, it was 24% to 35%. For those with incomes under USD 50,000, it was 38%. These findings may prompt credit card issuers and policymakers to reconsider their approaches. We see how useful credit cards are. Still, we need to watch the repayment habits of all those groups more closely. In the last section, we discuss how to improve financial advice. It should target specific groups. A better way to build and sustain this advice could then ensure healthy repayment behavior.

4.2. Robustness Checks

Before our policy suggestions, we must address an omitted variable. It is about the capacity to repay credit card debt. One might consider that low incomes, minority groups, younger respondents, and respondents with dependents all indicate that they are less likely to fully repay credit cards. After all, these are also the groups that have a lesser capacity to repay due to lower or more unstable incomes. In our own approach, we operated by assuming that the demographics we considered fully encapsulate the ability of the respondents to repay their debt.

We comment that the SCF does not offer a question capturing credit card holders' perception of their financial situation about the repayment of the credit cards. Yet, we proceeded with the following robustness check. The SCF survey has some questions about respondents' ability to pay off other loans. These include loans for property, home improvements, and vehicles. For our own check, we relied on a generic question found in variable x3004 of the 2022 SCF: "Now thinking of all the various loan or mortgage payments

you made during the last year, were all the payments made the way they were scheduled, or were payments on any of the loans sometimes made later or missed?" The possible answers were "All paid as scheduled or ahead of schedule" and "Sometimes got behind or missed payments". Based on the above, we constructed a binary variable for credit card holders, called Repayment Difficulty, which we set equal to 1 for credit card holders stating they were behind in such other loans or having missed payments and 0 otherwise. Next, we repeated the logistic regression, and the coefficient of Repayment Difficulty showed a highly significant effect with a *p*-value of 0.000. Nonetheless, we report that there was no change recorded in the signs and the significance of the rest of our coefficients. So, we used a proxy for debt repayment ability. But we think our model, with the demographics and no credit card debt, could still explain credit card repayment behaviors.

4.3. Predicted Probabilities

In Table 7, we present the predicted probabilities of credit card payoff behavior using Model 1 and Model 2. For the reference subject, we considered a subject with high financial literacy, non-college-educated, with no financial dependents in the household, white (not a minority), identifying as male, with an age greater than 45, and an income greater than USD 50,000.

Table 7. Predicted probabilities of credit card payoff behavior.

	Model 1			**Model 2**		
	P_1	**P_2**	**P_3**	**P_1**	**P_2**	**P_3**
Reference Subject [a]	0.15	0.13	0.72	0.13	0.11	0.76
Low Financial Literacy	0.29	0.19	0.52	0.16	0.12	0.72
Female				0.16	0.16	0.68
College Educated				0.06	0.05	0.89
Present Dependents				0.16	0.16	0.68
Minority				0.19	0.14	0.67
Income Less Than 50 k				0.19	0.14	0.67
Age Less Than 45				0.17	0.13	0.70

[a] Reference Subject: A respondent with high financial literacy, non-college-educated, with no financial dependents in the household, white (not a minority), identifying as male, with an age greater than 45, and an income greater than USD 50,000. P_1, P_2, and P_3 are the probabilities of hardly ever, sometimes, and always or almost always, respectively. Authors 'computations, 2022 Survey of Consumer Finances (SCF, 2023).

Indicatively, we comment on the following. In Model 1, low financial literacy seems linked to costly credit card use. Low literacy respondents were 14 percentage points more likely than high literacy ones to report hardly ever as their credit card payoff behavior. Similarly, low financial literacy respondents were 20 percentage points less likely than their high financial literacy counterparts to report always or almost always as their payoff behavior.

In Model 2, the pattern of negative predicted payoff behaviors for credit card holders with low financial literacy is still observed, but the forecasted decreases are lower in numerical value. Low financial literacy credit card holders are nearly 3 percentage points more likely than their high financial literacy counterparts to select hardly ever as their credit card payoff behavior. They are 4 percentage points less likely to select always or almost always as their payoff behavior.

We observe that for most of the other demographics—specifically, being female, being a minority, having a financial dependent, being under 45, and having an income below USD 50,000—all are predicted to increase the odds of reporting a hardly ever payoff behavior, while they all decrease the odds of reporting an always or almost always payoff behavior. In contrast, a college education is expected to reduce the odds of a hardly ever payoff behavior by 7 percentage points. It will also increase the odds of an always or

almost always payoff behavior by 13 percentage points, compared to those without a college education.

5. Conclusions and Policy Discussion

We conclude by summarizing our findings. We suggest that credit card issuers and policymakers closely monitor the repayment patterns of specific groups. We also discuss how to build and sustain financial literacy. Lastly, we wish to delineate possible limitations of our research, as well as future directions of our work.

Thus, we first comment that with the help of generalized ordered logit and partial proportional odds models, we attempted to capture the likelihood of credit card repayments by performing both univariate and multivariate analyses. In the multivariate models, we accounted for a series of factors besides financial literacy, controlling for the gender, education, race, and age of the respondent, as well as the respondent's income and the presence of financial dependents in the household. Our findings recorded that individuals with low financial literacy had significantly lower odds of moving to a higher category of payoff behavior. The same applied when respondents identified as female, being a minority, or had dependents. It also applied if their income was under USD 50,000 or they were under 45. In contrast, a college education was linked to much higher odds of always or almost always paying off a credit card.

Given the strong and significant negative effects on credit card repayment behaviors in some groups, we urge credit card issuers and policymakers to provide more financial advice and closer monitoring to these groups. We call for better monitoring and more financial advice for minority, female, under-45, and low-income cardholders. We recognize the usefulness of credit cards. So, we do not deter issuers from granting cards to minorities, low-income people, or those with dependents. But we urge increased financial advice and monitoring of repayment behaviors.

Next, we found that low financial literacy relates to costly credit card habits. So, we suggest ways to build financial literacy. In our effort, besides our results, we wish to also evoke and combine the latest research findings. Before anything, we wish to iterate the positive role of financial literacy on sound financial decision-making. As we have also articulated in our own literature review, there is evidence of financial literacy's positive effect on all fronts of investment and financial decisions. Our research found that low financial literacy harms credit card payoff behavior. It significantly decreased the odds of low-literacy card holders to advance to a healthier repayment category, like always or almost always paying off their monthly balance, compared to their high-literacy counterparts.

Given the above, we proceed with espousing the potentially beneficial effect of financial knowledge and financial literacy on individuals' and households' financial decision-making. We must, however, approach carefully the idea of building financial education and literacy. More specifically, we share the idea that education alone is insufficient to instill financial literacy in consumers. Acquisition of financial know-how requires more investment above and beyond a general education. Both the research and market communities agree on the value of financial education. Efforts to build it have ranged from high school financial literacy training to personal finance courses at universities. Nonetheless, it is important to stress that education does not end in the classrooms. Lusardi and Mitchell (2023) pointed to the key role of financial literacy as a type of human capital that people can acquire differentially over time and over the life cycle. Building financial knowledge is a lifelong journey. You can achieve this through workplace financial education and regular training sessions. As Lusardi and Mitchell (2023, p. 149) very poignantly commented, households must become the Chief Financial Officers (CFOs) of their own finances.

On a similar front, many researchers studied the role of behavioral interventions along with financial education in the shaping of sound financial decision-making skills. Heinberg et al. (2014) reported that, after a financial education program, participants' knowledge increased. This knowledge lasted for a while after the program ended. As Lusardi et al. (2020) commented, more research is needed to increase the effectiveness of these programs and reinforce such knowledge at key points over the life cycle. However, the staggering levels of American credit card debt perhaps would justify an increase in such interventions. Lastly, Remund (2010) reviewed the literature. He found that financial literacy includes empowerment and responsibilities. Individuals and households must be accountable for their actions. We deem that this accountability is key and could eventually lead to people's healthier finances.

Regarding possible limitations of our research, we first wish to point to the debatable issue of the right way to measure financial literacy. As Lyons and Kass-Hanna (2021) documented, despite all efforts, "there is still no widely accepted definition or methodological approach for measuring financial literacy". As with all measures, the Lusardi and Mitchell (2011) three-question instrument might also lack accuracy. To overcome any possible limitations, we first suggest that this three-question tool might be used in conjunction with other instruments. Also, we could keep the inflation/compounding questions. We could use the diversification question to measure advanced financial literacy.

Regarding future work, we suggest two areas. First, combine financial literacy measures. Second, study financial literacy patterns over time. The latter could be achieved with the help of panel data. The SCF financial literacy questionnaire was introduced in 2016. There is no panel data component available to study financial literacy over time. Yet, we could potentially achieve this by combining SCF cross-sections and adding year variables along with interactions.

Author Contributions: Conceptualization, C.I.G. and E.D.K.; methodology, C.I.G. and E.D.K.; software, C.I.G. and E.D.K.; validation, C.I.G. and E.D.K.; formal analysis, C.I.G. and E.D.K.; investigation, C.I.G. and E.D.K.; resources, C.I.G. and E.D.K.; data curation, C.I.G. and E.D.K.; writing—original draft preparation, C.I.G. and E.D.K.; writing—review and editing, C.I.G. and E.D.K.; visualization, C.I.G. and E.D.K.; supervision, C.I.G. and E.D.K.; project administration, C.I.G. and E.D.K. All authors have read and agreed to the published version of the manuscript.

Funding: Efstathia D. Korkou acknowledges financial support from the Cycle 53 PSC-CUNY Award, jointly funded by The Professional Staff Congress and The City University of New York.

Informed Consent Statement: Not applicable.

Data Availability Statement: The samples and coding for all derivations are available from the authors.

Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A

Below, we share the three Lusardi and Mitchell (2011) standard financial literacy questions, included in the SCF. We also give the correct answers with two asterisks, while we share that, according to the SCF codebook (SCF, 2022), for the public data set, the answers "don't know" and "refused" were combined.

(1) Do you think that the following statement is true or false: "Buying a single company's stock usually provides a safer return than a stock mutual fund".

True

False**

Don't know/Refused

(2) Suppose you had $100 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow?

More than $102**
Exactly $102
Less than $102
Don't know/Refused

(3) Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account?

More than today
Exactly the same
Less than today**
Don't know/Refused

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